

**Construction of MSME Technology Centre at Jaipur (Rajasthan) under the Scheme “Establishment of New Technology Centre/Extension Centre” on Engineering Design, Procurement and Construction (EPC) basis including Maintenance for 2 years during DLP Period**

(E-Tender No: IRCON/B1100009/MSME/e-Tender/EPC/TC JAIPUR/ET45)



**TECHNICAL SPECIFICATIONS  
(Section – VIII)**

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## **SPECIFICATION FOR DEMOLITION**

### **SECTION - 1**

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1.0 SPECIFICATION FOR DEMOLISHION WORKS.....5

**SECTION – 1 : SPECIFICATION FOR DEMOLITION WORKS****1.0 Specification for Demolition Works**

- 1.1 The term Demolition implies breaking up. This shall consist of demolishing whole or part of work including all relevant items as specified or shown in the drawing.
- 1.2 The term Dismantling implies carefully removing without damage (up or down). This shall consist of dismantling one or more parts of the structure and other structures specified or shown in the drawing.
- 1.3 The tenderer is deemed to have inspected the structures for dismantling /demolition and acquainted himself with their condition. The dismantling /demolition shall be done carefully, without causing any damage to the property of other agencies.
- 1.4 The information furnished is based on the assessment at site and IRCON does not accept any responsibility about its correctness or otherwise. The tenderers are therefore advised to inspect the site of work, acquaint themselves about the conditions prevailing at the site of work and then quote the rates accordingly. No claim whatsoever will be entertained by IRCON if the drawings/ details given along with the tender based on available records with it are not in complete correspondence to the structures, sizes etc., actually available at the site/ encountered during the course of execution of the work or in case the drawings are not provided along with tender document. Demolition works are to be carried out as per scope of work and all the dismantled materials either salvaged or demolished shall be cleared from the site and taken away by the contractor. The contractor shall carry out the work and / or stack the dismantled materials and debris, without causing any hindrance to the day-to-day functions of the adjoining areas and normal activities. The contractor shall at his own cost provide necessary danger signals and sign boards and also demarcate and isolate the working area so as to prevent unauthorized entry into the premises and also ensure safety of persons and property in the vicinity of premises. The contractor shall dispose-off all the building rubbish/malba / similar unserviceable dismantling or waste materials by mechanical means including loading, transporting, unloading, dumping for processing at Recycling Facility.
- 1.5 This document intended to show the position and extent of the Advance Demolition Works but neither they nor the Specifications are guaranteed to show or to describe every part or position of the Works. To enable the Contractor to carry out the Demolition Works, further instructions may be issued from time to time as necessary. The Contractor shall prepare his own drawings for any temporary works required by him. No examination or approval by the IRCON of any drawing or other documents submitted by the Contractor shall relieve the Contractor of any of his responsibilities or liabilities under the contract.
- 1.6 Buildings/structures etc. will be handed over in its existing condition i.e. on "As is Where is" basis. Once the contract is awarded, it is the responsibility of the contractor to take-over the Buildings/structures etc. and protect the salvageable materials by providing suitable watch and ward.

- 1.7 Demolition shall always be planned beforehand. The sequence and method adopted for demolition shall be approved by the IRCON before starting the work.
- 1.8 In addition to his general obligations under the Contract, full and complete notice shall be given by the Contractor of all operations of demolition to be carried out on the Site. Such notice shall be provided in advance for the IRCON to make all necessary arrangements for inspection and checking. Such inspection and checking shall not relieve in any way the obligations to the Contractor under the Contract.
- 1.9 Where the IRCON is required by the specification to give approval to the supply of materials or plant to be used in, or method of demolition of any part of the Works, this notice shall be sufficient to allow time to carry out inspections, checks or test prior to giving such approval and shall also allow time for the Contractor to make any alteration, or provide alternative sources, of supply in the event of IRCON failing to give his approval, or as directed by the IRCON.
- 1.10 Prior to the commencement of any part of the demolition Works, the Contractor shall submit a full and detailed Method of Execution Statement. This shall include details of plant to be used, demolition sequences and temporary loadings applied to permanent works. Details to be provided shall include drawings of any works to be undertaken.
- 1.11 The tenderer shall avoid nuisance to neighbors while carrying out the demolition and shall provide and erect screens of canvas or other suitable materials to minimize the dust nuisance and also provide for watering for this purpose as the demolition work proceeds. The screens shall be removed after completion of work.
- 1.12 Demolition shall be done in a systematic manner. All materials, which are likely to be damaged by dropping from a height or during demolishing the roof, masonry etc. shall be carefully removed first. The demolished articles shall be brought to the ground and stacked properly as directed by the IRCON's representative before being transported outside the Site.
- 1.13 Where fixing was done by nails, bolts, screws, rivets, welding etc., demolition shall be done by taking out the fixing with proper tools and not by tearing or ripping off.
- 1.14 Since the work is to be carried out during the working hours also, extra care must be taken to ensure the safety of the workmen and other people moving in that area.
- 1.15 While working at heights, the contractor shall use non-skid type safety ladders of adequate strength. The contractor should also provide necessary helpers for all the works, which are carried out at heights. Further, the contractor should also provide safety belts to their workers while they are working at heights.
- 1.16 The existing service lines such as electrical, water supply and sewers as well as meters, pumps, if any, yard lighting, compound wall etc., shall be carefully protected and preserved.

- 1.17 Associated equipment (e.g. electrical panels and piped services outlets) is to be removed by the Contractor. Care should be exercised when carrying out excavation, commensurate with normal practice for excavating near existing structures.
- 1.18 Drains, pipes, cables, overhead or underground electric wires, data cables and similar services encountered in the course of the Works shall be guarded from damage by the Contractor at his own cost, so that they may continue in full and uninterrupted use to the satisfaction of the IRCON and the Contractor shall not store materials or otherwise occupy any part of the "Site" in a manner likely to hinder the operation of such services. Should any damage be done by the Contractor on any mains, pipes, cables or lines (whether above or below ground), whether or not shown on the Drawings, the Contractor must make good or bear the cost of making good the same without delay to the satisfaction of IRCON.
- 1.19 If any service lines are damaged during demolition, they shall be made good by the contractor at his expense failing which IRCON will carry out such rectification work and the cost incurred in doing so will be recovered from any money due or becoming due to the contractor.
- 1.20 All demolished materials and debris shall be cleared from the site and the site shall be cleaned and levelled.
- 1.21 The Dismantling/ Demolition of existing structures and carting away of the salvageable materials shall be carried out without hindering the traffic operations in the vicinity or on the roadside of the site. No separate area for stacking salvageable materials / debris will be given and the contractor shall confine such stacking to within the site of demolition works.
- 1.22 All municipal regulations and labour laws should be complied with.
- 1.23 Any treasures, antiques, valuable etc., encountered during the demolition shall be handed over by the contractor to IRCON without being damaged in any manner.
- 1.24 Serviceable/ salvageable materials obtained from the demolition such as reinforcement steel, steel doors, other steel items etc., should be carted out of the site only after obtaining the specific and written approval of the Engineer-in-Charge's representative. Unserviceable materials like brickbats, debris etc., are to be carted out of the site simultaneously with the serviceable / salvageable material.
- 1.25 The contractor shall be solely responsible for any accident, damage or injury caused to any of his employees or IRCON's employees during the execution of the work and shall hold IRCON blameless in all respects thereof and also in respect of any claims made by the person in the employment of the contractor for any reason whatsoever.

1.26 The tenderer would undertake at his own studies and furnish with their bid, a detailed planning methodology supported with required number, type and capacity of each plant/ equipment for completion of work in time.

1.27 All contractors working within shall comply with the following rules and instructions:

- The Contractor should be in possession of a valid license issued from the local labour authorities.
- The Contractor shall ensure that his employees remain at the place of work assigned to them and do not loiter around any other working area. If any such infringement is observed, the employee is liable to be barred from further entry to the site.
- In case the Contractor finds any difficulty in compliance of above Security instructions, he may call on the any other authority as indicated by IRCON for the necessary guidance.
- The Contractor shall provide appropriate safety equipment to all his employees at their respective work locations.
- The Contractor shall comply with any other point which may be conveyed from time to time on the legislations/ directions received from the appropriate government authorities on the subject.

1.28 Sanitary Provisions

The Contractor shall, at all times during the continuance of the Contract, adopt such precautions as may be necessary to prevent soil or water pollution on the Site (including any area occupied by temporary accommodation) and shall compel his employees and labour to use the facilities provided which shall be carefully maintained by the Contractor throughout the currency of the Contract to the satisfaction of IRCON. The contractor shall be required to follow all the rules/norms of National Green Tribunal for Demolition /Dismantling including all the incidental activities leading upto & inclusive of final dumping of malba/debris at recycling plant.



## **TECHNICAL SPECIFICATIONS**

### **STRUCTURE WORK**

#### **SECTION - 2**

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**TECHNICAL SPECIFICATIONS STRUCTURE WORK****1 Preamble**

List of latest edition of relevant Standards & Specifications to be complied with, by the contractor for Design and Execution of this project/work are included in respective specifications of Structure, Architecture, MEP Services.

The list of Standards & Specifications provided hereunder is not exhaustive and any other Standard & Specification including Manual For Standards And Specifications For Railway Stations where applicable, which are not mentioned in this section are also applicable if required for the completion of work as per the Scope of Work, Technical Specifications, & Drawings.

All the Civil, Structural, Electrical work etc. shall be carried out as per latest CPWD specifications. Wherever, the specifications calls for a higher standard of materials & workmanship than those required by any of the CPWD specifications, then the specification as per the codes/specifications given in this section shall prevail.

Only OPC cement of 43/53 grade confirming to IS 8112 & High strength deformed steel bars and wires confirming to IS 1786 shall be used for all civil works.

**FOR STRUCTURAL WORKS**

S. No.		Code Name
a.	<b>DESIGN CODES, STANDARDS AND REFERENCE DOCUMENTS</b>	
1	IS:1893	2016 Criteria for Earthquake resistant design of Structures
2	IS:13920	Ductile detailing of Reinforced Concrete Structures subjected to Seismic forces
3	IS:4326	1993 Earthquake resistant Design and construction of Buildings
4	IS:875-1987 (Part I to III Part V)	Code and Practice for Design Loads (Other than earthquake) for Building and Structures like Dead, Imposed, Wind and other & Loads (Part I to III & Part V)
5	IS:456-2000	Plain and Reinforced Concrete (Code of practice)
6	SP:16	Design aids for Reinforced Concrete Structure
7	SP:34	Handbook on Concrete Reinforcement and Detailing
8	IS:3370 Part I, Part II & IV	Code of practice for Concrete structures for the storage of liquids
9	IS:1786	Specification for High Strength Deformed Steel bars and wires for concrete reinforcement
10	IS: 1904	Code and Practice for design and Construction of Foundations in Soils

S. No.		Code Name
11	IS:2950	Code and Practice for Design and Construction of Raft Foundations
12	IS:800-1980	Code of Practice for general Construction in Steel
	<b>TRANSPORTATION</b>	
1		Geometric Design standards for Urban Roads IRC 86-1983
2		Provision of speed breakers for Control of Vehicular Speeds IRC : 99-1988
3		Code of Practice for Water Bound Macadam IRC : 19-1977
4		Base coats of Bituminous Primer IRC 16-1965
5		Single Coat Bituminous Surface Dressing IRC 17-1965
6		Design of Rigid Pavement IRC-58-2002/Flexible Pavements IRC 37-2001
7		IRC 067 – code of Practice for Road Signs a. Road signaling design and requirements
8		Road Markings IRC 35:1997
9		National Building Code of India a. Parking requirements
10		IRC SP 41 – Turnin radius for heavy vehicles

## 1.2 Scope of Design Work

The Contractor shall carry out the complete design as mentioned in the tender documents and submit all plans to all relevant Authorities and submit the plans to Architectural Consultant for statutory approvals of all building and civil engineering works under the Contract and provide assistance in getting approvals. The Contractor is deemed to have allowed in his tender for all requirements in the tender document.

The design of all Works shall be carried out in compliance with the provision and regulations set out in the National Building Code, and also in compliance with the terms and conditions of the Contract.

The Contractor shall be fully responsible for the design, and supervision of all permanent works, including all Geotechnical Building Works (GBW). He shall engage a Professional Engineer and Specialist Professional Engineer to undertake this work in accordance with statutory requirements.

## 1.3 Design Responsibility and Liability

The Contractor shall be fully responsible for the complete design of all Works for the Contract, including all temporary works.

It is the responsibility of the Contractor to ensure that his design or his Consultant's design does not compromise the design intents of the Client/Consultant, the approved gross floor area, all authorities' compliances and approvals. All M&E services running through any structural elements shall be coordinated to achieve the required headroom and aesthetic considerations. The Contractor

shall fully comply with Client/Consultant/Architect requirements on wall & column locations, wall & column sizes, beam locations, beam sizes, minimum head rooms and ceiling heights etc.

The Contractor shall furnish sufficient details of the design of the Works including plans, specifications, assumptions, calculations, statement of method of construction and any other relevant information on the works to the Client / IRCON for circulation. The proposals are then to be cleared by the Client/ IRCON/Consultant and all the other relevant government authorities before commencement of works. All concurrence letters from the relevant authorities shall be forwarded to the Client / IRCON for record and all standard submission process and procedures shall apply.

Acceptance by the Client / IRCON of the Contractor's tender proposal and subsequent design, including any revisions, shall in no way relieve the Contractor of his entire responsibility for the adequacy and practicality of his design, fitness for the functional requirement and compliance with Authorities' requirements. All costs for any remedial work, be it temporary or permanent, that are ordered by the Client / IRCON as a consequence of the failure for the works, to satisfy the above-said requirements at any time in the Contractor's design, shall be borne by the Contractor.

#### **1.4 Technical Specifications for Construction**

The Contractor shall be responsible for the preparation of the complete set of Technical Specifications for the execution of works. The Contractor shall refer to Technical Specifications for Civil & Structural Works, which shall be the minimum requirement and he shall comply with these.

The Contractor shall ensure that the quality and workmanship of the works under the Contract shall not fall below the technical specifications. The Contractor shall be allowed to propose standards higher than but not below Client/Consultant current requirements.

The Technical Specifications for Construction, proposed by the Contractor, shall include proper work methods, materials to be used, material testing requirement and construction details, etc. to ensure good quality works.

Acceptance of the tender shall not relieve the Contractor in any way from his sole responsibility to comply with these minimum requirements during construction.

#### **1.5 Submission of Documents**

The Contractor shall submit requisite sets as specified each of the following documents after the award of work as directed by Engineer-in-Charge.

A summarized description of the proposed structural system, design assumptions and method of construction to be adopted for this contract.

## **1.6 Foundation Works**

Earth Retaining Stabilizing System (ERSS) with construction sequence and method statements and proposal for undertaking excavation works.

Basement retaining wall design, to be used in conjunction with proposed ERSS.

Modifications or additional Instrumentation and monitoring, including monitoring ground water levels, noise and vibration, settlements, deflections, twist and rotations of ground and structures etc.

Plans showing summary of all structural elements proposed for using precast concrete, where applicable, and the following:- Method statement describing the proposed fabrication, Assembly procedures and sequence of erection, Typical connection details including means for ensuring accurate fitting out and avoidance of excessive distortion stress.

Details of Contractor's QA/QC programme, including proposed Independent Testing Agency and corresponding Inspection and Test Plans for structural steel works and reinforced concrete works. Testing and proposals are to comply with Latest Indian /BS Codes where applicable.

Details including site drainage, washing bay, sedimentation tanks etc, use of tower cranes and mobile cranes, hoisting, storage facilities, temporary access, site office, etc.

Names and details of Proposed Professional Engineers (Civil) and/or Specialist Professional Engineer (Geotechnical) for:

Design and supervision of Base Building Structures for submission to Client / IRCON.

Design and supervision of ERSS by Specialist Professional Engineer (Geotechnical).

Design and supervision of Temporary works

Design and supervision of non base building structures such as railings, balustrades, façade, trellis, metal roof, canopies, building maintenance units, etc, and all associated welding and connections. These shall be submitted to Client / IRCON Design and supervision of landscape features and landscape furniture's.

## **1.7 Submission of Drawings**

The Contractor shall submit to the Client / IRCON, No. of sets as specified all drawings and Analysis Model, electronic calculations submitted to the Authorities, including as-built drawings.

## **1.8 CONSTRUCTION METHODOLOGY OF REDEVELOPMENT WORK**



### **1.8.1 Project Description:-**

Construction of MSME Technology Centre at Jaipur (Rajasthan)

Type of Buildings: RCC Beam, Column & Slab Arrangements, Steel Composite. Structure and situated in populated area, hence diaphragm walls shall be provided for the safety of the adjoining roads and properties all around the plot.

### **1.8.2 Objective and Assumption:-**

The following construction methodology and associated details and procedures are indicative and can be refined before to undertake the project. This methodology has been prepared to provide a basis for assessment of the amount of work involved.

The surveying, cutting/ filling and inspection of the sites will be considered as the usual practice and not included in the methodology.

### **1.8.3 Diaphragm Wall**

Demarcation of the diaphragm wall layout shall be marked on ground by pegs or by points and get its approval from Engineer-In-Charge / IRCON.

First of all RCC guide wall having 1.50 meter height and 15cm thick placed at both ends of Diaphragm wall and extending to full length of diaphragm wall is constructed. The excavation for the diaphragm wall shall be carried out in alternate panels of 4m to 5m sizes. The excavation is done using clamshell or crab suspended by cables. In case of encountering boulders, gravity hammer (chisel) is used to break the rock/boulder. The earth and split boulders are taken out using grab. At the ends of proposed width of wall panel, MS pipes of width of wall are inserted.

Bentonite slurry of appropriate viscosity is used to protect the sides of soil/wall from collapse. When desired level of excavation has arrived arrangements for lowering of reinforcement cage as per design and bar bending schedule and structural drawings shall be lowered, but it requires lap at sections to achieve the required depth. The laps are welded at few locations.

The concrete pouring shall be done in the diaphragm wall with the help of tremie pipe. The tremie pipe is lifted up with progress of concreting the bentonite solution is also pumped back in to the tank. The slump in concrete shall be maintained at 150 to 200 mm. The side pipes for retaining concrete are withdrawn after concrete has set.

The alternate panels of diaphragm wall are casted till full length of wall has been covered.

### **1.8.4 Excavation work and Anchoring**

After completion of diaphragm wall, excavation shall be started in three levels. After completing the first level of excavation, soil anchors as per approved design shall be driven in to the soil, same shall also be provided along with Waller beam, thereafter excavation of level 2 shall be start. After completion of level 2 excavation, anchoring and waller beam works of level 2 shall be completed.

To support the diaphragm walls, these shall also be cross supported by temporary steel girders and columns as per design submission/ approval.

Machinery : JCB / Excavator, Dumper / Tractor, Plate Compactor / Vibro-Roller, Proctor test equipment, Core Cutter, Weighing Balance, Rapid Moisture Meter.

#### **1.8.5 PCC**

The PCC work shall be carried out after the excavation and levelling work. The grade of concrete for PCC shall be referred from the GFC structural drawing.

#### **1.8.6 Waterproofing Work**

All dust, foreign matters, loose materials or any deposits of contaminants shall be cleaned and removed. All depressions / pot holes and hair line cracks will be filled with cement mortar mix 1:3 in ratio. The approved water proofing chemical compound shall be applied on the clean surface by the specified method or any other suitable means and allowed to dry as per specification. It shall be ensured that application of water proofing coating is uniform over the surface. Once the applied chemical has dried sufficiently, protective layer in form of Screed on horizontal surface and Plaster on Vertical surface will be done as per direction of Engineer-In-Charge.

#### **1.8.7 Re-bar & Steel plates**

Provide re-bar / coupler from the inside of the diaphragm wall at appropriate levels as per the instructions of the Engineer-In-Charge on top of water proofing for raft / foundation. Provide 12mm thick 250mm wide MS plates on specified levels on basement 1 level and basement 2 levels to weld the slab / beam reinforcement.

#### **1.8.8 Concreting of Raft:-**

Design Mix Concrete

Before establishment of the concrete mix design, the source and quality of all ingredients with its test results shall be submitted to the Engineer- In-Charge. The trial for all grades of concrete shall be carried out at batching plant under supervision of Engineer-In-Charge. The approved sample of each material shall be submitted to Engineer-In-Charge to be kept at sample lab. After establishment of mix proportion the same shall be submitted to the third party from any one of Indian Institute of Technology (IIT) / National Institute of Technology (NIT) for checking and inspection. After getting the trial mix results (grading, cube strength) the same will be submitted to the IRCON for information and record.

Site engineer / QC engineer will inform to the Engineer-In-Charge for checking and approval on the pour card for the pouring of concrete. All location of shear wall and column shall be checked and approved by Engineer-In-Charge before starting.

#### **1.8.9 Erection of Steel Columns:-**

Erection of steel columns as per the specified sizes and as per the column layout of structural drawings.

**1.8.10 Shuttering of Columns, Slab and Beams: -**

The contractor shall submit the composite Design and drawing of shuttering arrangement of shuttering's with prop supporting arrangements of complete floor for checking its compatibility for proposed Loads which are likely to be encountered during concreting.

For Structures below Plinth: -

Erected form work shall be watertight, shall conform to shape, lines, dimensions, vertically, rigid during placing, vibrating and configuring the concrete. Formwork system shall be of steel or timber or 12mm thick water resistant ply board, and shall be continuous, straight and without any warping. Form work design shall have dimensional tolerance. Ties shall be provided where required. Cambers shall be provided where shown. Props / supports of extra ceiling height shall be specially designed. Panels to be in largest practicable sizes to reduce the number of joints. All propping and centering shall be of adjustable steel supports (built -up sections of rolled steel) and tubular props to full height without joints, and with sufficient bracing to take into account the construction loads, namely full load of concrete with any live load and impact load likely to occur during concreting.

For Structures above Plinth:-

Erected formwork made of Laminated Ply/Aluminum which shall be light weight, water tight, shall conform to any shape, line, dimension, vertically and horizontally rigid during placing, vibrating and configuring the concrete. Form work shall be continuous, straight and without any warping. Form work design shall have dimensional tolerance. Ties shall be provided where required. Cambers shall be provided where shown. Props / supports of extra ceiling height shall be specially designed. Panels to be in largest practicable sizes to reduce the number of joints. All propping and centering shall be of adjustable steel supports (built-up sections of rolled steel) and tubular props to full height without joints, and with sufficient bracing to take into account the construction loads, namely full load of concrete with any live load and impact load likely to occur during concreting.

**1.8.11 Reinforcement:-**

It shall be ensured that reinforcement used shall be free from rust, scale, oil and dust. Before commencing the reinforcement work, bar bending schedule (BBS) shall be prepared, and submitted to the Engineer-In -Charge. After obtaining the approval from Engineer-In-Charge, the reinforcement shall be cut and bent into desired shapes and dimension as per approved BBS. It shall be ensured that bars are bent cold using appropriate pin sizes. The cut and bent reinforcement bars shall be shifted to the location where the same shall be fixed in such a way so as to prevent it from rusting. The reinforcement shall be placed on clean and dry surface. The reinforcements shall be fixed, supported and maintained in position by adequate use of chairs, PVC / cement mortar cover blocks and binding wires as approved by IRCON.

High yield strength deformed bars (Fe 500D) conforming to IS 1786 – 2008 with  $f_y = 500$  N/sq.mm has been proposed. Density of reinforcing Steel assumed as 78.5 kN/cu.m. While ductile detailing

as per IS 13920 – 2016 clause 5.3.1, the grade of reinforcement for shear links will be considered as fy 500, whereas while designing as per IS 456 – 2000 clause 26.5.1.6, 39.4.1 & 40.4, shear links will be considered as fy415 grade.

Only lapped splices shall be used for bar dia up to 16 mm for columns and for all diameters in beams. For dia 20mm and above couplers are proposed in column for splicing. The detailing of reinforcement shall be done as per SP-34, IS:4326 and IS:13920 - 2016.

#### **1.8.12 Construction of Slab/ Roof:-**

The slab & roof works mainly consists of pouring of concrete as per the drawing issued and as per the mix specified simultaneously. Machinery: concrete pumps, concrete vibrators.

The above mentioned process shall be repeated in all floor levels up to the terrace level /termination level.

#### **1.8.13 Structure Works – General**

The general conditions and special conditions of the contract including the drawings shall be read in conjunction with these technical specifications, and matters referred to, shown or described in one are not necessarily repeated in the other. These specifications are comprehensive but may exceed the requirements of this project.

Notwithstanding the sub-division of the specification into various headings, every part of it is to be deemed supplementary to every other part and is to be read with it, so far as it may be practicable so to do, or when the context so permits.

The works shall be carried out based on the latest revisions of "Central Public Works Department-Specifications" except for items specified in the tender documents. The most stringent requirements shall be complied. The contractor shall be required to conduct all site tests and tests from authorized testing laboratory, submit all Manufacturers' test Certificates as called for in the specifications.

The contractor shall keep at site, copies of all relevant Standards and Codes of practice referred in these specifications throughout the period of contract. These shall be the latest editions and shall include all revisions/addendums thereof.

### **1.9 PROJECT DESCRIPTION: -**

Type of Buildings: RCC Beam, Column & Slab Arrangements, Steel Composite Structures and situated in vacant area, however diaphragm walls shall be provided for the safety of the adjoining roads and properties all around the plot as per the soil conditions.

### **1.10 STRUCTURAL SYSTEM:-**

The scope of work comprises of construction of the following:

Training Block – consists of two floors above ground. Approximate area of the block is 5011 sqm. The structure is a RCC Framed structure.

Production Block - consists of One floor above ground. Approximate area of the block is 4094 sqm. The structure is a Steel Composite Structure.

Admin Block – consists of two floors above ground. Approximate area of the block is 5011 sqm. The structure is a RCC Framed structure.

Dining Block – consists of ground floor. Approximate area of the block is 375 sqm. The structure is a RCC Framed structure.

Other blocks as per the DPR.

Design Theme

The structure shall be designed as RCC beam, column, slab arrangements and steel composite structure. The structure shall be designed in accordance with the relevant Indian code of practice for Civil works i.e. IS 456:2000, IS: 800, IS: 1343:1980, IS 875:1987/2015, IS 1893:2016, IS 4326:1993, IS 13920:2016.

Production block Roof is in structural steel truss.

Buildings shall be checked for vibration due to nearby train movements. Isolation is proposed between station building & platform to mitigate the vibration due to train movement.

#### **1.11 FOUNDATION SYSTEM :-**

Based on loads from structure and soil bearing capacity.

#### **1.12 BRIEF CONSTRUCTION METHODOLOGY: -**

The surveying, cutting/ filling and inspection of the sites shall be considered as the usual practice.

##### **1.12.1 Application**

This specification applies to the Civil & Structural works to be executed by the contractor. It is to be read in conjunction with DPR, General Conditions of Contract, Construction Drawings and such other documents as specified in SCC comprising part of this contract.

##### **1.12.2 Clearing**

The contractor shall clear the site of all rubbish of old buildings, remove all grass and low vegetation and remove all bush, wood, trees, stumps of trees, and any other vegetation. All disused foundations, drains or other obstructions met with during excavation shall be dug out and cleared.

##### **1.12.3 Site Levels**

The contractor shall survey the site and shall establish sufficient number of grids and level marks to the satisfaction of the Engineer-In-Charge, who shall decide on the basis of this information, the general level of the plot and the plinth, the levels given in the tender drawings are relative / indicative only.

**1.12.4 Benchmarks**

Prior to Commencement of Construction, the contractor shall in consultation with the Engineer-In-Charge, establish several site datum benchmarks, their number depending on the extent of the site. The benchmarks shall be sited and constructed so as to be undisturbed throughout the period of construction.

**1.12.5 Site Investigation**

The contractor shall inspect the site and study the findings from the trial pits or bores in order to assess the problems involved in and methods to be adopted for excavation and earthwork. The contractor shall ascertain for himself all information concerning the sub-soil conditions, ground water table periods and intensity of rainfall, flooding of the site and all data concerning excavation and earthwork.

**1.12.6 Setting Out The Work**

The contractor shall set out the works and during the progress of the building shall amend any errors arising from inaccurate setting out.

During the execution of the work contractor must cross check his work with the approved drawings. The contractor shall be responsible for all the errors in this connection and shall have to rectify all defects and / or errors.

**1.12.7 Cleaning Up and Handing Over**

Upon completion of the work, all the areas should be cleaned. All floors, doors, windows, surface, and external development area etc. shall be cleaned down in a manner, which will render the work acceptable to the IRCON. All rubbish due to any reason shall be removed daily from the site and an area of at least TEN METRES on the outer boundaries of the premises will be cleaned by the contractor as a part of the contract. Upon completion of the project, the contractor shall hand over to the IRCON the following:

Certified reports of tests (materials and workmanship)

Written guarantee and certificates and

Maintenance manuals

**1.12.8 Tests**

All materials and methods of tests shall conform to the latest rules, regulation and / or specifications of the following authorities where specified herein as applicable, Bureau of Indian Standards (BIS) or British Standards code of practice (BS) in case no equivalent BIS is available. The Engineer-In-Charge will have the option to have any of the materials tested and if the test result shows that the materials do not conform to the specifications, such materials shall be rejected.

**1.13 EXCAVATION**

### 1.13.1 Diaphragm Wall

#### 1.13.1.1 General

This specification section details the requirements where vertical cut are required to have support measures installed or provided to maintain the stability of Diaphragm wall. This specification deals with cable anchoring and shall be read in conjunction with the conditions of contract Specification for Excavation. The Contractor shall comply fully with the requirements of this specification in the fabrication and installation.

The Diaphragm wall techniques consist of constructing reinforced concrete walls from existing ground level by first excavating a trench by grab. During excavation, the sides of the trench are supported by polymer/Bentonite slurry.

##### Guide Wall

In order to guide the grab during initial excavation for each panel and ensure the position and vertically of Diaphragm wall, a guide wall in RCC is constructed at around 1.5m below the ground level prior to commencement of diaphragm walling. The guide walls also provide support during suspension of reinforcement cage.

##### Primary panels

The design length of the primary panels (with two Water Stop Joint) is consistent with either the minimum length possible of the size of grab necessary to excavate or full bites at each end of the panel.

The obstacles are overcome either by chiseling or rock boring tools. After the completion of excavation in a panel, Two Water Stop joints in Primary panel and one Water Stop joints in successive panel are installed to full depth of Diaphragm wall panel. The Water Stop panels are removed after concreting.

##### Placing of reinforcement cage

Reinforcement cages are prefabricated at site and upon after recycling of bentonite/polymer and installation of Water Stop joints, the cage is lowered into the slurry trench by crawler crane. The cage is equipped with concrete spacer Skids to ensure specified concrete cover to the reinforcement is maintained. The cage is suspended to required level from the guide walls by measured suspension bars, of calculated lengths.

##### Placing of Concrete

Concrete is poured in to trench through tremie pipes of 250 mm dia and made up of coupled sections of 1.5m and 3 m in length. For a diaphragm wall of 5m length Two Tremie sets of 250mm dia shall be set up and simultaneous concreting is done .As the level of the concrete in the trench rises the tremie pipe column is raised by ensuring a minimum 2 meter embedment in concrete in order to avoid Bentonite inclusions.

Where works are ordered to be performed by the Contractor but are not specified in this specification, the Contractor must carry them out with full diligence and expedience as are expected for works of this nature and shall comply with the relevant clauses of the British Standard Code of Practice for Ground Anchorages (BS 8081: 2015 & BSEN-1537-2013) and in accordance with IS 10270.

### **1.13.1.2 Cable Anchoring work**

#### **1.13.1.2.1 General**

The work shall be executed to stabilize the excavated slope and vertical wall.

Post tensioned cable anchors are tensioned reinforcing elements of higher capacity than the other reinforcing elements, consisting of high tensile steel tendon.

The contractor shall furnish and install post tensioned cable anchors of 1200KN ultimate strength and 900 KN working load in area and to the extent shown on the drawings and as directed by the Engineer-in-Charge. The work shall be executed in stages, in step with progress of the excavation or after the excavation has proceeded downwards as directed by Engineer in charge.

Installation of cable anchors shall be undertaken after development of suitable bench to be executed by the contractor. The works shall include drilling, installation of anchors (with complete accessories and corrosion protection layers), primary grouting, stressing and testing and final grouting.

The entire work of drilling, fabrication, installation, grouting and testing of post tensioning cable anchors shall be carried out by a specialist agency having experience, equipment and technology for execution of these works and under strict quality control.

#### **1.13.1.2.2 References**

Guidelines for design & Construction Pre stressed anchors-IS -10270-1982

British standard code of practice for ground anchorage-BS-8081:2015

Execution of special geotechnical works-Ground Anchors -BSEN-1537:2013

FIP recommendations of design & Construction pre stressed concrete ground anchors PTI recommendations for pre stressed Rock and Soil Anchors.

#### **1.13.1.3 Scope and Application of works**

This scope of works includes drilling of holes, preparation, installation stressing and grouting of post tensioned cable anchoring works. The steps are listed as under :-

Fabrication of Anchors

Drilling of Holes



Installation and grouting of Anchors

Stressing and testing of ground anchors

Fabrication of anchors

Materials

The tendon shall be comprised of uncoated stress relieved low relaxation 7-ply strands confirming to IS 14268-Class-II.

Nominal diameter (mm)	12.7	15.2
Nominal area (mm <sup>2</sup> )	98.7	140
Nominal Mass (g/m)	785	1102
Tensile strength (MPa)	1860	1860
Minimum breaking load (kN)	183.7	260.7
Design Load/Jacking Load (KN)	139	198
0.2% Proof Load / Jacking Force not to Exceed (KN)	165.30	234.6
Relaxation after 1000 hrs at 70% of Minimum breaking load	Max. 2.5%	
Certificates of Shipment	Mill Test Certificates	
Identification	Metal Tag	
Quality in accordance	IS-14268-Class-II/ASTM-416	

The anchor head assembly shall allow the tendon to be stressed, test loaded and locked-off and if required re stressed. It shall distribute the tendon load to the main structure in accordance with the overall design of the structure through designed and tested components. The structural failure load of the anchor head shall not be less than the sum of the ultimate load of the tendon.

The contractor shall ensure the raw material are in conformance with all desired chemical and mechanical properties. Engineer In charge may get the wire/ strands tested from test laboratory.

Corrosion Protection

Anchor designed for permanent in nature (Permanent Anchor) the tendon shall be covered with corrugated HDPE sheathing conforming to the design requirements.

#### Fixed Length treatment

The high tensile wire or strands shall be cleaned with wires and thinner

The first coat of epoxy paint shall be applied uniformly on the wires /strands and the silica sand sprinkled over this bond area uniformly.

Outer annular grout shall act as a corrosion protection layer.

#### Free Length treatment

The first coat of epoxy paint uniformly applied on the HT strands/wire.

The HT strands/ wires encapsulated with PE pipe at least 2mm thick and the diameter of the PE pipe shall be greater than the diameter of HT strand.

The annular space between the PE and the strand shall be filled with grease.

The annular space outside PE pipe shall be covered with neat cement grout.

For anchor head protection measures the HDPE/Steel grout cap shall be bolted for the IIInd stage grouting.

Two coats of suitable anti corrosive paint shall be applied to all exposed steel after removal steel/ HDPE grout cap removal.

### 1.13.1.4 Properties of Grease

Guidelines for acceptance criteria for viscous corrosion protection compounds and examples of standards for the testing of material properties

Table B.1 -Acceptance criteria for viscous corrosion protection compounds

Property	Units	Acceptance values
Content of free sulphur, sulphates and sulphides	1 x 10 <sup>-3</sup> mgm/gm	<50
Content of ionic chlorides, nitrites, nitrates, rhodanites	1 x 10 <sup>-3</sup> mgm/gm	<50
Spec, resistivity	Q* cm	>109
Water absorption c(KOH) = 0.1 mol/l after 30 days	%	<2

Technical Specification for Structure Work		
Saponification (acidity)	mg KOH/gm	<5
Deoiling on filter paper at 50°C, 24 h : increase in diameter of oil spot	Mm	£5
Penetration depth in deoiling test on hardened cement grout 5 mm thick at 50°C after 7 days	Mm	1 2
Thermal stability, 24 h No oil droplet at sieve for temperature increases of 10°C every 2h.	°C Occurrence of oil droplets	>40
Drop point	°C	>60
Protection against rust - Marine for: 5% NaCl - 168h at 35°C		Visual inspection: zero corrosion
Bleeding at 40°C	%	<5

Transport and off loading

After assembly / fabrication of anchor at the store, anchor shall be packed in a truck in a "U" shape manner by means of belts and adequate wooden braces shall be arranged to protect the epoxy paint formulation on the strand surface. The U shaped anchors shall be straightened carefully laid on wooden planks so that the anchors do not touch the ground.

#### 1.13.1.5 Drilling of Holes

Drilling equipment shall be suitable for the strata to be encountered and to install the anchors at the specified depths and angle of inclination as shown in the drawing or as directed by the engineer in charge. The drilling method shall be suited to the type of soil and diameter of the drill hole.

The holes shall set out to a tolerance of  $\pm 75\text{mm}$ . Holes shall be positioned to avoid steel reinforcement within the waling and diaphragm walls/touch piles.

Diameter of the holes shall be at least 125mm, depth of the hole shall exceed the total cable anchor length by 300mm.

Holes shall be drilled by rotary method with water flush or pneumatic percussion method with air and water flush or any other type such that to avoid the disturbances to the adjoining rocks is minimal.

The contractor shall record the length, diameter and direction of the all holes prior to installing the anchor.

Drilling holes shall confirm to the least of the following tolerances :-

The deviation of the drill hole from the specified alignment shall not be exceeding 1 in 30.

Localized distortions shall not exceed 20 mm in any 3 m length of drill hole. Maximum acceptable set up error shall be 2.5°

During the drilling operations, all changes in the rock type shall be recorded together with notes on drilling logs. Upon completion of drilling in rock the entire length of the hole shall be washed out with clean water /compressed air, as approved by the engineer in charge.

In loose material the walls of the drill hole shall be supported by casing until the cable anchor (tendons) has been installed .In earth or rock liable to swell the cable anchor (tendons) shall be installed and grouted immediately as directed by the engineer in charge.

Any hole that becomes clogged or otherwise obstructed before the completion of homing the cable anchor operation shall be cleaned and re-drilled. If not possible another hole shall be provided by the contractor.

The contractor shall maintain drill log for each drilled hole for future reference and identifying of data as under :-

Type of strata encountered Depth of changes in the each strata Color of flushing return - Any borehole stabilization methods used by drilling agency (grouting, casing, etc.,)

Water pressure testing

When required water testing shall be carried out by isolating the fixed anchor length plus 2m with a pneumatic packer.

If the water loss is more than 3 lugeon (3 Litre/Minute/metre at 10 Kg/sq.cm pressure) at the surface applied for a period of 10 minutes, the hole shall be grouted adopting stage grouting and re drilled again and stage water loss test performed. Observation of water loss test shall be maintained and recorded properly.

#### **1.13.1.6 Installation and Grouting of anchors**

The tendon shall be slowly lowered into the hole in such a manner as to prevent any damage and tangling of the individual HT strands .after being lowered, the cable anchors shall be fixed in position so that no displacement can occur during grouting work. The tendon shall be centered in the hole by spacers so that adequate covering with the grouting material is ensured as directed by the engineer in charge.

Immediately after installation of cable anchors into the hole, the primary packer grouting of the fixed length plus 2m and outside of the sheathing shall be carried out. The grouting equipment must permit grout pressure up to 20 bars.

The grout shall have water cement ratio of 0.36 to 0.42.The grout mix shall have strength of 28 Mpa at 7 days and 40 Mpa at 28 days. Cement to be used for grouting shall be OPC-43 grade.

Proper grouting pipe shall be used to ensure grouting from bottom to top and achieve complete filling with neat cement grout.

Grout mixer shall have a tank for the mixing and agitation. The tank shall be connected to a pumping unit at the bottom of the mixer. Cement and water is mixed in the tank at least 4 -5 minutes till a homogeneous grout mix is obtained.

The following tests to be conducted for grout.

Flow ability check: This is done using a Flow Cone Apparatus. The time taken for the flow of premeasured quantity of grout is noted which shall be in the range of 11 to 20 seconds. Three tests to be conducted in 8 Hrs as per procedure given by BSEN-445,446,447.

Volume Change and bleeding test: Grout mix is poured into a transparent beaker. Shrinkage and bleeding are measured and records maintained.

For Bleeding two tests shall be conducted in a day one test at mixing plant and one test at outlet point.

For Volume change one test in a day.

Compressive Strength: Grout cubes of size 100 mm x 100 mm x 100 mm shall be taken and the compressive strength is tested after 7 days & after 28 days.

The test results of the grout shall have the following specifications.

Compressive Strength = not less than 30 MPa before stressing of anchor.

Expansion	=	Not more than 4% after 24	Hrs.
Shrinkage	=	Not more than 1% after 24	Hrs
Bleeding at 3 hours	=	Max 2% to 4%, and after 24 hrs-0 %.	

As soon as possible, after stressing or re stressing have been completed and cable anchors has been accepted by the engineer in charge, the secondary grouting shall be performed to encase completely the HT strands throughout the entire length of the hole.

#### 1.13.1.7 Stressing and testing of cable anchors

Stressing or testing of cable anchor shall be performed only when the grout has attained minimum strength of 30Mpa or and only after the fixed length of anchor has acquired the required strength.

The lock-off load =Design or working load +Allowance of 10% for long term losses. All cable anchors shall be checked for acceptance test and shall be tested at 125% working load and at least 5% of the cable anchors shall undergo proving test and suitability tests.

Investigation test or on site proving test shall be performed on at least 3 Nos. of anchors before commencement of the installation of working anchors. The test load to which cable anchors shall be subjected during various tests shall be 80% of the GUTS (Guaranteed Ultimate Tensile Strength) of the tendon. Table 1 provides the test result for investigation on anchors where ground conditions are not known or where prior anchoring data is not available.

Table 1 - Recommended load increments and minimum periods of observation for investigation tests on anchors where the ground conditions are not known, or prior experience of anchoring does not exist

Load increment % fpk)							Minimum period of observation min
1st cycle %	2nd cycle %	3rd cycle %	4th cycle %	5th cycle %	6th cycle %	7th and 8th cycles %	
5	2	5	5	5	5	5	1
10	50	30	40	50	60	70	1
15	25	35	45	55	65	75	1
20	30	40	50	60	70	80	5, 15
15	20	30	40	40	50	50	1
10	10	15	20	20	30	30	1
5	5	5	5	5	5	5	1

Note: - Load-displacement results shall be plotted as the test proceeds. In this way it can be possible at an early stage to observe trends in behavior and, in particular, the yield of the fixed anchor length as failure approaches.

#### 1.13.1.8 Onsite Suitability test

Onsite trials shall be undertaken to prove suitability of the ground anchorages for the conditions. Where the cable anchors are to be used as part of the rock support system a minimum of three tests shall be undertaken on first encountering the relevant rock mass condition. The working load (Tw) is as stated on the drawings.

Load the tendon to 10%Tw measure and record the extension. This load and extension shall be used as the datum.

Load the tendon to 150%Tw with intermediate readings at 10%Tw, 50%Tw and 100%Tw. Record the extension at the value of the load.

At 150%  $T_w$  hold the load for 15 minutes and record the extension at the beginning and end of the interval, the creep shall not exceed 5%  $A_e$  of the elongation over 15 minutes after allowing for the temperature change and structural movement.

Reduce the load to datum and read the extension at 100%  $T_w$  and 50%  $T_w$  and datum (10%  $T_w$ ). holding for 1 minute and recording the extension at the beginning and end of 1 Minute.

Reload 50%  $T_w$  and 100%  $T_w$  for at least 1 Minute record the extension at beginning at end of 1 minute. Continue loading at 150 %  $T_w$  for 15 minutes .Record the extensions at beginning and end of 15 minutes.

The anchor shall be deemed satisfactory if the creep is less than 5%  $A_e$  over 15 minutes after allowing temperature and movement of the structure.

Re-measure the residual load after 5, 15, and 50,150 minutes when the loss of load shall not be more than 1% for each interval.

The apparent free tendon length shall be calculated from the load extension graph over the range of 10%  $T_w$  to 150%  $T_w$ . The stressing free tendon length shall take account of any additional lengths of tendon either protruding from the anchor head through the jack or any lengths of tendon shall be added to the anchorage for stressing purposes.

The apparent tendon free length shall be greater than 90% and less than 110% of the free tendon length or less than the free length plus 50% of the tendon fixed length.

When testing an individual anchor where the anchor spacing is less than 1.5m, adjacent anchors shall be tested for possible interaction and observations recorded. The anchor shall be deemed satisfactory if the test results are in accordance with the above criteria.

Instruments for measuring load shall be calibrated with an absolute accuracy of 0.5% and the same for measuring extension shall be accurate to  $\pm 0.1$ mm.

Instruments for measuring load shall be calibrated with an absolute accuracy of 0.5% and the same for measuring extension shall be accurate to  $\pm 0.1$ mm.

#### 1.13.1.9 Test loads

For production anchors, the initial stressing load is limited to 150%  $F_{Serv;k}$  for temporary and permanent anchors. On the assumption that  $F_{Serv;k}$  approximates to 50% of characteristic strength of the tendon. This gives maximum stresses of  $150\% \times 50\% = 75\%$  of characteristic strength of the tendon for temporary and permanent anchors.

Table 2- Recommended load increments and minimum periods of observation for suitability test

Temporary and permanent anchors	Minimum period of
Load increment % $P_p$	

		Technical Specification for Structure Work
1st load cycle A) %	2nd and 3rd load cycles %	3rd cycles min
10	10	1
30	30	1
70	70	1
100	100	15
70	70	1
30	30	1
10	10	1

Table 2 above shows the load increments and minimum observation period for this load cycle, there shall be no pause other than that necessary for the recording of displacement data

#### 1.13.1.10 Acceptability test

Each anchor shall be subjected to acceptance test as follows :-

Load tendon to 10%  $T_w$  measure and record the extension. This load and extension shall be used as the datum.

Load tendon to 150%  $T_w$  with intermediate readings at 50%  $T_w$ , 100%  $T_w$  and record extension at each load. At 150%  $T_w$  hold the load for 15 minutes and record the extension at the beginning and end of the interval. With the load at 150%  $T_w$  the creep shall not to exceed 5%  $A_e$  over the 15 minutes after allowing for temperature change and structural movement.

Re-measure the residual load after 24 hours, if the total loss doesn't exceed 6% then the anchorage shall be deemed satisfactory. If the losses exceed 6% further observations shall be taken after at 3 days, and if necessary at 10 days, when total loss shall not exceed 7% and 8% respectively.

The apparent free tendon length shall be calculated from the load extension graph over the range of 10%  $T_w$  to 150%  $T_w$ . The stressing free tendon length shall take account of any additional lengths of tendon either protruding from the anchor head through the jack or any lengths of tendon shall be added to the anchorage for stressing purposes.

The apparent tendon free length shall be greater than 90% and less than 110% of the free tendon length or less than the free length plus 50% of the tendon fixed length.

When testing an individual anchor where the anchor spacing is less than 1.5m, adjacent anchors shall be tested for possible interaction and observations recorded. The anchor shall be deemed satisfactory if the test results are in accordance with above criteria.



Instruments for measuring load shall be calibrated with an absolute accuracy of 0.5% and the same for measuring extension shall be accurate to  $\pm 0.1\text{mm}$ .

Table 3- Recommended load increments and minimum periods of observation for acceptance tests

Temporary and permanent anchors		Minimum
Load increment % Pp		
1st load cycle A) %	2nd load cycles %	min (2 <sup>nd</sup> Load
10	10	1
30	30	1
70	70	1
100	100	5, 15
70	70	1
30	30	1
10	10	1

Table 3 above shows the load increments and minimum observation period for this load cycle, there shall be no pause other than that necessary for the recording of displacement data.

#### 1.13.1.11 Records

##### 1.13.1.11.1 Drilling and Installation:-

Cable Anchor reference number

Supervisor name and crew

Date of drilling and drilling method

Diameter, length and orientation of drill hole

Consistency, colour, structure and type of rock.

Date of installation

HT strand coil no, heat no etc.,

Fixed and free length

Grouting details and properties (mix design, bleed, shrinkage or expansion and setting time)

#### **1.13.1.11.2 Stressing and testing :-**

Jack type, Effective piston area, capacity of jack, stroke length

Pump type, pressure gauge range, accuracy

Calibration certificates for jack and pressure gauge

Details of all forces, extension, seating and other losses observed during all stressing operation.

#### **1.13.1.12 Corrosion protection**

As specified.

#### **1.13.1.13 Tendon bond length**

All installed tendons shall be provided with a minimum 10 mm cement grout cover to the borehole wall. Where aggressive ground conditions are known to exist, it may be appropriate to enhance the protection for example by the use of a single corrugated duct around the tendon(s).

##### **1.13.1.13.1 Tendon bond length**

The protection system shall have low frictional properties and allow movement of the tendon within the borehole. This may be achieved by the provision of one of the following :-

plastic sheath surrounding each individual tendon, end sealed against ingress of water;

plastic sheath surrounding each individual tendon, completely filled with corrosion protection compound;

plastic or steel sheath or duct common to all tendons, end sealed against ingress of water;

plastic or steel sheath or duct common to all tendons completely filled with corrosion protection compound; or (d) is appropriate for extended temporary use or in aggressive conditions. 1.13.1.13.2 Transition between anchor head and free length (inner anchor head)

The free length sheath or duct may be sealed to the bearing plate/anchor head, or a metal sleeve or plastic duct may be sealed or welded to the bearing plate. It shall overlap the free length sheath or duct and for extended temporary use be filled with corrosion protection compound, cement or resin which is contained at the lower end.

##### **1.13.1.14 Anchor head**

Where the anchor head is accessible for inspection and possible re-coating the following protection is acceptable :-

a coating of non-fluid corrosion protection compound; or

a combination of corrosion protection compound and tape which is impregnated with corrosion protection compound.

Where the anchor head is not accessible a metal or plastic cap shall be fitted and filled with corrosion protection compound for extended use.

Where aggressive conditions are known to exist, a metal or plastic cap shall be filled with corrosion protection compound.

## **1.14 WATERPROOFING**

### **1.14.1 Diaphragm wall joint treatment**

Providing and Laying swellable type water stop tape, 19mm x 25mm thick in linear meter (expansive nature) for construction joints treatment of RCC structure, such as raft slab, retaining walls, water storage tank and at the junctions of raft slab with the retaining walls etc. After cleaning the surface, one coat of required primer for swellable water stop tape shall be applied throughout the length of the joint @ 3.78 liter per 240 running meter. Over the primed surface swell able type water stop tape shall be placed. The work shall be carried out all complete as per specification and the direction of the Engineer- in charge. The product performance shall carry guarantee for 10 years against any leakage.

Providing and Laying of NRV Packers in diaphragm wall, post cured at Required Distance, complete after Packing/Drilling/fixing AS PER THE Instruction of Engineer-in-Charge.

Providing and Laying in Diaphragm wall Water activated Polyurethane Water stop & Seal Injection Foam Grout, complete with Electrically Operated Grouting Machine with Required Pressure complete as per the instruction Of Engineer-In-Charge.

Providing and Laying in Diaphragm Wall NSF Drinking water Contact Approved Super Flexible, Hydrophilic Polyurethane Injection Gel through the fixed Non Return Valve Packers, complete with Electrically Operated Grouting Machine with required pressure complete as per the Instruction of Engineer-In-Charge.

## **1.15 PROCEDURE**

### **1.15.1 Diaphragm Wall**

- 1.15.1.1 Constructing cast-in-situ RCC diaphragm wall by providing and laying machine batched, machine mixed, self-compacting, ready mix reinforced cement concrete, tremie controlled, of M 35 grade using minimum 400 kg cement per cum of concrete including providing and mixing required admixtures in recommended proportions as per IS:9103, as approved by the Engineer-In-Charge, for achieving 150- 200 mm slump, for diaphragm wall having thickness as per approved structural design not exceeding 600mm, in panels of required depth and lengths as per approved drawing, including constructing necessary guide walls as required and as specified including boring in all kinds of soils and rocks, including working in or underwater and / or liquid mud, in foul conditions and pumping and bailing out of water and removing slush, including disposal of earth / rock/ slush etc., for all leads and all lifts, including preparing, providing and recirculating bentonite slurry in

the trench as and when required for all depths, including agitating bentonite slurry during trenching etc.

Providing and fixing stop ends or form tubes, up to the required depth of diaphragm wall including extracting the same after casting, including chipping of the bentonite adulterated concrete or unsound concrete up to the cut off level for obtaining the sound concrete, dressing undulations on the exposed face of diaphragm wall after excavation by chipping / chiseling etc., including lifting the depression / cavities with sound concrete etc., complete and as directed by the Engineer-In-Charge, including providing recess for bearing plates and fixing insert boxes for inclined rock anchors etc., complete as per the specifications and approved design and as directed by the Engineer-In-Charge.

### **1.15.2 Reinforcement**

Supplying, fabricating and placing of Fe 500 grade steel for diaphragm wall including cutting, bending, welding, binding wire all as per technical specification, drawing, including charges for reinforcement welding, placing & lowering of the reinforcement and all labour, materials tools, equipment, fuel and all sampling, testing and records etc., complete.

### **1.15.3 Concrete Integrity Tests**

Supply necessary equipment and perform concrete integrity test on the diaphragm walls according to the specifications and as directed by the Engineer-In-Charge as per relevant IS codes, etc., complete.

### **1.15.4 Ground Anchors**

Designing, providing and installing pre-stressed ground anchors at founding level of following capacities in accordance with BS:8081 & specifications based on the provided data such as service life of anchor, design load, soil investigation report using pre-stressing steel with minimum fixed length of 5 mtrs. or more depending on the pull out criteria, Including drilling through over burden, all type of soils, weathered/hard rock with either rotary/pneumatic percussion method, flushing the hole, fabrication & installing of anchors, stressing of anchors after stressing the anchor after the grout achieving its strength to its capacity level & anchoring to the desired locking force level, providing adequate corrosion protective etc., including de-stressing of anchors if required and making the cutout finish in all respects & water tight also.

### **1.15.5 Dowels**

Providing and fixing Reinforcement dowels in diaphragm wall for RCC work including straightening, cutting, bending, binding and placing in position with 18 gauge annealed steel binding wire.

### **1.15.6 Insert Plates**

Supplying and fixing in position insert plates, including lugs in the reinforcement cages of diaphragm wall, including cutting, bending, drilling, threading and welding lugs etc. with all tools tackles and labour as per design or as directed by Engineer-In-Charge.

### **1.15.7 Rendering & Injection Grouting**

Making of inner surface of diaphragm wall good by rendering and injection grouting with cement slurry mixed with polymer at all the construction joints.

### **1.15.8 Waller Beam**

Supplying, fabricating, assembling, hoisting /erecting and fixing in position at all heights and with all leads, structural steel works of MS rolled sections/Plate as per structural drawings and as per detailed specifications (for materials & workmanship) in the situations described herein after complete, including primer and 2 or more coats of paint by spray gun as per detailed specifications and manufacturer's recommendations. The welding electrode to be used shall be IS 816 classification. The grade of steel shall be as per IS 1161.

### **1.15.9 Diaphragm Wall Anchors/Dowel Bar Treatment**

#### **1.15.10 Waterproofing of Anchors of Diaphragm Wall:**

Supplying and Installing single component , non -cured, rubberized asphalt coating for sealing anchor/dowel bars in diaphragm wall at various levels. The liquid membrane material should be such so as to keep viscous rubber characteristics, strong self-healing property, once touched immediately bonded. Liquid membrane should remain in non-cure state, & should be such to resolve ageing problem in high stress, various problem due to primary cracking stress transfer to the waterproof layer. Liquid membrane should be installed as per manufacturer's recommendation. Membrane should be supplied with original manufacturer's Material Test Certificate (MTC) & membrane should be installed in strict accordance with original manufacturer's instructions (private label supplier not allowed) and contractor should produce method statement from original product manufacturer.

The liquid membrane shall have following minimum properties:-

Solid Content (%): >80

Elongation/mm : >4mm

Heat resistance : 60 deg, no slide

All systems to be installed as per manufacturer's recommendations, etc. complete with all lead and lift for all materials and labour and as directed by Engineer in-charge.

- 1.15.11 Supply and injecting single component PU injection at all Diaphragm wall segment joints including drilling of holes and fixing of NRV packers of appropriate size so as to ensure sealing of all Diaphragm wall joints. PU injection may also be carried out at dowel anchors so as to ensure sealing of any leakages through anchors strands, all complete including drilling, fixing and supplying of packers complete in all respect as desired and direction of Engineer-In-Charge.

- 1.15.12 Third step will be to do cement guniting of entire surface of diaphragm wall so as to ensure that the diaphragm wall surface is completely waterproofed including placing of welded mesh over the entire diaphragm wall surface prior to guniting, all complete.

**1.15.13 Construction Joints Treatment**

Providing and applying of swellable type water stop tape, 19mm x 25mm thick in linear meter (expansive nature) for construction joints treatment of RCC structure, such as raft slab, retaining walls, water storage tank and at the junctions of raft slab with the retaining walls etc. After cleaning the surface, one coat of required primer for swellable water stop tape shall be applied throughout the length of the joint @3.78 litre per 240 running meter. Over the primed surface swellable type water stop tape shall be placed. The work shall be carried out all complete as per specification and the direction of the Engineer-In-Charge. The product performance shall carry guarantee for 10 years against any leakage.

**1.15.14 Diaphragm wall joint treatment**

- 1.15.14.1 Providing and Laying Self swellable /Soaked in the Diaphragm Wall Joint for use in combination with Hydroactive Waterstop Foam Grouts or Equivalent with Manufacturers Specifications in the joints of Diaphragm Wall, complete as per the instruction of Engineer-In-Charge.

- 1.15.14.2 Providing and Laying of NRV Packers, post cured at Required Distance, complete after Packing/Drilling/fixing as per the Instruction of Engineer-In-Charge.

- 1.15.14.3 Providing and Laying Water activated Polyurethane Waterstop & Seal Injection Foam Grout complete with Electrically Operated Grouting Machine with required Pressure complete as per the instruction of Engineer-In-Charge.

- 1.15.14.4 Providing and Laying NSF Drinking water Contact Approved Super Flexible, Hydrophilic Polyurethane Injection Gel through the fixed Non Return Valve Packers, complete with Electrically Operated Grouting Machine with required pressure complete as per the Instruction of Engineer-In-Charge.

**1.16 Excavation**

**1.16.1 Subsurface Investigation**

**1.16.1.1 Related Work**

- Clearing, grubbing and removing all vegetation from the site.
- Excavation including getting out, and necessary dressing to make surface ready to receive PCC.
- Filling and back filling and compaction of fills.
- Removal and disposal of surplus material.

- Stone soling to roads and paving.
- Barricading the site of construction from existing facility.

#### 1.16.1.2 Applicable Standards

The following standards shall be followed:

- IS: 3764-1966 Safety code for excavation work.
- IS: 1498-1970 Classification and Identification of soils for general purposes.
- Local building regulations and statutory regulations.

#### 1.16.2 Definitions

##### 1.16.2.1 Clear:

The removal of trees, scrub and artificial obstructions including fences, concrete slabs, kerb and channel, remains of old buildings and the likes in it.

##### 1.16.2.2 Grub:

The removal of tree stumps and roots.

##### 1.16.2.3 Topsoil:

Topsoil is all surface soils, which have sufficient humus to support plant growth without resort to artificial fertilization hence top 300mm depth shall be considered as the top soil.

##### 1.16.2.4 Cut:

A general term for 'In Place' material removed by digging from the ground. The term 'excavation' or derivatives thereof may be used interchangeably.

##### 1.16.2.5 Fill:

A general term for material spread and compacted over the ground to make up finished levels or levels to sub-grade. The term 'embankment' or derivatives thereof may be used interchangeably.

##### 1.16.2.6 Sub-Grade:

The finished, trimmed and prepared surface of the earth works after completion of all cut and fills operations. The term 'formation level' or derivatives thereof may be used interchangeably.

1.16.2.7 Sub-Base:

A selected filling layer spread and compacted over the sub-grade to make up levels to the underside of the base course or floor slab.

1.16.2.8 Base Course:

A selected filling layer spread and compacted to levels immediately below road wearing course.

1.16.2.9 Spoil:

Excess cut material remaining at the end of filling operations.

**1.17 Bulk Earthworks:**

Earthworks to create, by excavation and/or filling and compacting, building platforms, road formations, parking areas, reservoir, embankments, drainage canals or any other formation where the unimpeded use of large earthmoving equipment is possible. This is distinct from backfill of trenches, foundations or other earthworks immediately adjacent to completed or partially completed structures.

1.17.1 Site preparation

1.17.1.1 Site Inspection - Preamble

Any site details or site information included in the contract documents or drawings are provided for the contractor's guidance only. The information provided may not be a complete or accurate description of conditions existing below the surface of the ground. The correctness of the information is not guaranteed and the contractor shall be responsible to make its own interpretation of sub-surface conditions.

The contractor shall visit the site, examine the boreholes, and decide for himself the nature of the ground and the subsoil to be excavated.

1.17.1.2 Site Quality Control

The contractor shall provide in his quality assurance programme information to show that a system will be used to ensure that all works carried out under this section (**including any work done by sub-contractor**) will comply with all the requirements of this section.

1.17.1.3 Antiquities

Any ancient carvings, relics, coins or other curiosities discovered during the excavation or other work shall remain the property of the IRCON and shall be handed over to the IRCON.



#### 1.17.1.4 Setting Out and Clearing of the Site

The contractor shall set out the center line of the building or other involved works after clearing the site and get the same approved from Engineer-In-Charge. The contractor shall assume full responsibility for proper setting out, alignment, elevation and dimension of each and all parts of the work.

#### 1.17.1.5 Excavation Classification

- Excavate foundation from existing ground level to the formation levels shown in approved drawing.
- Excavation to pit working level.
- Earthworks outside property line if any.
- Excavation, compaction and backfill to plinth and service trenches.

### 1.18 Classification of Soil / Rocks

- Soils: Material such as sand, gravel, loam, clay, mud, black cotton, moorum, shingle, river or nullah bed boulders, disintegrated rock, soling of roads, paths, hardcore, macadam surface of any description (water bound, routed tarmac etc.) Lime concrete mud concrete or any combination of these. This class of material will yield to the application of picks, shovels, or any other manual digging implements.
- Ordinary rock: Material such as limestone, sand stone, laterite, hard conglomerate. This is any material that will not yield to manual implements, but is capable of being excavated by conventional earthmoving plant applicable to the site and the distances that material has to be moved. The use of a pusher unit or small crawler tractor with ripper to facilitate excavation shall be considered as part of conventional plant.
- Hard rock (Blasting Prohibited): hard rock like quartzite, granite above but where the blasting is prohibited for any reason and excavation has to be carried out by chiseling. Wedging or any other method agreed to by the Engineer-In-Charge.

#### 1.18.1 Classification of Soils

Excavation in all types of soil shall be as per the CPWD Specifications.

#### 1.18.2 Method of Excavation

Shall be as per CPWD Specifications.

The contractor shall ensure proper methods are adopted to control the creation of dust.

Method adopted shall be approved by the Engineer-In-Charge.

**1.18.3 Stacking of Excavated Materials**

All materials excavated will remain the property of the Engineer-In-Charge and excavation including sorting out of useful materials and stacking them on site as directed but at a safe distance from the edge of excavation to avoid collapse/shielding of excavated area. Materials suitable and useful for back filling, plinth filling or leveling of the plot or other use shall be stacked in convenient place but not in such a way as to obstruct free movement of men, animals and vehicles or encroach on the area required for constructional purposes.

**1.18.4 Disposal / Carting of Surplus Earth**

All top soils shall be stripped from areas to be excavated or filled and from other area or as directed to a depth of 150 mm without any extra cost shall be stocked at locations as directed by the Engineer -In- Charge for re-use and re-laid as directed. The remaining excavated earth, except for the hard rock excavated, shall be disposed-off including lifting out, transportation to locations approved by local bodies, government agencies or as directed by the Engineer-In-Charge as the case may be.

The contractor is responsible for finding suitable dumping yard and for the removal of all sub grade obstructions, whether indicated or not, wherever it is likely to interfere with execution and completion of the project.

All surplus and unusable earth shall be carted out and disposed-off outside the site confirming to their specifications but at a location approved by railway authorities/ local authority.

**1.18.5 Dewatering**

Excavation shall include bailing or pumping out which may accumulate in the excavation during the progress of work either from seepage, rain water or any other cause and for diverting surface flow, if any by bunds or other means. Pumping out water shall be done in such approved manner as to preclude the possibility of any damage to the foundation trench, concrete or masonry or any adjacent structure inside or outside the wall front. When water is met in foundation trenches or in tank excavation, pumping out water shall be from auxiliary pit of adequate size dug slightly outside the building excavations. The depth of auxiliary pit shall be more than the working foundation trenches / levels. The auxiliary pit shall be refilled with approved excavated materials after the dewatering is over.

The contractor shall adopt an appropriate method of dewatering work and shall submit its proposal for carrying out the dewatering work for the approval of the Engineer-In-Charge. The water shall be pumped continuously to keep the water level at a minimum of two feet (2') below the lowest point of excavation level. The operation shall be continued until the entire excavation has been completed so as to ensure the excavation is always dry.

**1.18.6 Shoring and Strutting**

The contractor shall uphold the faces of excavation work to retain the earth, if required, at locations where considered necessary. Shoring and strutting shall be erected depending on nature of soil and the work. The arrangement of shoring and strutting including sizes and Spacing of member used shall be approved by the Engineer-In-Charge. All such necessary work, including but not limited to making / preserving / maintaining adequate slopes, necessary precautions, etc. For ensuring safety of workmen below natural ground level shall be the responsibility of the contractor. Similarly the contractor shall be responsible to protect all the excavation from weather.

#### **1.18.7 Protection**

The contractor shall take all necessary measures for the safety of the excavation, persons working, tools and plants working in and near the excavation pits, property and people in the vicinity.

Protection and maintenance of all bench marks axis points and other similar reference points if disturbed and/ or damaged, to be replaced by the contractor.

Location of existing utility lines; if shown on the drawings, is only approximate and only for interpretation. The contractor shall be responsible of their protection during the duration of the contract without causing any damage, dislocation, injury and/ or interruption to these utility services. If so, the same is to be replaced/ restored to their original status.

All the temporary roads, constructions etc. shall be made and maintained according to the provisions of this contract and as per the instructions of the Engineer-In-Charge upon the completion of this contract. And restore the area in its original condition.

### **1.19 EARTHWORK – FILLS**

#### **1.19.1 General Filling**

- Deposit in horizontal layers not exceeding 300 mm thick before compaction.
- Where material is dry, wet each layer to its optimum moisture content for compaction purposes.
- Where material is wet, delay compaction and placement of additional fill until optimum moisture content is attained.

#### **1.19.2 Structural Filling**

- Deposit in horizontal layers not exceeding 200 mm thick before compaction.
- Each layer shall be uniformly moist and at the optimum moisture content for compaction purposes.

**1.19.3 Crushed Stone**

- Deposit in horizontal layers not exceeding 200 mm thick.
- Deposit material so that it is free from lenses, pockets, streaks and other imperfections.
- Consolidate using hand tamping, vibratory tampers or other approved methods.

**1.19.4 Water**

Water used for compacting fill or for washing crushed stone shall be clean and free from oil, grease, organic matter, suspended sediments and other deleterious substances.

**1.19.5 Back Filling and Compaction**

Filling shall be done with approved quality of selected earth and or borrowed from the approved locations free from roots, grass, organic materials, spoils, rubbish and lumps and clots exceeding 8 cm in any direction shall be broken down. Filling shall be done in layers not exceeding 30 cm at a time. Each layer shall be watered with optimum moisture content to achieve 95% of maximum laboratory dry density of the soil. Consolidation shall be done with mechanical rammer or roller of minimum half-ton weight. Where roller cannot work, wooden or steel rammer of seven to ten kg weight with back of 20 cm diameter should be used.

Contractor shall not fill over any work until it is approved by the Engineer-In-Charge.

The contractor would rectify and / or restore the damage (s) occurred due to improper backfill and compaction done by it.

If any settlement occurs due to improper backfill and compaction and/ or cracks developing in the sub-structure/ super structure works due to the same, the contractor shall make good its damages/ defects.

All the back filling and compaction works shall be of acceptable standard to the Engineer-In-Charge.

**1.19.6 Inclusions in Excavation**

Apart from other factors mentioned elsewhere in this contract, excavation shall also include for the following:

- 1 Clearing site.
- 2 Setting out works as required.
- 3 Providing shoring and shuttering to avoid sliding of soil and to protect adjacent structures and subsequently by removing the same.

- 4 Collection of excavated spoil and sorting out useful excavated materials and conveying beyond the structure and stacking them neatly on the site for back filling or re-use as directed.
- 5 Bailing and pumping out water as required and directed.
- 6 Excavation at all depth and removal of all materials of whatever nature wet or dry and necessary for the construction of foundation underground reservoir etc. and preparing bed for laying concrete.
- 7 Necessary protection including labour, materials, and equipment to ensure safety and protection against risk or accident.
- 8 Drilling of small holes as directed to explore the nature of substratum if necessary.

## **1.20 Soling Used as Sub-Base**

### **1.20.1 Location**

Soling shall be done in the area wherever required or as directed by Engineer-in-Charge..

### **1.20.2 Soling Materials**

The size of stones to used soling shall not be more than 120mm, nor less than 50 mm when measured in any direction, and their height shall be equal to the proposed soling course depth of 75mm +/-25mm.

### **1.20.3 Preparation of the Sub-Grade before Laying Soling**

The top level of the sub-grade shall be lower than the level of the underside of the floor or other structure, to be built over it, by a distance equal to the combine depth of soling and metalling (due allowance being made for consolidation). The depth of the soling shall be 75mm but to achieve this finished depth, an initial loose layer of approximately 100mm will be necessary.

### **1.20.4 Laying and Packing the Soling Stones**

A layer of sand or small size gravel 50mm thick shall be spread and consolidated on the sub-grade surface prepared.

The stones for soling shall be of a height equal to the required thickness of soling. Their length or breadth shall not be greater than twice the soling thickness. This means that the stones would pass through a ring 180mm in diameter but not a ring 100mm in diameter.

Soling stone shall be hand packed as close as possible with their broadest side downward and greatest length across the road. Gauge pegs shall be driven at close intervals to indicate the required thickness of the soling. The joints between stones shall be placed at the edges of the area to be covered. All interstices between stones shall be wedged in with smaller stones, well driven into achieve tight packing and complete filling of the interstices.

### 1.20.5 Consolidation of the Soling

The soling shall be thoroughly consolidated with mechanical rollers of 8 to 10 tonne weight starting at the edges and working towards the center, if the soling is to have a cross fall the rolling shall commence at the lowest edge and work over and up to the upper edge. Rollers shall pass over the same surface at least 8 times to ensure that the soling is well consolidated. The top surface shall be checked frequently to make sure that it conforms to the design grade and level.

Vibratory compactors may be used, if approved by the Engineer -In-Charge instead of mechanical rollers. For areas where access is difficult or restricted heavy hand rammers and hand rollers may be used if approval for this has been obtained from the Engineer-In-Charge.

## 1.21 Pre-Construction Anti-Termite Treatment

### 1.21.1 Chemicals

- i) The chemical used for the soil treatment shall be of the following concentration in Aqueous Emulsion:

Chemical (EC)	Concentration
Chloropyriphos 20% EC (DE-NOCIL or equivalent)	1% by weight

- ii) Chemicals are available in concentrated form in the market and concentration is indicated on the sealed containers. To achieve the percentage of concentration specified above, chemical should be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemical with water in the required proportion to achieve the desired percentage of concentration.
- iii) Chemical shall be brought to site of work in sealed original containers. The material shall be brought in at a time in adequate quantity to suffice for the whole or at least a fortnight's work. The materials shall be kept in the joint custody of the contractor and the Engineer-In-Charge. The empty drums shall not be removed from the site of work, till the relevant item of work has been completed and permission obtained from Engineer-In-Charge.
- iv) Hand operated pressure pump shall be used to carry out spraying operations to facilitate proper penetration of chemicals in the earth. To have proper check for uniform spraying of chemical, graduated containers shall be used. Proper check should be kept that the specified quantity of chemical is used for the required area during the operation.

### 1.21.2 Time of Application

Soil treatment should start when foundation trenches and pits are ready to take mass concrete in foundations. Laying of mass concrete should start when the chemical emulsion has been absorbed by the soil and the surface is quite dry. Treatment should not be carried out when it is raining or soil is wet with rain or sub-soil water. The foregoing applies also in the case of treatment to the filled earth surface with the plinth before laying the sub grade for the floor.

The treated soil barrier shall not be disturbed after they are formed. If by chance, treated soil barriers are disturbed, immediate steps shall be taken to restore the continuity and completeness of the barrier system.

#### 1.21.3 Treatment for Masonry Foundation and Basements

The bottom surface and sides (up to a height of 30 cm. from the bottom) of the excavations made for masonry foundations and basements shall be treated with the chemical emulsion mentioned above at 5 lit per sq.m of surface area.

#### 1.21.4 Treatment to Backfill Earth

After the masonry foundations and retaining walls of the basement come up, the back fill in immediate contact with the foundation structure shall be treated with the chemical emulsion at the rate of 7.5 lit per sq.m of the vertical surface of the sub-structure for each side. The earth is usually returned in layers and the treatment shall be carried out in similar stages. The chemical emulsion shall be directed towards the concrete or masonry surface of the columns and walls so that the earth in contact with these surfaces is well treated with the chemical.

#### 1.21.5 Treatment for RCC Foundations and Basements

In the case of RCC foundations the concrete, the treatment shall start at a depth of 50 cm. below the ground level, except when ground level is raised or lowered by filling or cutting after the foundations have been cast. In such cases the depth of 50 cm shall be determined from the new soil level resulting from filling or cutting mentioned above and soil in immediate contact with the vertical surface of RCC foundations. From this depth, the back fills around the columns, beams and RCC basement walls shall be treated at the rate of 7.5 lit per sq.m.

#### 1.21.6 Treatment of Top Surface of Plinth Filling

The top surface of the consolidated earth within the walls shall be treated with the chemical emulsion at the rate of 5 lit per sq.m of the surface before the sand bed or sub-grade is laid. If the filled earth has been well rammed and the surface does not allow the emulsion to seep through, holes up to 50 to 75 mm deep at 150 mm centers both ways may be made with 12 mm dia MS rod on the surface to facilitate absorption of the emulsion.

#### 1.21.7 Treatment at Junction of Walls and Floor

Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from the ground level (where it has stopped with the treatment described in (1.16.3) above, up to the level of the filled earth surface.

To achieve this, a small channel 3 x 3 cm shall be made at all the junctions of wall and columns with the floor (before laying the sub-grade) and rod holes made in the channel up to the ground level 15 cm. Apart and the rod moved backward and forward to break up the earth and chemical emulsion poured along the channel at the rate of 7.5 lit per sq.m of the vertical wall or column surface of the sub structure so as to soak the soil right to the bottom. The soil should be tamped back in to place after this operation.

#### 1.21.8 Treatment to Soil along External Perimeter of Building

After the building is complete, the earth along the external perimeter of the building should be rodded at intervals of 15 cm. And to a depth of 30 cm. The rods should be moved backward and forward parallel to the wall to break up the earth and chemical emulsion poured along the wall at the rate of 7.5 lit per sq.m of vertical surfaces. After the treatment, the earth should be tamped back in to place. Should the earth outside the building be graded on completion of building, this treatment should be carried out on the completion of such grading. In the event of filling being more than 30 cm. The external perimeter treatment shall extend to the full depth of filling up to the ground level so as to ensure continuity of the chemical barrier.

#### 1.21.9 Treatment for Walls Retaining Soil above Floor Level

Retaining walls like the basement walls or outer walls above the floor level retaining soil need to be protected by providing chemical barrier by treatment of retained soil in the immediate vicinity of the wall, so as to prevent entry of termites through the voids in masonry, cracks and crevices etc. Above the floor level. The soil retained by the walls shall be treated at the rate of 7.5 lit per sq.m of the vertical surface so as to effect a continuous outer chemical barrier.

#### 1.21.10 Treatment of Soil under Apron Along External Perimeter of Building

Top surface of the consolidated earth over which the apron is to be laid shall be treated with chemical emulsion @ 5 lit per sq.m of the vertical surface before the apron is laid. If consolidated earth does not allow emulsion to seep through, holes up to 50 to 75 mm deep at 150 mm centres both ways may be made with 12 mm dia mild steel rod on the surface to facilitate saturation of the soil with the chemical emulsion.

#### 1.21.11 Treatment of Soil Surrounding Pipes, Wastes and Conduits

When pipes, wastes and conduits enter the soil inside the area of the foundation, the soil surrounding the point of entry must be loosened around each such pipe waste or conduits for a distance of 15 cm. And up to a depth of 7.5 cm before the treatment is commenced. When they enter the soil



external to the foundations, they shall be similarly treated unless they stand clear of the walls of the building by about 7.5 cm, for a distance of over 30 cm.

#### 1.21.12 Treatment for Expansion Joints

Expansion joints at ground floor level are one of the biggest hazards for termite infestation. The soil beneath these joints should receive special attention when the treatment under (1.18.4) is carried out. This treatment should be supplemented by treating through the expansion joint after the sub-grade has been laid, at the rate of 2 lit per linear meter. This specification is of utmost importance and should be executed by the contractor very carefully as the area has a potential of rendering the whole anti termite treatment ineffective if treated casually.

#### 1.21.13 Safety Precautions

All chemicals used for anti -termite treatment are poisonous and hazardous to health. These chemicals can have an adverse effect upon health when absorbed through the skin, inhaled as vapor or spray mists or swallowed. Person using or handling these chemicals should be warned of these dangers and advised that absorption through the skin is the most likely source of accidental poisoning. They should be cautioned to observe carefully the safety precautions given below: These chemicals are usually brought to site in the form of emulsifiable concentrates. The containers should be clearly labeled and should be stored carefully so that children and pet cannot get at them. They should be kept securely closed.

Care should be taken in the application of chemicals to see that they are not allowed to contaminate wells or springs, which serve as sources of drinking water.

### 1.22 Cast in-Situ Concrete

#### 1.22.1 Related Work

- Concrete formwork
- Concrete reinforcement
- Concrete finishing
- Sealants

As per relevant IS codes

#### 1.22.2 Definitions

##### 1.22.2.1 Water/Cement Ratio

The ratio by weight of water to cement in a mix expressed as a decimal fraction. Water being that which is free to combine with cement, including free water in aggregate.

1.22.2.2 Hot Weather

Shade air temperature of 32° C and higher.

1.22.3 Quality Assurance

1.22.3.1 Supervising staff shall have qualifications and experience in the subject.

1.22.3.2 The following tests shall be carried out:

- Mandatory tests as per CPWD specifications on bricks sand, aggregate etc.
- Testing preliminary test cubes;
- Testing work test cubes;

1.22.4 Standards

Comply with the following codes, specifications and standards and as shown on the drawings.

- IS 456: 2000 – Specifications For Plain And Reinforced Concrete.
- IS 8112:1989 or Latest Amendment - Specifications For Ordinary And Low Heat Portland Cement.

Quality assurance shall be a prime concern for all works

1.22.5 Materials

All materials used in the works shall be of best quality of their respective kind as specified herein, obtained from suppliers and sources approved by the Engineer-In-Charge and shall comply strictly to tests instructed by the Engineer-In-Charge, and where tests are not laid out, with the requirements of the latest issue of the relevant Indian Standard.

1.22.6 Test Certificate

All manufacturer's test certificates, proof sheets, etc. showing that the materials have been tested in accordance with the requirements of the specification and of the approved Indian Standard(s) are to be supplied free of charge on request to the Engineer-In-Charge.

1.22.7 Cement

Cement shall be of Portland type and shall comply of IS: 8112:1989. The cement used shall be of approved manufacture and the sources of supply shall not be changed without approval of the Engineer-In-Charge.

It shall be received in bags of 50 kg each confirming to IS 2580-1982, IS 11652-1986 or IS-11633-1986 or IS-12174-1987. The bags shall be marked with the manufacturer's name or its registered trademark, if any, type of cement and grade legibly and each batch shall be accompanied by a test certificate from the factory.

Samples shall be taken immediately on receipt of cement at about one sample per 1000 bags. Tests shall be carried out on fineness, initial and final setting time and compressive strength as per IS: 4031 and result verified by the Engineer- In-Charge before use in the permanent works samples shall be taken immediately on receipt of cement at site. Sampling shall be as per IS 3535.

**1.22.8 Stacking and Storage of Cement**

As per CPWD specification.

**1.22.9 Aggregate**

**1.22.10 Coarse Aggregate**

To be crushed naturally occurring materials conforming to IS: 383-1970. All physical properties and grading parameters must conform to this code.

1.22.10.1 Aggregate, 95% of which shall be retained on 4.75 mm test sieve.

1.22.10.2 Aggregate shall be from crush granite, quartzite, trap, and basalt quarries.

1.22.10.3 Free from soft friable thin porous laminated or flaky pieces.

1.22.10.4 Free and clean from dust and foreign matters, namely injurious amounts of disintegrated pieces, alkali, vegetable matters and other deleterious substances.

1.22.10.5 Shall be chemically inert when mixed with cement.

1.22.10.6 The aggregate shall not contain any material that will attack the reinforcement. The maximum quantities of deleterious materials in coarse aggregates shall not exceed the limits laid down as per IS:2386 (part I & II)

1.22.10.7 Shall be angular in shape

1.22.10.8 Maximum size of the aggregate shall be 20mm.

- 1.22.10.9 Shall have a minimum specific gravity of 2.6(Standard surface dry basis)
- 1.22.10.10 When stone aggregate or gravel is brought to the site single sized (ungraded), it shall be mixed with single sized aggregates of different sizes in the proportion to be determined by the field tests to obtain graded aggregate or specified nominal size.
- 1.22.10.11 Coarse aggregates brought to site shall be washed clean if required and as directed by the Engineer-In-Charge in charge.
- 1.22.11 **Fine Aggregate**
- 1.22.11.1 Shall be washed dry sand and shall confirm to IS: 383-1970 between grading zone I and II for structural concrete.
- 1.22.11.2 Shall pass through IS sieve 4.75mm test sieve leaving a residue not more than 5%
- 1.22.11.3 The sand shall be thoroughly washed with water so as to bring the percentage of silt content within the prescribed limit, so it shall not contain any traces of silt.
- 1.22.11.4 Fine aggregates shall be so stacked as to prevent dust and foreign matter getting mixed up with it.
- 1.22.12 **Water**
- 1.22.12.1 Water for mixing and curing shall be fit for construction as per standard.
- 1.22.12.2 Water shall be tested in accordance with IS: 3025-1986. Maximum permissible limits of deleterious materials in water shall be as given in IS: 456-1978.
- 1.22.12.3 The pH value of water shall not be less than 6 and more than 9.
- 1.22.12.4 Water which may erode or discolour concrete or which has got more than 1000 ppm of chloride content shall not be used.
- The contractor shall make its own arrangements for storing of water if necessary in drums, tanks to the satisfaction of Engineer-In-Charge. Care shall be taken to ensure that water is not contaminated anyway.
- 1.22.13 **Miscellaneous**
- 1.22.13.1 Chemical curing compound of approved make to form a membrane or surface which will disintegrate and flake from that surface over a period of days, commencing at least 7 days after application.

- 1.22.13.2 Vapor barrier and separation layer to underside of concrete slab, as and when necessary, and grade 10 mil (0.25 mm) thick polyethylene sheets with laps 100mm on sides and ends.

**1.23 TRIAL MIXES**

- 1.23.1 Before commencing work on site, prepare trial mixes for each type of concrete and conduct 6 preliminary test cubes from each mix.

- 1.23.2 The contractor shall test three cubes at 7 days and three at 28 days for each type of mix where the difference between the higher and the lowest test results from any one trial mix at 7 days exceeds 15% of the average and any cube weaker than the minimum requirement, make a further trial mix, increasing the proportion of cement if necessary to obtain the required strength.

- 1.23.3 If any test results from any one-trial mix fail to exceed the minimum strength at 28 days:

- Remove site materials from which the trial mix was prepared.
- Provide new materials and prepare and test further trial mixes until specified requirements are achieved.

The design mix shall hold good so long as the materials continue to be of the same quality and from the same source. Minor adjustments are to be done daily based on the tests of materials used and the compressive strength of mix shall be as per IS.

Control concrete shall be proportioned to obtain the required strength by conducting lab tests based on the design mix.

Control concrete shall have suitable workability for proper consolidation.

At places having heavy reinforcement when compacting concrete is a problem, the control concrete shall be designed with special care to the required strength.

Testing facilities to access the moisture content of aggregate at frequent intervals, testing of concrete cubes and testing of aggregate shall be done at the site by establishing testing laboratories. Concrete shall be weighed batched. The dials of weigh-batching units shall be checked with standard weights periodically.

Under special circumstances the conversion of weights to volumes may be allowed by the Engineer-In-Charge at his sole discretion.

The minimum cement content to be used for the job will be as Indian Statdard Codes.

Further the contractor has to provide and maintain all the equipment and stock at the site throughout till the completion of project, to carry out the following tests in a small site laboratory or get these tests done from approved laboratories.

#### Grading of aggregate

- Silt content of sand
- Moisture content of aggregate and sand
- Slump test of concrete mix
- Concrete cube test

#### 1.23.4 Assumed Standard Deviation

Where sufficient test results for a particular grade of concrete are not available, the value of standard deviation given in table below may be assumed.

M 10	3.5
M 15	3.5
M20	4.0
M25	4.0
M30	5.0
M35	5.0
M40	5.0

However, when adequate past records for a similar grade exists and justify to the designer a value of standard deviation different from the shown in table above, it shall be permissible to use that value.

#### 1.23.5 Standard Deviation Based On Test Results

1.23.5.1 Number of test results - Total number of test results required to constitute an acceptable record for calculation of standard deviation shall be not less than 30. Attempts should be made to obtain the 30 test results, as early as possible, when a mix is used for the first time.

1.23.5.2 Standard deviation to be brought up to date - the calculation of the standard deviation shall be brought up to date after every change of mix design and at least once a month.

#### 1.23.6 Consistency

The concrete which will flow freely into the forms and around the reinforcement without any segregation of coarse aggregates shall be used. The consistency shall depend upon the type of vibrator etc. to be used. The controlling factor for the same is the slump test.

When considered necessary by the Engineer-In-Charge, the workability of the concrete shall be ascertained by compacting factor test and VEE BEE Consistometer method as per IS: 1199-1959. The computing of values of workability of concrete by above two methods, IS:456-2000 has to be referred to.

#### 1.23.7 Temperature of Concrete

The placing temperature of concrete shall not be more than 32° C. If it is more, the Engineer-In-Charge may order addition of ice or chilled water to the concrete. Also the contractor shall take following precautions:

Mixer and weigh batcher shall be painted white color.

Aggregate storing bin shall not be exposed to the sun, water shall be sprinkled on aggregate well before concreting to keep the temperature low.

Similarly, during the cold weather, concreting shall not be done when the temperature falls below 4.5° C. The concrete placed shall be protected against by suitable covering. The concrete damaged by frost shall be removed and work redone.

#### 1.23.8 Shrinkage Cracks

Concreting shall be avoided in very warm weather. Under such circumstances, the placed concrete shall be covered with damp hessian cloth within two hours of placing of concrete.

To achieve good result the concrete shall be immediately covered with a plastic sheet and not allowed to come into direct wind contact, to eliminate shrinkage cracks.

#### 1.23.9 Workmanship

All works shall be true to level, plumb and square and all corners and edges in all cases shall be unbroken and neat. Any work not to the satisfaction of the Engineer-In-Charge will be rejected and the same should be rectified or removed and replaced with work of the required standard of workmanship.

### **1.24 Proportioning, Batching & Mixing Of Concrete**

#### 1.24.1 Proportioning

##### 1.24.1.1 Aggregate

The proportions, which shall be decided by conducting preliminary tests, shall be by weight. These proportions of cement, fine and coarse aggregates shall be maintained during subsequent concrete batching by means of weight batchers conforming to IS 2722 capable of

controlling the weights within one percent of the desired value. The different sizes shall be stocked in separate stockpiles. The grading of coarse and fine aggregate shall be checked as frequently as possible, as determined by Engineer- In-Charge to ensure maintaining of grading in accordance with the samples used in preliminary mix designs. The material shall be stockpiled well in advance of use.

**1.24.1.2 Cement**

The cement shall be considered by weight, for design mix.

**1.24.1.3 Water**

Only such quantity of water shall be added to the cement and aggregates in the concrete mix as to ensure dense concrete, specified surface finish, satisfactory workability, consistent with the strength stipulated for each class of concrete. The water added to the mix shall be such as not to cause segregation of materials or the collection of excessive free water on the surface of the concrete.

**1.24.1.4 Water/Cement Ratio**

The actual water cement ratio to be adopted shall be determined in each instance by contractor and approved by the Engineer-In-Charge.

**1.24.1.5 Proportioning By Water/Cement Ratio**

The W/C ratio specified for use by Design Mix shall be maintained. Contractor shall determine the water content / moisture content of the aggregates as frequently as desired by the Engineer-In-Charge as the work progresses and as specified in IS 2386 (part III) and the amount of mixing water added at the mixer shall be adjusted as directed by the Engineer-In-Charge so as to maintain the specified W/C ratio. To allow for the variation in their moisture content, suitable adjustments in the weights of aggregates shall also be made.

**1.25 Batching and Mixing of Concrete**

**1.25.1** The proportions of the materials for the concrete mix as established by the preliminary test for mix design shall be followed for all the concrete in the works and shall not be changed except when specifically permitted by the Engineer-In-Charge.

**1.25.2** The batching and mixing plant shall be fully automatic.

**1.25.3** The contractor has to arrange to erect batching plant for the design mix concrete on his own.



- 1.25.4 The concrete shall be transported to the site in specially made Transit Mixers & shall have suitable retarders so that it should not set before placing in position. It should have sufficient flow so that at height the concrete shall be placed by pumping only.
- 1.25.5 Each Transit Mixer, reaching site shall invariably, have manufacturer's certificate containing details like truck number Grade of mix, time of leaving the plant, time of reaching at site etc. A copy of the same shall be handed over to Engineer-In-Charge or his authorized representative.
- 1.25.6 However samples for testing etc. shall be taken as per the mandatory tests prescribed in latest CPWD specifications.
- 1.25.7 The water will be tested with regard to its suitability for use in cement concrete work.
- 1.25.8 To receive anchor bolt / foundation for machines to be installed at later date, pocket of size minimum 110x100x300 mm shall be kept while concreting of RCC/ CC members and shall be filled with CC 1:1:2 with plasticizer or as per the direction of Engineer-In-Charge.

**1.26 Ordinary Concrete**

Weigh batching shall be followed if mixed at the site for all structural concrete works. The contractor shall provide concrete batch mixers, vibrators, weigh batchers conforming to relevant IS specifications and from approved and recognized manufacturers. The capacity and number of mixers and vibrators required at the site from time to time shall be to the approval of Engineer-In-Charge. The contractor shall maintain a platform weighing scale of capacity 300 kg with fraction of 100 gm at the site.

The machine will have to be got calibrated by the contractor once in every two weeks or after 2000 cum of concrete whichever is later. The dials of the weigh batchers shall be checked with standard weights periodically.

- 1.26.1 Ordinary Portland cement concrete where specified shall be used.
- 1.26.2 Proportions 1:3:6, 1:2:4, 1:1.5:3, etc., in the specification refers to the quantity of cement by volume, dry coarse sand by volume, quantity of coarse aggregate by volume.
- 1.26.3 Cement shall be weighed, based on 1 cum. of cement weighs 1440 kgs or 1 full bag of cement 50 kgs corresponding to 35 Its by volume.
- 1.26.4 Correction factors to be applied for bulking of sand when the sand is either wet or moist.

Water cement ratio used shall be just sufficient for the workability of concrete. Minimum strength of concrete shall be obtained as below:

S. No	Proportion of concrete	Preliminary tests	Work-tests
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1.	1:3:6	135 Kg/Sq.cm.	100 Kg/Sq.cm.
2.	1:2:4	200 Kg/Sq.cm.	150 Kg/Sq.cm.
3.	1:1.5:3	265 Kg/Sq.cm.	200 Kg/Sq.cm.

Comprehensive strength of concrete shall be obtained by testing 15 cm. Cubes after 7 and 28 days of curing.

#### 1.26.5 TESTING

6 cubes shall be taken from any mix, 3 of them to be tested at 7 days, 3 at 28 days. Strength of concrete at 7 days shall be 2/3rds of the strength of concrete at 28 days. Strength of concrete at 28 days shall be as mentioned in table above and the criterion for accepting concrete is only as per the strength of concrete at 28 days achieved.

#### 1.27 Placing of Concrete

Placing of concrete shall be done using pumps only at all levels. The pumps shall be of sufficient capacity to achieve necessary heights wherever required. The slump of concrete placed with the help of pumps shall be more than 100mm and up to 130mm, unless otherwise instructed by the Engineer-In-Charge. Concreting shall commence only after formwork is approved, reinforcement is recorded and permission to proceed with concreting has been approved in writing from the Engineer-In-Charge.

For concreting of slabs and beams wooden plant or catwalks of chequered MS plates or bamboo mats or any other suitable materials supported directly on the centering by means of wooden blocks or lugs shall be provided to convey the concrete to the place of final deposition without disturbing the reinforcement in anyway. In no case labour or any other persons are allowed to walk over the reinforcement. In case of columns and walls, it is desirable to place concrete without any construction joints.

#### 1.28 Compaction of Concrete

Concrete shall be thoroughly compacted into a dense mass as depositing shall proceed by means of suitable vibrators. The vibrator shall maintain the entire concrete under treatment in an adequate state of agitation and shall continue during whole period occupied by placing of concrete. Care should be taken not to over-vibrate the concrete. While vibrating no holes should be visible in concreting. Compaction should be completed before the initial setting time. Compaction shall be done till air bubbles cease to appear. Concrete already set shall not be disturbed by successive vibration.

Hand tamping shall not be permitted. But only in exceptional cases, depending on the thickness of the members and feasibility of vibrating the same, the Engineer-In-Charge may permit hand tamping. Hand tamping or compaction shall be done with the help of tamping rods so that concrete

is thoroughly compacted and completely worked around the reinforcement embedded fixtures, and into the corners of the form work.

The layers of concrete shall be so placed that the bottom layer does not finally set before the top layers are placed. The vibrators are so applied so that the centre of mass being compacted at the time of placing of concrete.

When electric vibrators are in use the standby petrol, diesel or kerosene vibrator should always be available at the concreting point.

## **1.29 Construction Joints**

Construction joint shall be avoided as far as possible. If provided, concreting shall be carried out continuously up to the construction joints as directed by the Engineer-In-Charge and/or at the location and arrangement shown in the structural drawings. However, the number of such joints shall be kept to a minimum and they shall be as straight as possible.

Proposed location of construction joints shall be submitted by the contractor well in advance for approval of Engineer-In-Charge. The joints shall be at places where shear force is nil or at a minimum (normally at 1/3rd to 1/4th point of a span) and these shall be straight and at right angles to the direction of the main reinforcement. Stop ends provided shall be with necessary slots for reinforcement bars to pass freely without bending or other obstructions. They should be supported firmly so that the concrete can be properly vibrated and compacted at these points.

Before commencement of concreting after a break, adjacent concrete stopper and surfaces shall be cleaned, chipped free of any loose mortar and roughened to expose the aggregate and then brushed and cleaned. The concrete surface shall be sprayed with water for 24 hours before casting and kept wet until casting.

### **1.29.1 Horizontal Joints in Walls:**

1.29.1.1 Form horizontal joints in walls designed to be continuous with floor slabs at the top of an integrally cast kickers minimum 25mm high. No other horizontal joints will be allowed. Form horizontal joints in walls other than above:

- At the top of footings
- At the top of slabs
- At a minimum 20mm above the soffit of beam or girders connecting into columns.
- 15mm above soffit of suspended floors.

### **1.29.2 Construction Joints in Ground Slabs:**

- To comply with IS codes
- To align with column or grid lines where practicable.

#### 1.29.3 Isolation Joints:

- Form diamond shaped or circular separations around columns.
- Ensure all edges of slabs are isolated from adjoining construction.

#### 1.29.4 Control Joints:

- Space at 4 - 7 metre in width for one panel.

#### 1.29.5 Form By Either:

- Sawing a continuous straight line in the top of the slab
- Grooving fresh concrete with hand grooves
- Placing strips of wood, metal or pre-moulded joint material at joint locations. Top edges of strips shall be flush with concrete.
- Control joints shall be extended  $1/5$  to  $1/4$  times slab thickness into the slab.

#### 1.29.6 Vertical Joints in Walls:

Space not exceeding 5m centers and also locate where abrupt changes in thickness or height occur, at least 2m from corner.

### 1.30 EXPANSION JOINT

As indicated in drawing or as directed by the Engineer-In-Charge.

#### 1.30.1 Curing

Curing of concrete is most important. There shall be no compromise on this activity as it is for the contractor to arrange for everything necessary to make sure that the concrete is cured to the complete satisfaction of the Engineer-In-Charge in charge.

#### 1.30.2 Finishing

Concrete surface shall be finished keeping in mind the next operation to be carried out over the surface. For guidance the following points shall be noted:

- 1.30.2.1 Roof shall be trowelled even and smooth with a wooden float, before the concrete begins to set.
- 1.30.2.2 Surface that will receive plaster shall be roughened immediately.
- 1.30.2.3 Surfaces that will be in contact with masonry shall be roughened immediately
- 1.30.2.4 Surfaces that will receive floor finishes, tiling, etc. Shall be roughened while it is still green.
- 1.30.2.5 Every care shall be taken not to disturb the freshly laid concrete.
- 1.30.2.6 For ramps and basements concrete shall be broom-finished.

On finishing standards and quality / workmanship, the decision of the Engineer-In-Charge shall be final and binding on all parties.

### **1.31 Inspection and Corrective Measures**

Immediately on removal of formwork, the RCC surface shall be examined by the Engineer-In-Charge. Till such time, no remedial measures shall be carried out by the contractor. All remedial actions including breaking, if any, shall be on the instructions of the Engineer-In-Charge. In case of any violation of this rule, the concrete poured stands rejected. The decision of the Engineer-In-Charge in this regard shall be final and binding to all parties.

Sagged, bulged, patched, honeycombed work to an extent detrimental to structural safety or architectural concept shall stand to be rejected and contractor shall rectify by breaking or redoing, if required, as directed by the Engineer-In-Charge.

Surface defects minor in nature may be accepted as a special case by the Engineer-In-Charge whose decision in this matter is final and binding on the contractor.

### **1.32 Cracks**

Cracks observed shall be examined. It shall be kept under observation and a record shall be maintained for a period of 45 days. It shall be shown to the Engineer-In-Charge and the following procedure shall be followed:

Cracks not propagating/developing further and according to the Engineer-In-Charge not detrimental to the strength of the construction shall be grouted with non-shrinking epoxy based cement slurry or as directed by the Engineer-In-Charge.

Cracks developing further and felt detrimental to the strength of construction shall be tested as per the relevant Indian Standards.

Based on results, the Engineer-In-Charge shall order remedial measures or order the contractor to dismantle construction, cart away the debris, replace the construction and carry out all the consequent works thereto as directed/specified.

### 1.33 Quantum of cube testing

The minimum frequency of cube testing shall be as follows. Each set of sample shall consist of 6 cubes.

Concrete Quantity	Number of Sample Sets
up to 5 cum a day	1
5 cum to 15 cum a day	2
15 cum to 50 cum a day	3
more than 50 cum per day <sup>3</sup>	+ one additional for each 50 cum or part thereof

Three cubes shall be tested on the 7th day and three cubes on the 28th day.

### 1.34 Acceptance of Work

It shall be in accordance with in IS: 456-2000, SP-23 and SP-24.

### 1.35 Concreting under Special Conditions

During hot or cold weather concreting should be done as per the procedure set out in IS:7861 part I or IS:7861 part II or as directed by the Engineer-In-Charge.

Fixtures: any fixture, steel angles, holdfasts etc. shall be embedded according to the drawing or as instructed by the Engineer-In-Charge.

### 1.36 Precast Jali Blocks Louvers, Shelves, Etc.

All precast jali shall be exactly of the size and pattern as per standard or requirements and shall be made face up in the following manner. All units shall be integrally cast; steel formwork shall be used for making jalis. Provided in the formwork, stiff plastic concrete 1:1.5:3 shall be used with coarse aggregate 12mm and down size.

The precast units shall not be removed from the forms for three days. Precast work shall be cured under cover and shall be kept under water for fifteen days before placing in position. Samples of each part shall be approved by the Engineer-In-Charge before proceeding with the work.

All precast design mix concrete shall be weigh batched.

### **1.37 Ready Mix Concrete**

It shall be in accordance with in IS 4926-1976

### **1.38 Basis of Supply**

The ready mixed concrete shall be manufactured and supplied on the following basis.

- Specified strength based on 28-day compressive strength of 15-cm cubes tested in accordance with IS: 456-1964.
- When the concrete is manufactured and supplied on the basis of specified strength, the responsibility for the design of mix shall be that of the manufacturer.

### **1.39 General Requirement**

1.39.1 In addition to the requirements specified in this specification, the ready-mixed concrete shall generally comply with the requirements of IS: 456-2000.

1.39.2 The minimum quantity of cement and the details regarding proportioning shall be as per IS: 456-2000.

1.39.3 When a truck mixer or agitator is used for mixing a transportation of concrete, no water from the truck-water system or from elsewhere shall be added after the initial introduction of the mixing water for the batch, when on arrival at the site of the work, the slump of the concrete is less than that specified; additional admixtures shall be added to bring the slump within required limits into the mixer under such pressure and direction for the requirements for uniformity.

1.39.4 When a truck mixer of agitator is used for transporting concrete, the concrete shall be delivered to the site of the work and discharge shall be complete within 1.5 hours (when the prevailing atmospheric temperature is above 20°C) and within 2 hours (when the prevailing atmospheric temperature is at or below 20°C) of adding the mixing water to the dry mix of cement and aggregate or of adding the cement to the aggregate, whichever is earlier.

1.39.5 Temperature: the temperature of the concrete at the place and time of delivery shall be not less than 4.5°C. No concrete shall be delivered, when the site temperature is less than 2.5°C and the thermometer reading is falling.

1.39.6 The temperature of the concrete shall not exceed 50°C.

1.39.7 Sampling and testing: Adequate facilities shall be provided by the contractor for the IRCON to inspect the materials used, the process of manufacture and the methods of delivery of concrete. He shall also provide adequate facilities for IRCON to take samples of the materials used.

- 1.39.8 Sampling and testing: The sampling and testing of concrete shall be done in accordance with relevant requirements of IS: 456-1964, IS: 1199-1959 and IS: 516-1959.
- 1.39.9 Consistency or workability: The tests for consistency or workability shall be carried out in accordance with requirements of IS: 1199-1959.
- 1.39.10 Strength test: The compressive strength and flexural strength tests shall be carried out in accordance with the requirements of IS: 516-1959 and the acceptance criteria for concrete whether supplied on the basis of specified strength or on the basis of mix proportion, shall conform to the requirements of table 5 and other related requirements of IS: 456-1964.

The concrete quality shall meet all requirements and specifications of concrete as stated hereof. Contractor shall be allowed to use own batching plant or procure concrete, but quality tests will be the responsibility of the contractor and off-site batching plants shall be open for inspection to the Engineer-In-Charge throughout the project.

#### **1.40 Admixtures**

##### **1.40.1 General**

Admixtures may be used in concrete only with the approval of Engineer- In-Charge based upon evidence that, with the passage of time, neither the compressive strength nor its durability get reduced. Calcium chloride shall not be used for accelerating setting of the cement for any concrete containing reinforcement, or embodied steel parts. When calcium chloride is permitted to be used, such as in mass concrete works, it shall be dissolved in water and added to percent of the weight of the cement in each batch of concrete. When admixtures are used, the designed concrete mix shall be corrected accordingly. Admixture shall be used as per manufacturer's instructions and in the manner and with the control specified by Engineer-In-Charge.

##### **1.40.2 Retarding Admixtures**

Where specified and approved by Engineer-In-Charge retarding agents shall be added to the concrete mix in quantities specified by Engineer-In-Charge.

##### **1.40.3 Water Reducing Admixtures**

Where specified and approved by Engineer-In -Charge water reducing lignosulfonate mixture shall be added in quantities specified. The admixtures shall be added in the form of a solution.

##### **1.40.4 Water Proofing Agent**

Where specified and approved by Engineer-In-Charge, chloride and sulphide free waterproofing agent shall be added in quantities specified.



#### 1.40.5 Other Admixtures

1.40.5.1 The Engineer-In- Charge may at his discretion instruct the contractor to use any other admixtures in the concrete.

1.40.5.2 If the contractor so wishes to use admixtures, then the following should be adhered to (subject to Engineer-In-Charge's approval).

- No reduction will be allowed to target mean strength when compared to admixture free concrete of the same class.
- Dosage of admixture shall be strictly in accordance with the manufacturer's instruction.

1.40.5.3 The following information about the admixture shall be submitted to the Engineer-In-Charge for record and approval.

- Long and short term effects of the admixture in the concrete.
- Effect of admixture of concrete permeability.
- Effects of over and under dosage.
- Shortage life and special storage requirements.

1.40.5.4 The contractor when requested shall provide the services of a full time field technician of the admixture manufacturer to advise the proper addition of the admixture to the concrete or adjustment of concrete mix proportions to meet changing conditions.

1.40.5.5 The contractor shall furnish a statement of responsibility from the admixture manufacturer for their products.

#### **1.41 Miscellaneous Works**

The following items are not intended to exclude any other items of works required by the contractor, or that may be required by local code or good construction practice. The following work shall be included by the contractor as they may not have been detailed specifically on the architectural drawings and specifications but are required in order that job is complete in every respect:

- The supply, maintenance and removal of all temporary rungs, and ramping as necessary on the site.
- All finishes and to the concrete work as shown or specified.

- Allowed for the removal of constructions encountered.
- The excavation and concrete construction of all sump pits, manholes, drains under slabs, etc. as described in the specifications and shown on the drawings.
- Formwork, reinforcing, embedded items and layout for concrete tank cradles.
- All roof mechanical and other building services equipment pads and kerbs at the HVAC and electrical openings, concrete including dowels, formwork and roughing of concrete.
- All fire grading and removal of standing water before the placing of concrete.
- Included for all below slab, surface water and drainage, including brick fill, within the tender.
- Points and in steel below slabs lightening protection systems as detailed.
- The contractor, in the preparation of his bid, is to allow for watertight construction.
- Allow for keeping the works clear and tidy at all times and for the removal of debris arising from the works, and to be disposed-off at locations designated by the Engineer-In-Charge, and frequent removed off the site. Any surplus concrete deposited at the work front of on the site (concrete droppings) must be removed by the contractor.
- Provisions, hoisting, distribution and fixing of all embedded items required.
- Leaving all necessary holes and pockets for steel work beams for lifts and for making good after installation by other sub-contractors. Casting in all slots and inserts for fixings to guides and runners to lift shafts.
- All trench drain box-cut with necessary recesses and casting in all anchor bolts and providing and installing trench drains and other embedded items as per requirement.
- Include design mix weight and storage box for samples and test cylinders.
- Levelling of the floors to proper elevations as shown on the drawings to the tolerances and cambers and slopes specified including all changes of slab elevation.
- All means of transportation of concrete.
- Providing and casting into concrete slots to receive masonry or blockwork ties to support all such walls as shown on the drawings or as directed by the Engineer-In-Charge.
- Forming holes to riser ducts.

- Forming necessary cutouts at pipe locations to accommodate electrical, plumbing, sprinkler and electrical services.
- Forming in the concrete members chases for any asphalt "track-in" and/ or flashing and the like.
- Provide grout for lift saddle and floor closures prior to setting (setting by others).
- Grout pumps and other mechanical equipment as required.
- Provide temporary shoring and strutting as required due to the operations of the contractor.
- Provide and maintain ladders until stairs are usable.
- Provide adequate lighting at all areas
- Erect sufficient safety signs, posters and maintain high level of safety during the entire construction period.

## **1.42 Reinforcement**

### **1.42.1 Related Works**

- Concrete Formwork
- Cast In-Situ Concrete

### **1.42.2 Steel Grades**

Reinforcements for concrete shall be conforming to the relevant Indian Standards and their latest amendments.

### **1.42.3 BIS Certification**

Material received at the site shall have BIS certification mark. Such bundle or coil containing the bars shall be suitably marked with BIS certification mark. Bars shall also be marked to identify categories. This shall be done as per IS: 1387.

All reinforcements shall be free from loose mill scale, excessive rust, loose rust, pitting, oil, grease, paint, mud or any other foreign deleterious material present on the surface. Cleaning should be done to the satisfaction of the Engineer-In-Charge.

Material not acceptable as per EIC shall be removed from the site by the contractor within 15 days of its rejection.

## 1.42.4 Storage

Reinforcement bars received at the site shall be stored on hard, concreted platform and clear of the ground to a minimum of 300 mm with the use of timber sleepers or any other means. Reinforcements shall be kept covered by tarpaulins or plastic to avoid excessive corrosion or any other contamination. It is advised to follow storage methods as described in IS: 4082. The contractor shall comply with the instruction of the Engineer-In-Charge on method of stacking of steel.

## 1.42.5 Quality Assurance

Supervisory staff shall have qualification and experience in the above field.

## 1.42.6 Handling

- Bend test requirements shall conform to the following and shall be based on 1800 bends of full size bars around pins.

Bar Diameter (mm)	Pin Diameter for Test Bend
10, 12, 16	3.5 x BARDIA
20, 22, 25	5.0 x BARDIA
28, 30, 32	7.0 x BARDIA

- Tying wire shall be of 18 g black annealed mild steel wire or other approved type double fold to tie the reinforcements. It shall be free from rust, oil, paint, grease, loose mill, scales or any other deleterious material undesirable for concrete or reinforcement or which may prevent adhesion of concrete to reinforcement.
- Cover blocks shall be non-corrosive material such as plastic, but not wooden or broken bricks or stone. Specially made concrete blocks shall be used. Such cover blocks shall be cast from concrete and not from cement mortar; strength of these blocks shall be equal to the concrete in use.
- Cover Block shall be of any of the following :-
  - Wire
  - Precast Concrete
  - Moulded Plastic

Cover Block material shall be of durable quality and shall not lead to corrosion of reinforcement or spilling of concrete.

Precast concrete cover blocks shall be of the same mix as that of surrounding concrete.

1.42.7 Execution

1.42.7.1 Cutting And Bending

1.42.7.1.1 Flame cut and hot bending is absolutely forbidden.

1.42.7.1.2 Cut and bend reinforcement to approved shop drawings and details shall be used.

1.42.7.1.3 Bars to be cold-bend, either mechanically or by hand, but to correct radius using proper tools, machine and platform and confirming to IS 2502-1963.

1.42.7.1.4 Do not rebend without approval. In case of re bending, care shall be taken that the rating of bend is not less than 4 x bar dia at construction joints for plain steel bars and 6 x bar dia for high strength bars.

1.42.7.1.5 Reinforcement projecting from concrete shall not be bent without approval.

Bar bending schedule to be submitted for approval of the Engineer-In-Charge prior to commencement of any cutting, bending and binding of steel at site.

- Cracked end of bars shall not be used on this project.
- Bars should be inspected for visible defects such as cracks, brittleness, excessive rust, loose mills scale, etc.

1.42.7.2 Welding

- Do not weld reinforcement unless authorized by the Engineer-In-Charge and recommended by the manufacturers.
- Site welding shall be done with suitable safeguards and techniques.
- Welding, if approved, may be used for:
  - i) Lapping reinforcement in position
  - ii) Fixing reinforcement to other steel members.
- The length of run deposited in a single pass shall not exceed 5 x bar diameters. If Longer welded length is required divide into sections with the space between runs not less than 5 x bar diameters.
- Welded joints:

- a. Shall not be made at bends in reinforcement.
- b. Stagger joints in parallel bars of principal reinforcement unless otherwise approved.
- c. The distance between staggered joints shall not be less than the end anchorage length joints.

**1.42.7.3 Mechanical Splicing**

- To comply with IS 456-2000, ACI 318-1983 and ACI 439-3R-83
- Use as indicated in structural drawings.
- The mechanical splices shall be get approved from Engineer-In-Charge before using it at site.

**1.42.7.4 Inspection**

- Ensure that the reinforcement placing is checked by Engineer-In-Charge.
- Ensure that the formwork to receive the reinforcement is clean and free from debris.
- Cracked end of bars to be cut out.

**1.42.7.5 Anchoring**

Anchoring of bars and stirrups shall be provided exactly as detailed in the structural drawings or as directed by Engineer-In-Charge. In case of reinforcement steel in tension, deformed bars may be used without end anchorage provided the development length requirement is satisfied. Hooks shall normally be provided for plain bars in tension. Development length of the bars shall be determined as per relevant clauses of IS: 456 - 2000.

The anchorage length of straight bar in compression shall be equal to the development length of the bars in compression as specified in relevant clause of IS: 456 - 2000.

**1.42.7.6 Lapping of Bars**

Laps shall be strictly as per the structural drawing or as directed by the Engineer-In- Charge. For general guidance the following principles shall be followed as given in IS: 456 - 2000:

**1.42.7.7 Concrete Cover**

- Shall be in accordance with IS: 456-2000 and as per the instructions in structural drawings.

**1.42.7.8 Footings, Retaining Walls and Similar Member**

I.	Members in contact with earth but not cast against earth	-	50 mm
II.	Slabs-		20 mm
III.	Walls, Ribs	-	20 mm
IV.	<b>Beams:</b>		
	For Main Bars	-	Min.25 mm or dia
	For Stirrups	-	15 mm
V.	<b>Columns</b>	-	40 mm
	Columns Less Than 20 Cms	-	25 mm
VI.	<b>Water Tanks:</b>		
	In Contact With Water	-	40 mm
	In Contact With Air	-	20 mm
VII.	Walls In Contact With Water Earth	-	40mm

#### 1.42.7.9 Spacers Chairs and Other Supports

- Provide necessary supports to maintain reinforcement in its correct position.
- Provide spacer bars of same diameter as longitudinal bars but not less than 25mm diameter between two layers at 1.5 mm centers except where bundled bars are detailed.

#### 1.42.7.10 Precautionary Measures

- Do not insert bars into placed concrete.
- Do not damage forms and form linings.
- Fixing reinforcement.

#### 1.42.7.11 Adjustment and Cleaning

- Check reinforcement prior to and during placing concrete with particular attention to the top reinforcement in cantilever sections.
- Ensure that reinforcement is clean and free from corrosive pitting, loose rust, loose mill scale, oil and other substances, which may adversely affect reinforcement concrete or the bond between the two.
- Protect the projecting reinforcement from weather where the rust staining of exposed concrete surfaces may occur.

### 1.43 Form Work

1.43.1 Related Work

Concrete Reinforcement

1.43.2 Section Includes

Design, Fabrication, Erection and Striking of Formwork For In - Situ Concrete

1.43.3 Quality Assurance

Design and construction shall be executed and supervised by fully qualified personnel.

In accordance with quality assurance programme, the contractor shall provide the Engineer-In-Charge with information demonstrating that a system will be used to ensure that the work carried out under this section will comply with the requirements of the specifications.

1.43.4 Design Criteria

Formwork system shall be executed and designed by a specialist qualified, to the shapes, lines, forms and dimensions as per drawings. The contractor shall submit to the Engineer- In-Charge a method statement backed by design calculations. Required drawings and sketches shall be enclosed along with the statement for the proposed area to be taken up for working at a time. The number of repetitions expected, type of material used, etc. shall be detailed therein.

1.43.5 Basic Points to be understood in Designing of Formwork are stated below:

- Erected form work shall be watertight, shall conform to shape, lines, dimensions, vertically, rigid during placing, vibrating and configuring the concrete.
- Formwork system shall be of timber and 12mm thick water resistant ply board Aluminium / steel / and shall be continuous, straight and without any warping.
- Before placing of any formwork, design shall be approved by Engineer-In-Charge.
- Form work design shall have dimensional tolerance, removable without shock, disturbance or damage to concrete.
- All construction joints in beams and slabs shall be provided as per standard CPWD specification.
- Ties/inserts/dowels etc. shall be provided where required.
- Cambers shall be provided wherever required.



- Props / supports of extra ceiling height shall be specially designed.

#### 1.43.6 Form Work Material

Construction formwork shall be of smooth faced laminated plywood, aluminium, steel or timber to produce smooth straight level and sharp profiles shall be used for the works. Panels shall be of largest practicable sizes to reduce the number of joints. Formwork systems shall be a proprietary system by one of approved supplier manufacturers.

- Form material shall have strength adequate to withstand pressure of newly placed concrete without excessive and adjustable bow or deflection.
- Factory fabricated, adjustable length, removable or snap of metal form ties, design to prevent from deflection and to prevent spilling concrete surfaces on removal.
- Ties shall be such that a portion remaining within the concrete shall be at least 150mm from the outer concrete surface and that it will not leave a hole larger than 25mm dia meter on the concrete surface.
- Form coating compound that will not bond with, stain, not adversely affect concrete for required bond or adhesion not hamper the wetting of surface to be covered with water or curing compound.

All propping and centering shall be of adjustable steel supports (built-up sections of rolled steel) and tubular props to full height without joints, and with sufficient bracing to take into account the construction loads, namely full load of concrete with any live load and impact load likely to occur during concreting.

Steel shuttering used for concreting shall be sufficiently stiffened. The steel shuttering shall also be properly repaired before repetition and properly cleaned to avoid stains and defects in concreting.

#### 1.43.7 Workmanship

Formwork shall be classified based on the ultimate finishes required of the concrete surface as:

- Textured or decorative finish
- Fair-faced finish
- Rough finish

##### 1.43.7.1 Guidelines for Good Workmanship

Following are a few points as guidelines for good workmanship in formwork.

- 1.43.7.1.1 Erection of formwork may be from pre-moulded, pre-fabricated, pre-assembled plates or form reasonable enough to transport and erect at site to correct lines and levels as set at site.
- 1.43.7.1.2 Supports shall be firm and maintained in position by nails, cross bracing, tie-rods, locking bolts, nuts, etc. It shall be rigid and stiff so as to retain its shape during and after concreting.
- 1.43.7.1.3 Joints shall be water-tight and no cement slurry shall be allowed to get through
- 1.43.7.1.4 Pre-fabricated or site forms shall be assembled so as to de-shutter without any jerk to the green concrete. For this double wedges shall be used. The wedges shall be nailed. The heads left with, allowing easy removal while de-shuttering.
- 1.43.7.1.5 Pre-fabricated or site formwork shall be sufficient thickness with supporting spans in both directions. These shall be standardized in size for easy replacement and universal use at site
- 1.43.7.1.6 Props shall be of steel only. Its spacing shall be as per design. It shall be vertical and plumb. Base shall be of proper steel plate or timber plank for equal distribution of load
- 1.43.7.1.7 In case of multi-storied buildings, any upper floor shall be suitably supported on at least one floor below the same, or as approved by the Engineer-In-Charge.
- 1.43.7.1.8 Props shall be adequately cross-braced horizontally.
- 1.43.7.1.9 At the design and erection stage following additional points shall be considered and be incorporated into the setting :-
  - Opening of cleaning prior to the start of concreting.
  - Pouring points shall avoid high drops and provide easy access to vibrating needles
- 1.43.7.1.10 Surfaces shall be treated with suitable releasing oil or emulsion prior to the reinforcement laying. Such releasing oil shall be got approved from the Engineer-In-Charge.
- 1.43.7.1.11 Ensure that forms and adjacent surfaces are thoroughly cleaned to receive concrete.
- 1.43.7.1.12 Locate construction joints in a manner so as not to impair strength and appearance of structure.
- 1.43.7.1.13 Without absolving the details on the above, the contractor shall comply with instruction of the Engineer-In-Charge regarding formwork designing, erection, execution, rotation, maintenance and reuse.

Following points shall be observed very carefully:-

- 1.43.7.1.14 Joints of formwork shall be watertight. It is easy to check from the bottom and make sure no light is visible
- 1.43.7.1.15 Props shall be on solid base, plumbed, in straight line, braced horizontally and cross
- 1.43.7.1.16 Tie-bars, bracing and spacers in beams, walls and columns shall be at correct place/location and fully tight.
- 1.43.7.1.17 Wedges shall be fully secured and nailed with heads left out for easy removal
- 1.43.7.1.18 All saw dust, dirt, shavings and any other unwanted material shall be cleaned and hosed out
- 1.43.7.1.19 Provision shall be made for watching formwork while concreting and any other platform needed for movement of workers without any disturbance to the reinforcement
- 1.43.7.1.20 Provision is made for traffic on formwork: not to bear directly on reinforcing steel.
- 1.43.7.1.21 Number of reuses shall be decided by the Engineer-In-Charge on examining the condition of formwork after each use. If during concreting any weakness develops or formwork shows any distress, the work shall be stopped and remedial action taken.
- 1.43.7.2 Tolerances

Tolerance is a specified permissible variation from lines, grades or dimensions given in drawings. Unless otherwise specified, tolerances given in the following sections shall be permitted.

#### 1.43.7.2.1 Tolerance for RCC Buildings

Variation from plumb should be as follows:

- In the lines and surface of columns, walls, and other vertical members, viz. inside face of lift shaft, etc. 3 mm per 3.0 metre but not exceeding 10mm for the full height of the building.
- For Exposed Corner Column and Other Conspicuous Lines

In any Bay Up to 5 m Maximum	3 mm
In 10 m or More Bays	5 mm

- Soffits of Slabs, Ceilings and Beams

2.5 m Bays	3 mm
5.0 M Bays	3 mm
10 M or more Bays	10 mm

- Lintels, Sills, Parapets, Grooves and Other Conspicuous Lines

In any Bay Up to 5 m Maximum	3 mm
In 10 m or More Bays	5 mm

- Variation of the Linear Building Lines from Established Positions in Plan and Related Position of Columns, Wall and Partitions

In any Bay Up to 5 m Maximum	5 mm
In 10 m or More Bays	10 mm

- Deviation from dimensions of footing / foundation:

- (I) Dimension in plan (+) 50mm
  - Eccentricity in plan: 0.02 times the width of the footings in the direction of deviation but not more than 50mm
- (II) Thickness: (+) 0.05 times the specified thickness.
- (III) Surface of foundation against ground: -5mm, +10mm
  - Top surface of foundations, bases, piers : +5mm, -20mm

- Variation in sizes and location of sleeves, opening in walls and floors to be 5 mm (except for anchor bolts)
- Variation in cross-sectional dimension of columns and beams and thickness of slabs and walls -5 mm, +10 mm

#### 1.43.7.2.2 Variation in Steps

In A Flight of Stairs	Risers	Treads
In Flight of Stairs	3 mm	5 mm
In Consecutive Steps	1.5 mm	3 mm

All the tolerances mentioned above shall apply to concrete dimensions only, and not to positioning of vertical steel or dowels.

### 1.44 Removal of Formwork

Formwork shall not be struck until the concrete has reached strength at least twice the stress to which the concrete may be subjected at the time of removal of formwork.

#### 1.44.1 Minimum Time Requirements

For other cements the stripping time shall be suitably modified in consultation with the Engineer-In-Charge.

For precast moulds the stripping time shall be 24 hours.

Striking time shall be as follows:

	Type of Formwork	Minimum period before striking (excluding the day of casting)
I	Walls, Columns	12 Hrs
II	Vertical Faces	12 Hrs
III	Removal of Formwork with Props Fully Left Under Spanning Over 6m	7 Days
IV	Between Ribs Not More Than 1 To 2 M	7 Days
V	Ribs, Joists, Beams, Soffits	
a)	Up 3m Clear Span – Beams	7 Days
b)	Between 3m to 6m – Beams	14 Days
c)	Above 6m Clear Span Beams	21 Days
VI	One Way Floor Slabs - Up to 3m	7 Days
VII	One Way Floor Slabs - Between 3m to 6m	10 Days
VIII	One Way Floor Slabs - Over 6m	14 Days
IX	Beams and Girder Sides Removal of Props Below Slabs Spanning	12 Days
X	Over 6m	21 Days

Striking of formwork within the time limits listed above is subject to successful crushing of tubes compressive strength results. However re-shuttering and re-propping can be done if the required strength is attained as per the instructions of Engineer-In-Charge.

### 1.45 Miscellaneous Works

#### 1.45.1 Cleaning and Oiling of Forms

The contractor shall ensure that the surface of the forms that will touch the concrete shall be free from encrustations of mortar, grout, or other foreign material. Temporary openings shall be left at the bottom of formwork to enable sawdust, shavings, wire off-cuts and other foreign material to be removed from the interior of the forms before the concrete is placed. Compressed air shall be used to clean the complete formwork and remove all traces of dust and debris before pouring concrete the temporary holes shall then be closed.

The surface of the forms to be in contact with the concrete shall be coated with a reliable coating that will effectively prevent the adherence of concrete and will not stain the concrete surfaces. After each use, the surfaces of forms which have been in contact with concrete shall be cleaned of mortar and any other material sticking to them, then well wetted and treated with form oil approved by the Engineer-In- Charge. The contractor shall provide commercial form release agent that will not bond with, stain or adversely affect concrete surfaces and will not impair subsequent treatment of concrete surfaces.

#### **1.45.2 Openings / Inserts**

Contractor shall provide all required openings, pockets, inserts as detailed in drawings. The contractor shall provide required material and labour for fixing and supporting during concreting. It is imperative to consider that all openings and pockets shall be de-shuttered with care and all corners of openings shall be preserved, i.e. shall be in correct line and level. After concreting the openings shall be secured against any accident by proper covering and guard rail, warning notice, lighting, etc.

#### **1.45.3 Fair Face Finished Concrete**

These are additional requirements for fair faced concrete and include all visible concrete surfaces that are not specified or called for on drawings as plastered, including foundations and edges of slabs on ground.

#### **1.45.4 Related Work**

The contractor shall coordinate the work with masonry, electrical, mechanical, plumbing and other trades.

#### **1.45.5 Samples**

The contractor shall provide samples of fair face cast in place concrete colour finish showing the limits of colour variation. These shall be kept with the Engineer-In-Charge for reference.

#### **1.45.6 Form Ties**

Form ties may be used to prevent form deflection. They shall be evenly spaced for appearance. Form ties, steel reinforcement and tie wire to have sufficient cover as called for, to prevent any spilling of concrete. The contractor shall provide form ties that, when removed will not leave holes larger than 25mm diameter in the concrete surface.

### **1.46 Aluminium Formwork**

The panels of Aluminium formwork shall be made from high strength Aluminium alloy, with the face or contact surface of the panel, made up of 4mm thick plate, which is welded to a formwork of

specially designed extruded sections, to form a robust component. The panels shall be held in position by a simple pin and wedge arrangement system. The panel shall fit precisely, securely and requires no bracing. The walls shall be held together with high strength wall ties, while the decks are supported by beams and props.

The formwork system shall be precisely-engineered system fabricated in Aluminium. All the elements of a building namely, load bearing walls, columns, beams, floor slabs, stairs, balconies etc. shall be constructed with cast in place concrete. The resulting, structure shall be of good quality surface finish and within dimensional tolerances.

Aluminium Form work shall be a customized formwork for monolithic construction RCC members with a repetitive usage by using aluminium grade 5052 for panel sheets of minimum 4 mm thick and aluminium grade 6061 (Type-6) for extruded sections.

#### 1.46.1 Design and Approval:-

The Aluminium form work shall be designed based on structural requirements of buildings units, based on this, Proper Shell plan and Shop Drawing shall be made and submitted for approval to Engineer-In-Charge before start of fabrication.

The formwork shall bear, besides its own weight, the weight of wet concrete, Steel reinforcement, the live load due to labor, and the impact due to pouring concrete and workmen on it. The vibration caused due to vibrators used to compact the concrete should also be taken care off.

The surfaces of formwork should be dressed in such a manner that after deflection due to weight of concrete and reinforcement, the surface shall remain horizontal.

In the design of formwork for columns or walls, the hydrostatic pressure of the concrete shall be taken into account.

#### 1.46.2 Material

Since the basic elements of the formwork system are the panel, which is a framework of extruded Aluminium alloy sections welded to an Aluminium alloy sheet and consists of high strength special Aluminium alloy components. The panels shall be manufactured in standard sizes with required elements to suit the project requirements as per approved shapes and sizes.

#### 1.46.3 Workability

Aluminium Formwork panels shall be designed for any condition/component of building such as bay windows, stairs, balconies and special architectural features. This system is unique as all the components in a building, including slabs, floors, walls, columns, beams, staircases, balconies and window hood are to be monolithically constructed and there is no need for block works or brick

works. The resulting structure component shall be casted monolithically which control the concrete quality and workability.

#### 1.46.4 Time:

Since the Aluminium Formwork System is a monolithic construction technology, typical floor to floor construction shall be less than 7 to 8-day cycle, in consultation with Engineer-in- Charge.

#### 1.46.5 Components of Aluminium Formwork

The basic element of the formwork is panels, which is an extruded Aluminium alloy rail section, welded to an Aluminium alloy sheet. This produces a lightweight panel with an excellent stiffness to weight ratio, yielding minimal deflection under concrete loading.

Panels shall be manufactured in the desired size and shape to suit the requirements of specific projects.

#### 1.46.6 Beam Components

- 1.46.6.1 Beam Side Panel
- 1.46.6.2 Prop Head for Soffit Beam
- 1.46.6.3 Beam Soffit Panel
- 1.46.6.4 Beam Soffit Bulkhead

#### 1.46.7 Deck Components

- 1.46.7.1 Deck Panel
- 1.46.7.2 Deck Prop
- 1.46.7.3 Prop Length
- 1.46.7.4 Deck Mid-Beam
- 1.46.7.5 Soffit Length
- 1.46.7.6 Deck Beam Bar
- 1.46.8 Wall Components
  - 1.46.8.1 Wall Panel



1.46.8.2       Rocker

1.46.8.3       Kicker

1.46.8.4       Stub Pin

### **1.47 Other Components**

1.47.1 Internal Soffit Corner

1.47.2 External Soffit Corner

1.47.3 External Corner

1.47.4 Internal Corner

### **1.48 Assembly**

All panels shall be clearly labelled and marked to ensure that they are easily identifiable on site and shall be smoothly fitted together using the formwork modulation drawings.

1.48.1       Pin and Wedge System

The panels shall be held in position by a simple pin and wedge system that passes through holes in the outside rib of each panel. The panels shall fit precisely, simply and securely that require no bracing.

1.48.2       Quick Strip Prop Head

A unique V shaped prop head system that allows the 'quick strip' to take place whilst leaving the propping undisturbed. The deck panels can therefore be reused immediately.

1.48.3       Formwork Structure

Architectural details shall be incorporated during the design and manufacture of the Aluminium panels and shall be designed for condition such as bay windows, stairs, balconies and special architectural features. The accurate regular dimensions shall be achieved with the Aluminium formwork system enabling pre-fabrication of cast in items i.e. door and window frames and electrical and plumbing components.

1.48.4       Concreting Activities

There shall be two operatives on standby position during concreting for checking pins, wedges and wall ties as the pour is in progress. Pins, wedges or wall ties shall be secured properly in position, which shall not lead to the movement of the formwork. Following checks to be adopted during concreting:

Dislodging of pins / wedges due to vibration. Beam / deck props adjacent to drop areas slipping due to vibration. Ensure all bracing at special areas slipping due to vibration. Overspill of concrete at window opening etc.

**1.48.5 Post - Concrete Activities**

All formwork shall be struck after minimum 24 hours and back propping where ever required shall be provided as per direction of Engineer-In-Charge.

The Post-Concreting Activities includes:

**1.48.5.1 Cleaning**

All components should be cleaned with scrapers and wire brushes as soon as they are struck. Wire brush is to be used on side rails only.

**1.48.5.2 Striking**

Once cleaned and transported to the next point of erection, panels should be stacked at right place and in right order. Proper stacking shall be a well-managed operation that easily allows the next sequence of erection as well as prevents clutters and impede other activities.

**1.48.5.3 Filling of Tie Holes**

The formwork requires number of spacer, wall ties etc. which are normally placed @ 2 feet c/c; these create problems such as seepage, leakages.

The holes shall be properly filled by following process:

It shall be filled with Non shrink grout mortar or shall be filled by baker rod and ends sealed with non-shrink grout (min. 50mm from each ends) or as directed by Engineer-In-Charge.

**1.49 Plastering Work**

Refer to architectural specifications.

**1.50 Structural Steel Work**

This section covers the supply, fabrication, erection and transportation to site and erection on prepared foundations, walls, the structural steel work consisting of beams, columns, trusses, stairs, bracings, shear connections (horizontal/vertical), chequered plates, inserts, pergolas and other miscellaneous MS structural steel work. All structural steel shall be sandblasted and given two or more coats of spray synthetic enamel paint over zinc chromate steel primer

Grade of Steel used for the structures will be as per IS codes.

- Providing, fabrication, cutting binding to required size and shape, drilling punching, counter-sinking, welding, filling etc. finishing, erecting and fixing in position at all heights and depths with all lead and lift.
- M.S. grills/railing/rolling shutters/weld mesh etc. shall be fixed to masonry/ concrete jambs of floor by means of required size and number of M.S. lugs grouted/ embedded in cement concrete block 1:2:4 or fixed by means of suitable counter sunk screw with raw plugs.
- M.S. ladder shall be fixed to concrete slab by grouting in C.C. block 1:2:4 finished.

The accessories such as M.S. hold-fasts, lugs screws, raw plug, fasteners, G.I. pipe pieces, grouting in C.C. block 1:2:4 etc. shall be included in respective works.

- All steel work shall be painted with two coats of paint of approved make over two coat of red oxide primer.
- Transport of fabricated items from one place to another place.
- Necessary pockets shall be provided in columns to receive bolts and they shall be grouted by rich concrete where the trusses or other structural steel is supported over brackets or columns.
- Shop drawings for the structural steel work shall be prepared by contractor and they shall be got approved from the Engineer-In-Charge before commencing the fabrication work including submitting 6(six) blue prints of each drawing including the original tracing of the final drawings.
- Mild steel electrodes used for welding works shall be of approved make or equivalent make as per IS: 814.
- Domestic LPG Cylinder shall not be used for any cutting of steel members.
- All holes shall be drilled and no gas cutting shall be allowed.
- Localized 'Earthing' to be provided while welding to avoid any damage to electronic equipment's in the running plant

Fabrication drawings shall include the following:-

- Member sizes and details
- Types and dimensions of welds and bolts
- Shapes and sizes of edge preparation for welding
- Details of shop and field joints included in the assemblies
- Quality of structural steel, welding electrodes, bolts, nuts and washers, etc. to be used.
- Erection assemblies, identifying all transportable parts and sub-assemblies, associated with special instructions, if required, showing part marks and erection marks.
- Calculations where asked for approval.

The specific electrodes for the specific connections of various members at different locations as per the instructions of the Engineer-In-Charge.

- Details of all members and connections.
- Cambers and permissible tolerance in fabrication.

Main columns are spaced at required intervals. These columns will be supporting the floors and the roof. These columns are adequate thickness to carry the gravity loads and the lateral loads due to wind loads and the seismic loads.

Main Beams are designed for the moment, torsion and shear obtained from the analysis for various load combinations as per IS: 800 – 2007.

As the space frame structural steel will be exposed to ambient conditions and given that the building has an extended design life, the internal steel work should be galvanized and coated and fireproofed where appropriate

### **Quality of Steel**

Steel shall comply in all respects with BIS 2062 Grade E-350/410/550 or other approved and equivalent grade.

Rolled Steel and Hollow Sections

All steel sections shall comply with BS 4848 Parts 2 and 4. The rolling or manufacturing tolerances shall be such that the actual weight of sections does not differ from the theoretical weight by more than  $-2\frac{1}{2}\% + 5\%$ . Sections of sizes or thickness outside of these specifications shall be subject to the tolerance clauses of an equivalent nominal size.

### **Other Materials**

Other materials used in association with the steelwork shall comply with the appropriate IS, BS, or AISC/ASTM Standards unless such material is covered by a relevant local bye-law or regulation which shall override such standards.

#### **1.50.1 Workmanship**

The workmanship shall be of the best quality normally associated with this type of construction. All work shall be adequately supervised and care shall be taken to ensure that the structural members remain in proper position.

#### **1.50.2 Materials**

All materials shall be new and shall conform to their respective specifications as specified. The use of equivalent or higher grade or alternative materials will be considered only in very special cases subject to the approval of the Engineer-In-Charge.

#### **1.50.3 Welding Materials**

Welding electrodes shall conform to IS: 814.

Approval of welding procedures shall be as per IS: 823.

#### **1.50.4 Mild Steel**

Structural steel shall conform to IS: 2062 - GRADE-A.

#### **1.50.5 Black Bolts and Nuts**

Black bolts, nuts and screws shall be in accordance with IS: 1363 - "Black Hexagonal Bolts (6 to 39mm) with nuts, and black hexagonal screws (6 to 24mm) and IS: 1364 and IS: 1367 for other sizes.

Bolts shall comply with BS 4190 Grade 4.6. HSFG bolts, Grades 8.8 or 10.9, when used as friction grip shall comply with BS 4395, BS 4604, and BS EN 14399 unless otherwise shown. All bolts, nuts and washers shall be coated to match the weather protection system of the adjoining system (e.g. primed and painted after installation, hot-dipped galvanized prior to installation, etc.).

High grade F10T (10.9) or ASTM A490M or greater bolts shall not be hot dip galvanized, but shall be corrosion protected with Dacromet or approved equal.

All materials shall conform to their respective specifications. The use of equivalent or higher grade or alternate materials will be considered only in very special cases subject to the approval of the Engineer-In-Charge in writing.

#### **1.50.6 Quality Certificate of Materials**

The contractor shall be required to produce manufacturer's quality certificates for the supplied materials. Notwithstanding the manufacturer's certificates, the Engineer-In-Charge may ask for testing of materials in approved test houses. The test results shall satisfy the requirements of the relevant Indian standards. In addition to the routine external testing of materials as per the directions of Engineer-In-Charge, the contractor shall indulge in continuous checking / testing of material at site.

Whenever quality certificates are missing or incomplete or when material quality differs from standard specifications, the contractor shall conduct all appropriate tests as directed by the Engineer- In-Charge. Materials for which test certificates are not available or for which test results do not comply with relevant BIS standard shall not be used.

Design drawings shall indicate the welds to be given non - destructive tests or the main visual examination. The extent of each type of test for each weld, and the method of testing shall be noted.

### **1.51 Tests on Welds**

#### **1.51.1 General**

Engineer- In-Charge shall be the final authority to decide the importance of any weld and prescribe the mode of testing required for reassurance of the quality.

#### **1.51.2 Weld Inspection**

The weld seams shall satisfy the following:

- Shall correspond to design shapes and dimensions; and
- Shall not have any defects such as cracks, incomplete penetration and fusion, under-cuts, rough surfaces, burns, blow holes porosity, slag intrusion etc. beyond permissible limit ST

### **1.52 Masonry Works**

#### **1.52.1 Brickworks**

- The bricks shall conform to the IS 1077-1986 of minimum crushing strength of 75 kg./cm<sup>2</sup>.
- The building bricks are to be the best quality table moulded kiln burnt, patent bricks, hard sound, square with sharp arised, even and uniform in shape and colour free from cracks, stones, flaws and other defects. Samples of bricks are to be submitted to the Engineer-In-Charge for approval before full quantity is ordered. All supply of brick to conform to the sample approved. No brick after 14 hours immersion in water shall absorb water more than 15% of its own weight.
- The cement and sand shall be as described under 'cement concrete' and the mortar unless specified otherwise in indicative items is to be composed of one part cement to four parts of coarse sand by volume, thoroughly mixed by hand. Hydrophobic cement used in mortar shall be thoroughly machine mixed. No mortar that has started to set shall be used in the work.
- Every brick shall be thoroughly soaked in water before use. Broken bricks shall not be used except as closers. The courses shall be truly horizontal and the work strictly plumb, joints shall be broken vertically and they shall not exceed 1/2" in thickness. All joints in brick work are to be well filled with mortar.
- The brick work shall not be raised more than 12 single courses per day and shall be built in English bond, except brick on edge and half brick thick walls shall be built in stretcher bond. Except for brick on edge work, the bricks shall be placed with "frog" facing upwards.
- All joints in brick work shall be raked out 1/2" deep as the work proceeds, and before the mortar sets.
- The brick work is to be carried out with all necessary setbacks, projections, cuttings and toothings in conformity with the drawings.
- The brick work shall be cured by watering and continuously kept wet for 10 days, and the work shall be well protected during rainy season.
- All uneven, irregular and bad brick work poor in workmanship shall be demolished if deemed necessary by the Engineer-In-Charge and rebuilt by the contractor. If necessary the contractor will have to provide wooden plug, etc. The work will have to be executed at all height and lift.
- Should any efflorescence be observed in brick work, it should be washed down by clean water and brick surface treated with such chemicals as are deemed necessary by the Engineer-In-Charge, till efflorescence subsides. Should the efflorescence persist, the brick work shall be demolished if deemed necessary by the Engineer-In-Charge and the work rebuilt with new bricks including making Good all the work disturbed.
- Half brick masonry

All brick work under 115 mm thick shall be reinforced with hoop iron, 16 gauge 25 mm wide, or 2 nos. 6 mm dia bars, in every coarse in the bottom for the first four coarses and in every fourth coarse thereafter. The said bars shall be cast in or securely fixed to adjoining concrete walls or columns. 75mm thick RCC bond with 1:2:4 mix concrete and 2 nos. 10 mm dia MS bars with 'u' shaped 6 mm thk MS strips @ 150 mm centres, shall be provided at every 2 metre height or as directed.

#### 1.52.2 Mortar

The mortar for masonry work shall be cement and sharp coarse sand and shall be made in small quantities so as to be used up within 30 minutes. The cement and sand of the required proportion shall be first mixed dry thoroughly and water added and mixed to a sufficiently thick consistency as required by the Engineer-In-Charge. No left over mortar shall be used. Unless otherwise specified the mortar shall be of the following proportions.

- One cement and five coarse sand for 230 mm thick masonry work and above.
- One cement and four coarse sand for piers, half brick walls, honeycombed brickwork, hollow blocks.

#### 1.53 Autoclaved Aerated Concrete Block

The autoclaved aerated concrete blocks having oven dry density 550 to 650 kg/cum, fire resistance minimum 2 hours. The characteristics of AAC block will be conforming to IS-2185

BIS-1984: autoclave aerated concrete block BIS - 6041: construction of AAC block masonry

BIS - 6072 - 1971: specification of autoclaved reinforced cellular concrete block masonry

BIS - 6042 - 1969: construction of light weight concrete block masonry

BIS- 6441 - 1972: methods of test for autoclaved cellular concrete products

BIS- 6073 - 1971: autoclaved reinforced cellular concrete floor & roof slabs

BIS- 3809 - 1979: fire resistance test of structure

The blocks shall be stored on the site on a level ground. Protected against rain fall and snow fall.

Laying of mortar: the mortar shall not be spread so much ahead of the actual laying of the units that it tends to stiffen and lose the plasticity there by resulting in poor bond.

Consistency as per requirement of site must be maintained at the point of laying over bed.



Mortar joint shall be struck off flush with wall surface and when the mortar starts stiffening, it shall be compressed tightly.

## **1.54 Raw Material for Manufacturing of Bricks**

### **1.54.1 Flyash**

Generally flyash is obtained from the boiler of the power plant. It can be dry flyash or bottom ash obtained directly from the hopper or obtained from the slurry pond, confirming to the granulation size passing 95% from 0.06mm mesh.

### **1.54.2 Sand**

Siliceous sand used for production of flyash and line coloured bricks or to get light grey colour.

It should not contain more than 10% of water content in it.

### **1.54.3 Lime**

Quicklime having active calcium oxide (cao) used for production of fly ash sand lime bricks should be ground to fulfill following requirements:

Granulation of Quicklime If	0.063 mm.max. 0.1%
Supplied as Powder (Residue of Sieve Mesh)	0.08 mm.max. 80%

## 1.55 Waterproofing

### 1.55.1 Standards

Indian and other International Standards are followed for this section. Any discrepancies or ambiguities seen shall be brought to the notice of the IRCON and clarification / confirmation sought. Engineer-In-Charge decision shall be final. However, as a general rule, more stringent specifications shall be followed.

### 1.55.2 Quality Assurance

Manufacturer's qualification

- Not less than five years' experience in manufacturing of membrane roofing.
- Obtain primary materials from single manufacturer. Manufacturer's name shall be approved by Engineer- In- Charge.
- Provide secondary materials as required by manufacturer of primary materials. 1.52.3

Applicators Qualification

- Approved by manufacturer prior to execution of this work order, with experience on at least five projects.

Foreman of field crew: minimum five years' experience with system of waterproofing being installed.

### 1.55.4 Certifications

Manufacturer's certifications on manufacturer's letterhead :

- Certify system design; penetration, transition, and perimeter details; and system.
- Certify products proposed for use comply with standards.
- Certify materials ordered and supplied are compatible with each other suited for local and purpose intended and shipped in sufficient quantity to ensure proper timely installation.
- Certify materials have express warranty of merchantability and fitness for particular purposes of this project.

- Certify manufacturer has reviewed project and will issue warranty upon successful completion of installation.
- Certify materials shipped to site meet membrane manufacturer's published performance standards and requirements of this specification.
- Membrane manufacturer's approval of insulation type and method of installation.
- Manufacturer's approval of installer.

#### 1.55.5 Submittals

##### 1.55.5.1 Product Data

Contractor to submit along with his proposal product data for material he proposes to use.

##### 1.55.5.2 Informational submittals.

- Certifications specified in quality assurances
- Manufacturer's instructions

#### 1.55.6 Waterproofing Compounds

Waterproofing compounds shall be cementitious (cement based) non-shrinking, self-curing mixtures, these shall be :-

- Free from sodium and chlorides
- Free from material detrimental to concrete and reinforcement.
- Able to create a membrane in one or multiple coats as per manufacturer's instruction.
- Membrane capable to prevent infiltration when applied to interior faces and ponded.
- Permeability, shear bond strength, compressive strength, volume changes meets minimum requirements of codes.

#### 1.55.7 Accessories

All other accessories materials such as primers, bonding agents, polymers etc. Shall be as recommended by waterproofing manufacturer.

#### 1.55.8 Guarantee

The waterproofing work and sealing of sleeve after passing cable, bunch of wires and pipe etc. Shall be guarantee for 10 years on the non-judicial stamp paper of appropriate value.

#### 1.55.9 Materials

##### 1.55.9.1 Cement

Cement shall be Ordinary Portland Cement conforming to IS and shall be of grade 43 or 53.

##### 1.55.9.2 Sand

Natural sand deposited by stream or glacial agencies as a result of disintegration of rock is the best form of sand and shall be used.

Sometimes it is obtained from crushed stone screenings but often contains a high percentage of dust and clay. It tends to be flaky and angular. This type produces harsh concrete and should be avoided.

Sea sand shall not be used.

Sand shall be hard, durable, clean and free from adherent coatings and organic matter and shall not contain any appreciable amount of clay. Sand shall not contain harmful impurities such as iron, pyrites, coal particles, lignite, mica shale or similar laminated material, alkali, and organic impurities in such form or quantities as to affect the strength or durability of concrete or mortar.

When tested as per IS 2386 part II, sand shall not exceed permissible quantities of deleterious materials as given in IS 383.

Grading of sand shall conform to relevant IS code and shall fall within limits. Sand shall be stored in such a way that it does not get mixed with mud, grass, vegetables and other foreign matter. The best way is to have a hard surface platform made out of concrete, bricks or planks. It should be to the approval of the Engineer-In-Charge.

##### 1.55.9.3 WATER

- Water used for mixing and curing shall be clean, reasonably clear and free from objectionable quantities of silt, oils, alkalies, acids, salts so as not to weaken mortar, or concrete or cause efflorescence or attack the steel in RCC while curing. It shall be free of elements, which significantly affects the hydration reaction. Potable water is generally satisfactory but it shall be water tested shall be in accordance with IS 3025. Maximum permissible limits of deleterious materials in water should be as given in IS 456.

- Water storage tanks shall be such as to prevent any deleterious materials getting mixed with it.

### 1.56 Water Proofing using Injection Grouting

- a) Water proofing treatment by chemical injection grout process on walls of UG sump and basement using 12mm dia MS nozzles of minimum 25mm deep in walls placed and fixed @ 1.50m distance in both directions in the walls and @ 0.75m c/c along construction joints, consisting of injecting cement slurries of different viscosities under pressure by pump using pidicrete AM @ 225 gm / kg of cement and sealing off nozzles after the injection operation with suitable admixture including providing and applying two coats of cementitious coatings in the ratio of 3:1 (3 parts of cement : 1part WP compound) keeping w/c ratio as per manufacturers specifications & providing 12-15mm thick neat finished cement plaster 1:4 (1 cement:4 coarse sand) added with pidiproof LW @ 200 ml / kg cement as per manufacturers specification and direction of IRCON. At construction joints V-grooves to mode and filled with acrylic mortar with pidicrete MPB @ 10% by wt. of cement.
- b) Water proofing treatment by chemical injection grout process on base slab of UG Sump/OH tanks using 12mm dia MS nozzles of minimum 25mm deep in walls placed and fixed @ 1.50m distance in both directions in the walls and @ 0.75m c/c along construction joints, consisting of injecting cement slurries of different viscosities under pressure by pump using pidicrete AM @ 225 gm / kg of cement and sealing off nozzles after the injection operation with suitable admixture including providing and applying two coats of pidicrete MPB cementitious coatings in the ratio of 3:1 (3 parts of cement: 1part pidicrete MPB) keeping w/c ratio as per manufacturers specifications & providing 25 mm thick neat finished cement plaster 1:4 (1 cement:4 coarse sand) added with pidiproof LW @ 200 ml / kg cement as per manufacturers specification and direction of IRCON. At construction joints v-grooves to mode and filled with acrylic mortar with WP compound @ 10% by wt. Of cement and top of cement plaster provide embedded P-gravels.

### 1.57 Water Proofing Works

#### Waterproofing-Membrane & Cementitious

Surface Requirement to do the effective waterproofing.

- All surfaces to be waterproofed should be made sound, clean and dry.
- Concrete surfaces should have a light steel-trowel followed by a fine hair-broom or equivalent finish, which is dry and free of dust, oil and other contamination.
- Sharp projection, moss and lichen must be removed physically.

- Grouting periphery of spout pipes with water insensitive epoxy, pressure grouting of construction joints and honey comb areas with cement grout, proper preparation of the concrete surface by mechanical means / hydro blasting to ensure a good bond between the topping and the substrate.
- Testing of the surfaces prior to start the work, grouting or sealing of joints, packing bore holes, making watta (coving) at corners / junctions etc complete.

#### **Important Notes -**

**Specialized agency to be approved by IRCON/Client who shall give Guarantee for 10 years for the Waterproofing Works done at Site.**

Contractor shall give both material and performance guarantee in the format approved by Clients / Consultants.

#### **Treatment to Periphery of the Pipes**

Sealing of Core cutting areas with micro concrete in the sequence below to ensure water tightness at the junctions.

- Core cutting and hacking
- Wash thoroughly this hacked off areas to expose the clean concrete surfaces between outlet pipe and concrete.
- Place and fix the pipe mechanically make necessary shuttering from the bottom.
- Pour micro concrete, 4 parts micro concrete and 1 part of water to fix and seal the pipe. Remove the shuttering after one day / two day and curing done for 7 days.

#### **Detailing Around the Pipe**

Providing & fixing deck web of required size around the pipe sand-witched with waterproofing membrane.

Note: treatment to periphery of the pipe shall be done.

#### **1.57.1 Under Raft Slab/Stich Slab/Pile Caps Waterproofing System**

**Waterproofing of Raft/Base Slab:** Supplying & installing positive side waterproofing treatment for “Raft Slab/Base Slab” by using minimum 1.5mm thick, Pre applied, flexible, fully bonded HDPE sheet membrane before casting of the base RCC slab. Fully bonded HDPE membrane should have minimum HDPE thickness of 1mm and need not require dry PCC and can be installed on wet/damp PCC as long

as PCC is free from ponded water allowing faster construction. Fully bonded HDPE membrane should have sufficient high puncture resistance and does not require protection screed protection also & steel reinforcement can be laid directly over the HDPE membrane allowing faster construction.

Fully bonded HDPE membrane shall provide an intimate bond to the underneath of the poured concrete used as base/ raft slab to resist water migration. Membrane should be supplied with original manufacturer's Material Test Certificate (MTC) & membrane should be installed in strict accordance with original manufacturer's instructions (private label supplier not acceptable) and contractor should produce method statement from original product manufacturer. The fully bonded HDPE sheet membrane shall consist of a multi layer composite film which consists of highly resilient 1mm HDPE film, strong adhesive and a trafficable weather resistant layer.

The fully bonded HDPE sheet waterproofing membrane shall have following typical properties:

- Elongation: > 300%
- HDPE Thickness - >1mm
- Membrane Thickness – 1.5mm minimum
- Puncture Resistance > 900 N

Fully bonded HDPE membrane shall be laid over the entire area and returned on to a vertical slab formwork. No Screed Protection Required for Fully Bonded HDPE Membrane Allowing Faster Construction

The membrane shall be installed with manufacturer's instructions over the entire area and turned up on to a vertical timber formwork/block work, as per recommendations/drawings. The fully bonded HDPE membrane shall be laid over the concrete blinding having uniform surface including necessary removal of release liner on the selvedge while applying, necessary overlaps between the membranes and fixing overlaps by Double Side Tape, firm rolling onto the surface to get a tight seal, etc. complete all as per manufacturer's recommendations, etc. complete with all lead and lift for all materials and labour and as directed by engineer in charge.

#### 1.57.2 Retaining wall:

##### **Waterproofing of Un-Confined Retaining Wall:**

Supplying & installing 1.5mm thick self adhesive, cold applied, flexible waterproofing membrane comprising of a self adhesive rubberized asphalt with minimum 0.5mm HDPE film. Membrane should be supplied with original manufacturer's Material Test Certificate (MTC) & membrane should be installed in strict accordance with original manufacturer's instructions and contractor should produce method statement from original product manufacturer. The self adhesive membrane shall have following minimum properties :

- Lap Adhesion : > 670 N/M
- Thickness : 1.5mm with HDPE thickness of 0.5mm
- Elongation (to ultimate failure of rubberised asphalt) : >200%
- Puncture Resistance : >240N

Self adhesive membrane Termination on retaining wall which includes providing a chase of (20 x 20) mm at a distance of 300 mm from ground level or 150 mm from podium/roof slab level for membrane termination. The self adhesive membrane should be dressed into the chase and pointed with mortar or as approved by supplier prior to backfilling .

All system to be installed as per supplier's recommendations, etc. complete with all lead and lift for all materials & labour & as directed by Engineer in-charge.

The membrane shall be applied as per following procedure:

- Clean the RCC surface free from dust with brush. Remove any sharp protrusions on the RCC wall by chipping and local repairs.
- Apply solvent based local primer on the surface and allow to dry.
- Roll out membrane, cut it to manageable lengths and stick it to the surface by peeling off the release paper on the back of the membrane. Press membrane in place. Adjacent rolls to come on 50 mm overlaps lines on the membrane. Roll the laps and joints by hand roller.
- Continue applying the membrane till entire area is covered.
- Membrane Protection : Protection of membrane with Supply & spot bonding 7-8mm thick dimpled HDPE protection board spot bonded onto the self adhesive membrane with liquid mastic. and shall be applied prior to backfilling. The backfilling shall be done within 2-3 days of fixing protection board.

#### 1.57.3 Toilet/Foodcourt-Kitchen/Pantry Waterproofing

Providing and Applying waterproofing and filling for Toilet in following parts as per the specifications listed below and as approved by the Project Manager.

##### Flooring



The First part consist of all surface area should cleaned up to visible of hair cracks / aggregate texture. Cleaning of RCC member should be done by hacking tool, wire brush, wire grinder & air blower etc. Open cracks & construction joints should be sealed with cement mortar with additive. All clean & treated area should tested for water tightness by flooding water. All wet spots & water leakage area should mark for treatment.

The Second part consisting of Providing and applying proprietary high polymer modified cement elastic waterproofing coating made up by acrylate, cement and inorganic materials with minimum elongation of 200% with one coat of primer followed by two coats waterproofing membrane (0.9 KG / sqm / Coat) waterproofing system and should have following properties:

- Tensile Strength MPa : >1.2
- Solid Content % : 70
- Elongation > 200%

shall be applied as per manufacture specification.

### Walls

The First part consist of all surface area should cleaned up to visible of hair cracks / aggregate texture. Cleaning of RCC member should be done by hacking tool, wire brush, wire grinder & air blower etc. Open cracks & construction joints should be sealed with cement mortar with additive. All clean & treated area should tested for water tightness by flooding water. All wet spots & water leakage area should mark for treatment.

The Second part consisting of Providing and applying high polymer modified cement elastic waterproofing coating made up by acrylate, cement and inorganic materials with minimum elongation of 200% with one coat of primer followed by two coats waterproofing membrane (0.9 KG / sqm / Coat) waterproofing system and should have following properties:

- Tensile Strength MPa : >1.2
- Solid Content % : 70
- Elongation > 200%

shall be applied as per manufacture specification.

The third part consist of protecting with avg. 10-12mm thick, CM1:4 plaster admixed with Integral Waterproofing Compound approved makes as per manufacturer's specification up to 3' height and shower area up to 7' height.

#### 1.57.4 Landscape garden waterproofing:

The First part consist of all surface area should cleaned up to visible of hair cracks / aggregate texture. Cleaning of RCC member should be done by hacking tool, wire brush, wire grinder & air blower etc.

Open cracks & construction joints should be sealed with cement mortar with additive. All clean & treated area should be tested for water tightness by flooding water. All wet spots & water leakage area should mark for treatment.

The Second part consisting of providing and applying high performance, low odour, one-part, fast curing, high solids, cold applied polyurethane elastomer (PU) waterproof membrane over uniform surface of slab. Apply minimum 1.6 kg/sqm to achieve the required minimum DFT of 1.5mm. PU waterproof coating shall be such which can be applied to damp/green concrete allowing faster construction and efficient waterproofing in all weather.

PU waterproof coating which cannot be applied on damp concrete/green concrete inhibiting fast construction are not acceptable. PU should have following minimum properties:

- Solid % Vol: 84
- Tensile Strength > 200 PSI
- Elongation > 500%
- Chemical Resistance – Excellent shall be applied as per manufacturer specification."

Third Part consisting of laying screed to slope with minimum 50mm at rain outlet (for easy flow of water/rain water). Treated surface shall be kept ponded for continuous period of 7 days to detect any seepage/ leakage/ dampness if any, the surface then shall be cleaned to withstand weather and domestic use.

The Fourth part consist of Providing & laying rolled matrix soil filter cum drainage system of minimum 8mm thickness Cavity Drain having a compressive strength of 180 KN/sqm of 8mm height with geo textile on top, as per manufacturers specification, complete as directed.

The minimum properties should be:

- 1) Compressive strength 180 KN/m<sup>2</sup>

Providing and laying non-shrink grout of size 30x30mm complete around junctions.

#### 1.57.5 Water Retaining Structures - UGT / OHT

Treatment to concrete defects like Construction Joints, Cold Joints, Honey Combs & Porous Concrete.

All construction joints, honey combs, cold joints, of concrete shall be treated by hacking and opening the affected area till sound concrete, fixing nozzles and grouting the same, under pressure with cement

slurry mixed with plasticizer non shrink additive and sealing all the construction joints with non shrink mortar."

Cleaning the surface thoroughly, providing and applying waterproofing system in two coats by trowelling as per manufacturer's specifications. The 1st coat shall be applied to the prepared surface at coverage of 1 kg/sqmt. Whilst the 1st coat is still "green" a second coat at a coverage of 1 kg/Sqmt shall be applied. The slurry coatings shall be applied with a stiff masonry brush or stiff broom and worked into every irregularity on the surface by means of toweling or by spray only. Treatment to floor slabs shall be carried out by trowel application in 2.0 kg/Sqmt coverage using a steel trowel into hardened concrete slab surface including curing, cleaning etc complete.

#### **Food Grade Epoxy Coating:-**

Providing and applying 2 coats epoxy coating by mixing 2 components using slow speed heavy duty drilling machine fixed with mixing paddle, applying first coat using brush or roller and allowing it to dry for 16-18 hrs, applying second coat and allowing it to dry completely, etc and complete as per manufacturer's specification. [The properties of membrane are:-Pot life: 30 min; Mixed density: 1.45 – 1.55 gms/ml at 27° C; Time between the coats: 6-8 Hrs; Walkability: 24 Hrs; Full cure: 7 days; Bond strength: > 1.5 N / Sqmm; Dry film thickness: 130 microns;]

#### **1.57.6 Roof Waterproofing-**

Over the mother slab, providing and laying slope with 100mm average thick Plain concrete topping (PCC) of mix 1:2:4 with 1 part cement, 2 part coarse sand and 4 part graded aggregates laid in slope of 1: 20 with Waterproofing compound confirming to IS 2645 shall be added to the mix as per the manufacturers specification.

Providing and laying 1.52mm EPDM Membrane treatment over Concrete Roofs prone to water, including preparation of the surface as required for treatment consisting following operations:

##### **Horizontal**

The surface of the roof top structure should be cleaned of all dirt, loose material and kept dry.

Providing and laying providing and laying specially formulated single-ply 60 mil (1.5 mm) EPDM non-reinforced (Ethylene, Propylene, Diene Terpolymer) membrane non-reinforced black with minimum Roll width 6 meters with factory applied on one side of the membrane. Membrane shall be laid loose. Over lap joint shall be made using tape. Membrane shall have minimum of 75mm side and end laps which shall be sealed with highly formulated double sided tape. Membrane shall be able to resist 40mtr. head pressure, with tensile strength of > 11.0 mpa, elongation > 465% and water vapour diffusion of < 24'000 microns, Tear resistance to ASTM D624, Die C dimensional change < -0.7%. 100% UV resistance, Ozone resistance according to ASTM D1149, membrane shall be taken

## Vertical

Providing and laying non-reinforced 60 mil 1.52 EPDM membrane by overlapping on the horizontal membrane on the vertical parapet walls after removing any sharp material etc. from the surface by sealing the membrane with tape with sheet to the extended portion of the horizontal memberane as per the manufacturers specifications in all complete. The membrane shall be fully bonded with Seal Bonding adhesive with vertical surface. At the top end on the vertical side the membrane is fixed with aluminium flashing and sealed with Sealant and Water cutoff mastic.

The membrane shall be covered with the geo textile of 200 gsm membrane for the protection of EPDM membrane to avoid to get membrane punctured while working further and protected by laying 1:2:4 protection Cement Concrete screed laid in slope of 1:120 by the Contractor.

### 1.57.7 Insulation:

Providing and laying roof insulation 100 mm thick with density 40kgs/cum extruded polystyrene of approved manufacture having compressive strength not less than 250 kpa as per ASTM 1621 with the thermal conductivity shall be greater than 0.026 W / mK and water absorption of less than 0.1 on over deck surface thoroughly cleaned with wire brushes, minute gaps shall be filled and entire surface shall be fortified against fungal growth by application of 2-3 coats of black Japan paint primer, slip sheet such as polythene film of 170 gms (min) should be laid on top of (water proofing membrane to prevent damage to it by Fines and Grit being washed down). Extruded polystyrene sheets shall then be installed on the slip sheet using CPRX compound to secure them firmly with their drain channels facing down, 3/4 inch space allowed at penetration and cant strips, insulation and joints staggered boards ship lapped tightly with maximum 3/8 inch gap allowed and finishing done by filling and / or covering the joints with CPRX and / or self adhesive insulation tapes complete as directed.

### 1.57.8 Making Khurras

45x45 / cm with average minimum thickness of 5 cm cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate of 20 mm nominal size) over P.V.C. sheet 1 m x 1 m x 400 micron, finished with 12 mm cement plaster 1:3 (1 cement : 3 coarse sand) and a coat of neat cement, rounding the edges and making and finishing the outlet complete.

### 1.57.9 Providing And Fixing Heat Resistant Terrace Tiles

Tiles to exposed structural roofs (300 mm x 300 mm x 20 mm) with SRI (solar refractive index) > 78, solar reflection > 0.70 and initial emittance > 0.75 on waterproof and sloped surface of terrace, laid on 20 mm thick cement sand mortar in the ratio of 1:4 (1 cement : 4 coarse sand) and grouting the joints with mix of white cement & marble powder in ratio of 1:1, including rubbing and polishing of the surface upto 3 cuts complete, including providing skirting upto 150 mm height along the parapet walls in the same manner.

1.57.10 The water proof treatment shall be of type and specifications as given in the drawings and other documents:

- a) The water-proofing of basement, roofs, water retaining areas shall be and remain fully effective for a period of not less than 10(Ten) years to be reckoned from the date of expiring of the Defect Liability period, prescribed in the contract. At any time during the said guarantee period if IRCON finds any defects in the said treatment or any evidence of re-infestation, dampness, leakage in any part of buildings or structure and notifies the contractor of the same, the contractor shall be liable to rectify the defect or give re-treatment and shall commence the work or such rectification or re-treatment within seven days from the date of issue of such letter to him. If the contractor fails to commence such work within the stipulated period, the IRCON may get the same done by another agency at the Contractor's cost and risk and the decision of the Engineer-in-Charge of IRCON for the cost payable by the contractor shall be final and binding upon him.
- b) Re-treatment if required shall be attended to and carried out by the Contractor within seven days of the notice from Engineer-in-Charge of IRCON.
- c) The IRCON reserves the right to get the quality of treatment checked in accordance with recognized test methods and in case it is found that the chemicals with the required concentration and rate of application have not been applied, or the water proofing treatment is not done as per specifications, the contractor will be required to do the re-treatment in accordance with the required concentration & specifications at no extra cost failing which no payment for such work will be made. The extent of work thus rejected shall be determined by IRCON.
- d) Water proofing shall be got done through approved / specialized agencies only with prior approval of Engineer-in-Charge.
- e) The contractor shall make such arrangement as may be necessary to safe guard the workers and residents of the building against any poisonous effect of the chemicals used during the execution of the work.
- f) During the execution of work, if any damage shall occur to the treatment already done, either due to rain or any other circumstances, the same shall be rectified and made good to the entire satisfaction of Engineer-In-Charge by the contractor at his cost and risk.
- g) The contractor shall make his own arrangement for all equipments required for the execution of the job. The contractor whose tender is accepted shall execute Guarantee Bond in the prescribed form as appended for guaranteeing the water proofing treatment.

## **1.58 CENTERING & SHUTTERING**

Marine plywood or steel plates or any material mentioned elsewhere in the tender document or as approved by Engineer-in-Charge shall be used for formwork. The shuttering plates shall be cleaned and oiled before every repetition and shall be used only after obtaining approval of IRCON's Engineers

at site. The number of repetitions allowed for plywood and steel shuttering shall be at the discretion of Engineer-in-Charge of IRCON depending upon the condition of shuttering surface after each use and the decision of Engineer-in-Charge in this regard shall be final and binding on the contractor. No claim whatsoever on this account shall be admissible.

## **1.59 Steel Sheet Piling**

### **1.59.1 Necessity**

The sides of excavation in foundations whether of shallow or deep, depending on site conditions, shall be protected and taken care of by the Contractor.

Steel sheet piles used for protection of sides of excavation shall be driven adequately below excavation levels to give stability. The sheet piles shall be supported at several points, by soldier beams, Wales and struts. Wherever the excavation width is more inclined bracing or rakes shall be provided to support the sheet pile.

### **1.59.2 Contractors Responsibilities**

The Contractor shall submit his plans on sheet piling for the pits and trenches, shoring and strutting system along with the tender.

The Contractor shall be responsible for the design of the shoring which shall be strong enough to resist side thrust and prevent slips / blows and damage to adjacent works and property. It shall be capable of safe removal when all the items of work for which it is required are completed, without causing damage to adjacent property or the foundations already completed.

Adequate protective measures shall be taken to see that the foundation excavation does not affect or damage adjoining structures and sides of foundations. The Contractor shall take all measures required for ensuring stability of the excavation and safety of the property and people in the vicinity.

### **1.59.3 Shapes of Sheet Piling**

Steel piling comprises a row of piles engaging with or interlocked with one another so as to form a continuous wall, which may be a temporary retaining wall to protect the sides of vertical cut for deep foundations or shallow foundation depending on specific site condition. Steel sheet piling shall have suitable joints, which do not deform during driving and shall form a continuous protection wall. The pile length can be increased either by welding or bolting.

The shapes of steel sheet piles shall be of either straight sheet piling, shallow arch-web piling, arch-web piles and or Z- piles. The deep arch-web and Z-piles shall be used in cases where the large bending moments are to be resisted. Where the bending moments are less, the shallow arch piles with corresponding smaller section module shall be used. Straight-web

sheet piles shall be used where the web will be subjected to tension.

### **1.59.4 Driving steel sheet piles**

Steel sheeting shall be driven by a pile frame with hammers or by an automatic double acting hammer suspended from a derrick. The pile shall be guided to an interlock system. A drop hammer or a double acting hammer shall be used for clay and non-cohesive soils such as coarse sand and gravel respectively for non-cohesive soils.

Alignment of the piling shall be maintained. Double acting hammers shall be operated either by steam or by compressed air. The operation of a double acting hammer shall be in such a manner that the whole weight of the hammer always rest on the head of the pile. The hammer shall hit directly on the pile or on a suitable head fixed on the pile.

Steel sheet piles shall be interlocked in pairs with helmets. Steel sheet piles with web section shall be reinforced by steel strips bolted or welded on to minimise skin friction on the pile driven in stiff cohesive soil.

#### **1.59.5 Extraction of sheet piles**

The driven steel sheet piles shall be withdrawn on completion of foundation, carefully without disturbing / damaging the newly laid foundation or the adjoining area using either double acting hammer fitted with an extracting attachment or an extractor suspended from a derrick.



**TECHNICAL SPECIFICATIONS  
ARCHITECTURE / CIVIL FINISHING  
SECTION - 3**

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**TECHNICAL SPECIFICATIONS – ARCHITECTURE / CIVIL/ FINISHING**

The technical specifications included as under shall be read in conjunction with drawings, design basis report and more stringent requirement shall apply for execution of work. Any discrepancy should be brought to be notice prior to submission of bid and nothing extra whatsoever shall be paid on any account.

**1.1 General**

The specifications herein are intended for the general descriptions of the work, quality and workmanship. The specifications are not, however, intended to cover the minute details. The work shall be executed in accordance to the detailed specifications given herein or in its absence the relevant CPWD Specification, or the best practice recommended by reputed manufacturers, or the best Public Works Department practices or to the recommendations of relevant Indian Standard/ International Practice or accordance to the instructions of the IRCON.

Wherever reference to CPWD/Indian Standard Code / NBC and practices is made, they shall be referred to the latest edition/revision of the same. The tenderer is expected to get clarified any doubts about the specifications and details before submission of the Tender in writing with the IRCON in respect of interpretation of any portions of these documents.

Before commencing any works, obtain clarification or instructions in relation to any discrepancy or ambiguity, which is discovered within and between the Specification Work sections, and one or other contract documents issued.

All testing shall be to the best standards offered in the respective specialists' trade practice. Detailed shop drawings shall be prepared and got approved. Mock-ups if necessary, shall be prepared and submitted along with site visits to similar installations to facilitate proper monitoring of execution to the best standards. Nothing extra shall be payable on this account.

The Contractor shall provide a performance guarantee to provide for expenses, to cover the risk and cost of rectification of defect, noticed during guarantee period. Guarantee period to start from the date of completion of the project. Such performance guarantees shall be provided all works as specified in the tender. The price quoted by the bidder shall be deemed to include the cost of all such performance guarantees.

The Specification shall be read in conjunction with the other documents, which together shall form the contract specifications. Notwithstanding the subdivision of the specification under different headings, every part of it shall be deemed supplementary to and complementary to the other part.

The standard specification set out the basic quality of material and workmanship required from the contractor. Any statements pertaining to the sequence and the procedures for the construction of the works herein specified shall be regarded only as a guide to the contractor.

It shall be contractual duty and responsibility of the contractor to have his own in depth studies by his consultants for proper details, procedure, mode of execution, use of relevant type, form and size of machineries for the works, form and extent of temporary works requirement and providing the works as specified in or necessarily to be inferred from the documents and drawings forming this contract.

The Contractor shall perform the contract works in proper manner and with due competency for the satisfactory completion of the same.

## **1.2 Plastering and Pointing**

The primary requirement of plasterwork shall be to provide absolutely water tight enclosure, dense, smooth & hard and devoid of any cracks on the interior and/or exterior. The contractor shall do all that is necessary to ensure that this objective is achieved. All plastering shall be finished to true plane, without any imperfections and shall be square with adjoining work and form proper foundation for finishing materials such as paint etc.

Masonry and concrete surfaces which call for applications of plaster shall be clean, free from efflorescence damp and sufficiently rough and keyed to ensure proper bond, subject to the approval of the Engineers / Architects.

Wherever directed by the Engineer / Architect, all joints between concrete frames and masonry in filling shall be expressed by a groove cut in the plaster. The said groove shall coincide with the joints beneath as directed. Where grooves are not called for, the joints between concrete members and masonry in filling shall be covered by Plaster mesh strips 200 mm wide on either sides or as called for on drawings/documents, which shall be in position before plastering.

### **1.2.1 Indian Standards**

Indian Standards to be followed are:

All relevant standards as specified elsewhere in this volume are applicable.

IS 383 Specification for coarse and fine aggregates for natural sources for concrete.

IS 412 Specifications for expanded metal steel sheets for general purposes

IS 1542 Specifications for sand for plaster

IS 1661 Code of practice for application of cement and cement-lime plaster finishes

IS 2402 Code of practice for external rendered finishes

IS 2645 Specifications for integral cement water proofing compound

### **1.2.2 Materials**

## Cement

Cement shall be ordinary Portland cement conforming to IS and of grade 43.

## Water

Water used for mixing and curing shall be clean, reasonably clear and free from objectionable quantities of silt, oils, alkalis, acids, salts so as not to weaken mortar.

Water tested shall be in accordance with IS 3025. Maximum permissible limits of deleterious materials in water shall be as given in IS 456.

Coloured cement may be either ready-mixed material or may be obtained by mixing pigments and cement at site. The pigments to be mixed with cement shall conform to IS 2114 code of practice for laying in-situ Terrazzo Floor Finish.

Sand shall conform to IS 1542 specification for sand for plaster. For white or coloured renderings, only quartz or silica sand shall be used. For textured finishes produced by treatment of freshly applied final or finishing coat with a tool coarser, particles used shall be screened through 3.35 mm IS sieve or 2.36 mm IS sieve. For torn texture a slightly larger portion of material coarser than 4.75 mm IS sieve shall be used.

Aggregate shall conform to IS 383.

Marble dust obtained from crushing of hard marble stone shall not contain more than 8% of silt determined by field test. Fineness modulus shall be greater than 1.0.

Integral water proofing compound shall conform to IS 2645 (specification for integral water proofing compound).

## Fibrous materials

Certain natural fibers, such as flax, sisal, manila, jute hemp, and coconut fibers may be used for incorporation in the mortar. They shall be clean, dry and free from oil. Mineral fibers like asbestos may also be used.

## Expanded metal

Expanded metal used as background for rendering shall comply with requirements of IS 412.

## Plaster Mesh

Plaster mesh approved make shall be used over junctions of concrete and masonry or two dissimilar materials about 200 mm wide fixed with GI wire nails etc. as directed by the EIC.

### 1.2.3 Mortars

#### General

Mortars shall be prepared by mixing fine graded aggregate with cement, the lime or a combination of these in the proportion specified for respective items of work as detailed below. Mixing of mortars shall be done by mechanical mixers only. Hand mixing may be permitted in specified cases on the written permission of the IRCON.

Mortars shall be specified by proportion only and not by strength. Volumetric mixing shall be based on dry volumes of each ingredient. For convenience, measurement shall correspond to volume of one cement bag i.e. 0.035 cu m. Boxes shall be of size 40 X 35 X 25 cm. These shall be marked as mortar mixing boxes by red paint and shall be used throughout the contract. Hand mixing or mechanical mixing proportions shall be done with the use of these boxes.

#### Cement mortar

Cement mortar shall be prepared by mixing cement and sand in specified proportions. Proportioning shall be carried out as detailed above. Sand shall be added suitably to allow for bulkage if required. Bulkage shall be determined as specified in IS 2386 Part III. Cement and sand added to mixer shall be thoroughly mixed and water shall be added to it gradually. After addition of water the mixer shall run for a minimum of 3 minutes. The mortar mixed shall be consumed within 30 minutes of its mixing.

### 1.2.4 Workmanship

#### Preparation of mortar mix

The material used in preparation of plastering mixes shall be measured by volume using gauge-boxes or by weight.

When cement is measured by weight, 1440 kg of material shall be taken equivalent to one cubic meter.

#### Mixing

Mixing shall be done mechanically. Each mortar batch shall be used within half an hour. Hand mixing if permitted as special case shall be carried out on a clean, watertight platform. The mixing operation shall be continued with addition of necessary quantity of water until a uniform appearance and consistency of mortar is obtained.

Cement and sand shall be mixed dry in required proportion to obtain a uniform colour and water shall then be added to get the required consistency for the plaster.

Method of plastering:

Surfaces to be plastered must be clean and free from dust, loose material, oil, grease, mortar droppings, sticking of foreign matter, traces of algae, etc. It is very important to ensure that there should not be any chance of the plaster getting de-bonded due to presence of materials harmful for bonding.

Raking out of joints is expected to be carried out along with masonry but it should be checked thoroughly so as to receive good key.

Walls should be sufficiently damp prior to plastering. Water from plastering mortar must not be absorbed by masonry under any condition.

Any unavoidable projections in masonry and concrete surfaces shall be chiseled back. Care shall be taken that surrounding surfaces are not damaged and reinforcement is not exposed.

Thickness of one coat should not be more than 15mm and less than 8 mm for single coat finished plaster. Thickness of plaster for various applications is mentioned in the following sections.

In case of multicoat plaster, sufficient time shall be allowed for the undercoat to harden (cured, dried and shrunk properly) before subsequent coats are applied.

Undercoats shall be scratched or roughened before they are fully hardened to form a mechanical key.

The method of application is also important and hence it is recommended that the mix be thrown on the surface rather than stuck with trowel. This increases the adhesion.

Scaffolding should be rigid, allowing free and safe movement on the platform and it should be at sufficient distance or height from the working areas. Scaffolding with railing gives more confidence to workers and improves the quality of work.

Actual plastering shall be undertaken only on the approval of the EIC. Plasterwork should only follow the steps mentioned below:

- Surface must be thoroughly cleaned.
- Plaster area must be provided with level dabs or spots allowing working and checking with 2-3 m straight edge. Depth of plaster must not be less than 8 mm at any point.
- Required concealing services must be completed and tested.
- No further cutting of masonry must be required.
- Repairs carried out to masonry or concealing work must be cured and dry.
- Surface must be sufficiently damp.
- Plaster dabs are checked for plumb and level by the EIC or his representative.

- Joints, concealing and repairing areas must be covered with 20 gauge GI chicken mesh or as per the IRCON's instruction.
- Corners, external or internal, shall be finished along with final coat. It is advisable to have rounded corners.
- Plaster shall be cured for 14 days by wet curing except in neeru finish plaster. During this period plaster shall be protected from exposure to extremes of temperature and weather.
- Plaster shall be leveled and lined by aluminium hollow section, 2-3 m long. (This will give even and leveled surface). There shall not be more than 2 mm difference in level when checked with 3 m straight edge. It is important that enough pressing and beating is done to achieve compact filling of joints and that the area is fully compacted.
- Finishing of plaster may be carried out with wooden float (randhas) or trowelled smooth with sheet metal trowels as specified. Care shall be taken to avoid excessive trowelling and overworking of the wooden float.
- All corners, internal or external, shall be truly vertical or horizontal. These shall be finished with a proper template to achieve best workmanship for rounding and chamfering as specified or directed.
- Plaster shall be cut to correct horizontal or vertical line at the end of the day or if work requires to be suspended for any reason.

It is advisable to limit the area of plaster to 15 sq m to avoid cracks due to thermal movements of dissimilar material in contact; it is advisable to provide joints treated with groove or any other detail as suggested by the Architect. These joints if not specified shall be treated with 200 mm wide reinforcing Plaster mesh (approved by the EIC) fixed over joints by GI nails and the area plastered.

### 1.2.5 Type of Plaster

#### **Internal / external cement plaster**

Single coat cement-sand plaster with cement-sand mix in proportion of 1:6 shall be carried out over the entire area as detailed above with Plaster mesh of approved manufacture at all concrete & masonry interfaces of width 200mm.

Equivalent make all fixed as per manufacturers instructions. The plaster shall be finished just with wooden float to give the best smooth surface possible duly lime rendered as indicated clause above after hydrating the lime for 24 hours before commencing the work. Plaster thickness to be of 12/ 15 mm for internal plaster and to be of 18 mm for external plaster or as specified.

The Edges of door openings and corners to be protected using GI meshes of approved manufactures at the time of Plastering.



**Ceiling cement sand rendered plaster**

Single coat cement-sand plaster with cement-sand mix in specified proportion shall be carried out over the entire area as detailed above with GI mesh of 200mm width, at all concrete & masonry interfaces. The plaster shall be finished with wooden float etc. to give the best smooth surface. Thickness to be 6 mm minimum or as specified.

**External Water proof Plaster**

Two coats cement and sand mortar in proportion of 1:4 shall be applied to external surfaces. The first or the scratch coat shall be carried out continuously without break to the full lengths of walls or natural breaking points, such as doors, windows and the like. The scratch coat shall be applied to prepared surfaces with heavy pressure to produce a true and even surface and then lightly roughened by cross scratch lines to provide a bond for the finishing coat. The scratch coat shall be cured for at least 7 (seven) days and then allowed to dry.

The second coat shall not be applied until at least 10 (ten) days after the application of the scratch coat. Before the application of the second coat the scratch coat shall be uniformly dampened. This coat shall be applied from top to bottom in one operation and without joints and the finish shall be straight, true and even. Only approved white sand shall be used for the second coat and for finishing work. Sand for finish shall be of even coarse size and shall be dashed on the surface and sponged. Water proofing compound shall be added as per manufacturer's specifications in the plaster mix.

Where 32mm thick plaster or render is specified for the purpose of providing beading, bands and the like work shall be carried out in either two or three coats as directed by the Employer or his representative.

For pebble face finished plaster or render, stone pebbles of approved size and quality shall be used in the final surface to obtain a uniform pattern to the satisfaction of the Employer or his representative.

**Waterproof Finishes**

Where specified or directed by the Employer or his representative the Contractor shall incorporate approved waterproofing admixtures obtained from reputed manufacturers into the mortar for plasterwork and render. Quantities to be used and the method of incorporation shall be strictly in accordance with the manufacturer's instructions subject to the satisfaction of the Employers Representative or his representative. Admixtures shall not contain calcium chloride unless specifically approved by the Employer or his representative and shall conform to IS 2645.

**1.3 Painting****1.3.1 Scope of work:**

The work covered under these specifications consists of furnishing the various types of paints and also the workmanship for these items, in strict compliance with the specifications.

### **1.3.2 Materials:**

Paints, oils varnishes etc. of approved brand and manufacture shall be used. Ready mixed paints as recovered from the manufacturer without any admixture shall be used. If for any reason, thinning is necessary in case of ready mixed paint, the brand of thinner recommended by the manufacturer or as instructed by the Engineer-In- Charge shall be used. Approved paints, oils or varnishes shall be brought to the site of work by the contractor in their original containers in sealed condition.

The contractor shall associate the chemist of paint manufacturers before commencement of work, during and after the completion of work who shall certify the suitability of the surface to receive painting and the paint before use etc.

### **1.3.3 Commencing Work:**

#### **1.3.3.1 Scaffolding:**

Wherever scaffolding is necessary, it shall be erected on double supports ties together by horizontal pieces, over which scaffolding planks shall be fixed. No bellies, bamboos or planks shall rest on or touch the surface which is being painted. Were ladders are used; pieces of old gunny bags shall be ties on their tops to avoid damage or scratches to walls. For painting of the ceiling, proper stage scaffolding shall be erected.

### **1.3.4 Preparation of Surface:**

The surface shall be thoroughly cleaned. All dirt, rust, scales, smoke and grease shall be thoroughly removed before painting is started. Minor patches if any in plastered / form finished surfaces shall be repaired and finished in line and level in CM/ 1:1 and cracks and crevices shall be filled with approved filler, to the full satisfaction of the Engineer- In - Charge. The prepared surface shall have received the approval of the Engineer-In-Charge after inspection, before painting is commenced.

### **1.3.5 Application:**

Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its containers. When applying also, the paint shall be continuously stirred in the smaller containers so that consistency is kept uniform.

The external surfaces of the buildings under reference including the R.C.C. Jali, fins and the panels above and below the window etc. shall be finished with colours of approved shade. The contractor will make suitable samples at site for approval before taking up the work in hand and they will be allowed to proceed with the work only after getting approval for the same.

The painting shall be laid on evenly and smoothly by means of crossing and laying off, the later in the direction of the grain in case of wood. The crossing and laying off consists of covering the area with paint, brushing the surface hard for the first time and then brushing alternately in opposite directions

two or three time and then finally brushing lightly in direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying will constitute one coat.

Where so stipulated, the painting shall be done with spraying. Spray machine used may be (a) a high pressure or (b) a low pressure (large air gap), depending on the nature and location of work to be carried out. Skilled and experienced workmen shall be employed for this class of work. Paints used shall be brought to the requisite consistency by adding a suitable thinner. Spraying should be done only when dry condition prevails.

Each coat shall be allowed to dry cut thoroughly and rubbed smooth before the next coat is applied. This should be facilitated by thorough ventilation.

Each coat except the last coat shall be tightly rubbed down with sand paper or fine pumice stone and cleaned of dust before the next coat is laid. No left over paint shall be put back into the stock tins. When not in use, containers shall be kept properly closed.

The final painted surface shall present a uniform appearance and no streaks, blisters, hair marks from the brush or clogging of paint puddles in the corners of panels, angles of moldings etc. shall be left on the work. In case of cement based paints / primers, the absorbent surfaces shall be evenly damped so as to give even suction. In any weather, freshly painted surfaces shall be kept damp for at least two days.

In painting doors and windows, the putty around the glass panes must also be painted, but care must be taken to see that no paint stains etc. are left on the glass. Tops of shutters and surfaces in similar hidden locations shall not be left out while painting. Prospect covers of electrical switch boxes have to be painted from inside by removing them. Care shall be taken while removing them in position after painting with respective approved paints. In painting steel work, special care shall be taken while painting over bolts, nuts, rivets, overlaps etc.

Any damage caused during painting work to the existing works / surfaces shall be made good by the contractor.

Painting, except the priming coat, shall generally be taken in hand after all other builders work, practically finished.

#### **1.3.6 Precautions:**

All furniture, lightings, fixture, sanitary, fittings, glazing, floors etc. shall be protected by covering and stains, smears, splashing, if any shall be removed and any damage done shall be made good by the contractor.

#### **1.4 Painting, Priming Coat on Wood, Iron or Plastered Surfaces**

The primer for wood work, iron work or plastered surface shall be as specified in the description of the item.

Primer for wood work / Iron & Steel / Plastered / Aluminium surfaces shall be as specified below:-

Sl.No.	Surfaces	Primer to be used
a)	Wood work (hard and soft wood)	conforming to IS 3536 - 1966
b)	Resinous wood and ply wood	Aluminium Primer
c)	Iron & Steel, aluminium and galvanized steel Work:	Zinc chromate primer conforming to IS 104-1962
d)	Plastered surfaces, cement brick work, Asbestos surfaces for oil bound	Cement primer

The primer shall be ready mixed primer of approved brand and manufacture.

#### 1.4.1 Preparation of Surface

##### 1.4.1.1 Woodwork:

The wood work to be painted shall be dry and free from moisture.

The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sand paper and shall be well dusted. Knots, if any, shall be covered with preparation of red lead made by grinding red lead in water and mixing with strong glue sized and used hot. Appropriate filler material with same shade as paint shall be used where so desired by the Engineer-In-Charge.

The surface treated for knotting shall be dry before painting is applied. After the priming coat is applied, the holes and indentation on the surface shall be stopped with glaziers putty or wood putty (for specifications for glaziers putty and wood putty - refer as mentioned herein before). Stopping shall not be done before the priming coat is applied as the wood will absorb the oil in the stopping and the latter is therefore liable to crack.

##### 1.4.1.2 Iron and Steel Work:

All rust and scales shall be removed by scrapping or by brushing with steel wire brushes. Hard skin of oxide formed on the surface of wrought iron during rolling which becomes loose by rusting, shall be removed.

All dust and dirt shall be thoroughly wiped away from the surface.

If the surface is wet, it shall be dried before priming coat is undertaken.

##### 1.4.1.3 Plastered Surface:

The surface shall ordinarily not be painted until it has dried completely. Trial patches of primer shall be laid at intervals and where drying is satisfactory, painting shall be taken in hand. Before primer is applied, holes and undulations, shall be filled up with plaster of Paris / putty and rubbed smooth.

**a) Application:**

The primer shall be applied with brushes, worked well into the surface and spread even and smooth. The painting shall be done by crossing and laying off as described herein before.

**b) Other details:**

The specifications for Painting (General) shall hold good so far it is applicable.

**1.5 French Spirit Polishing:****1.5.1 Polish:**

Pure shellac varying from pale orange to lemon yellow colour, free from resin or dirt shall be dissolved in methylated spirit at the rate of 140 gm. of shellac to 1 liter of spirit. Suitable pigment shall be added to get the required shade.

**1.5.2 Preparation of surface:**

The surface shall be cleaned. All unevenness shall be rubbed down smooth with sand paper and well dusted off. Knots if visible shall be covered with a preparation to red lead and glue size laid on while hot. Holes and indentations on the surface shall be stopped with glaziers putty. The surface shall then be given a coat of wood filler made by mixing whiting (ground chalk) in methylated spirit, the surface shall again be rubbed down perfectly smooth with glass paper and wiped clean.

**1.5.3 Application:**

The number of coats of polish to be applied shall be as described in the item. A pad of wooden cloth covered by fine cloth shall be used to apply the polish and shall be moistened with the polish and rubbed hard on the wood, in a series of overlapping circles applying the mixture sparingly but uniformly over the entire area to give an even level surface. A trace of linseed oil on the face of the pad facilitates this operation. The surface shall be allowed to dry and the remaining coats applied in the same way. To finish off, the pad shall be covered with a fresh piece of clean fine cotton cloth, slightly damped with methylated spirit and rubbed lightly and quickly with circular motions. The finished surface shall have a uniform texture and high gloss.

**1.6 White Washing with Lime****1.6.1 Preparation of surface:**

Before work which is to white washed, the surface shall be thoroughly brushed free from mortar dropping and foreign matter.

**1.6.2 Preparation of lime wash:**

The wash shall be prepared from fresh lime stone white lime. The lime shall be thoroughly slaked on the spot, mixed and stirred with sufficient water to make a thin cream. This shall be allowed to stand for a period of 24 hours and then shall be screened through a clean coarse cloth. 40 gm. of gum dissolved in hot water or Binder which shall be added to each 10 cubic decimeter of the cream. The approximate quantity of water to be added in making the cream will be 5 liters of water to one kg. of lime. Indigo (Robin Blue) up to 3 gm per kg. of lime dissolved in water, shall then be added and wash stirred well. Water shall then be added at the rate of about 5 liters per kg. of lime to produce a milky solution. The lime shall be tested in a chemical laboratory and test certificate submitted, to conform the quality of lime with regard to its physical and chemical properties.

### **1.6.3 Application of Whitewashing:**

The white wash shall be applied with brushes or by spray in the specified number of coats. The operation for each coat in the case of brush application shall consist of a stroke of the brush given from the top downwards, another from the bottom upwards over the first strike, and similarly one stroke horizontally from the right and another from the left before it dries.

Each coat shall be allowed to dry before the next one is applied. No portion of the surface shall be left out initially to be patched up later on.

The finished dry surface shall not show any sign of cracking and peeling nor shall it come off readily on the hand when rubbed.

## **1.7 Distemping**

### **1.7.1 Acrylic Distemper**

As per (IS 428 -1969) of approved brand and manufacture, colour and required shade shall be used. The primer where used as on new work shall be cement primer or distemper primer as specified in the item. These shall be of the same manufacture as distemper. The distemper shall be diluted with water or any other prescribed thinner in a manner recommended by manufacturer. Only quality of distemper required for days work shall be prepared.

### **1.7.2 Preparation of surfaces**

The surface shall be prepared as described herein before for painting work in so far as it is applicable and approved putty / filler shall be applied to the entire area to get uniform and smooth surface before application of primer.

### **1.7.3 Application**

The cement primer or distemper primer shall be applied by brushing and not by spraying. Hurried priming work shall be avoided, particularly on absorbent surfaces. The surfaces shall be finished as uniformly as possible leaving no brush marks, priming coat shall be allowed to dry for at least 48

hours. Before applying distemper, the surface shall be lightly sand prepared to make it smooth for receiving, the oil bound distemper, taking care not to rub out the priming coat. A time interval of at least 24 hours shall be allowed between consecutive coats to permit the proper drying of the preceding coat. Two or more coats of distemper as are found necessary shall be applied over the priming coat to obtain an even shade.

All paints have to be low VOC paints and certificates of the same should be provided by the contractor.

## **1.8 Texture Paint**

(Work to be carried out as per Manufacturer Specification)

### **1.8.1 Material**

The paint shall be (Quartz reinforced Textured acrylic paint/ premium acrylic smooth waterproof exterior paint over texture finish) of approved brand and manufacture.

This paint shall be brought to the site of work by the contractor in its original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the contractor and the Engineer-In-Charge. The empty containers shall not be removed from the site of work till the relevant item of work has been completed and permission obtained from the Engineer-In-Charge.

### **1.8.2 Preparation of Surface**

For new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, algae, fungus or moth, grease and other foreign matter of brushing and washing, pitting in plaster shall make good, surface imperfections such as cracks, holes etc. should be repaired using white cement. The prepared surface shall have received the approval of the Engineer-In-Charge after inspection before painting is commenced.

### **1.8.3 Application**

Base coat of water proofing cement paint. All specifications in respect of base coat of water proofing cement paint shall be as describe.

Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its container, when applying also the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform. Dilution ratio of paint with potable water can be altered taking into consideration the nature of surface climate and as per recommended dilution given by manufacturer. In all cases, the manufacturer's instructions & directions of the Engineer-In-Charge shall be followed meticulously.

The lids of paint drums shall be kept tightly closed when not in use as by exposure to atmosphere the paint may thicken and also be kept safe from dust. Paint shall be applied with a brush on the cleaned and smooth surface. Horizontal strokes shall be given, First and vertical strokes shall be applied

immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks. The specifications in respect of scaffolding and protective measures shall be as described.

External Texture finish of approved makes as per approved design and pattern. Texture finish shall be applied over the plastered surface with required thickness to form the necessary approved design by using trowel / putty blade and it should be allowed for drying minimum 12 hrs., before the application of top painting, 2 coats or more of external weather proof water based emulsion shall be applied over this and a coat of primer may be applied based on the approved texture pattern. Including surface preparation like through cleaning, pre wetting & removal of loose mortars, etc.

## **1.9 Expansion Joint**

### **1.9.1 Materials**

#### **1.9.1.1 Premoulded Joint Filler in Expansion Joint**

It shall conform to IS 1838 (Pt. I). The thickness shall be 25 mm with tolerance 1.5 mm and shall be of the maximum available standard length not less than one lane width. The filler board shall be positioned vertically with the prefabricated joint assemblies along the line of the joint within tolerance of + 10 mm from the intended line of the joint.

The depth of board shall be 25 mm less than thickness of slab within a tolerance of  $\pm 3$ mm so that the top of the board shall be below the surface or will not impede the passage of the finishing straight edge or oscillating beam of the paving machine.

#### **1.9.1.2 Sealing Compound**

The joint sealing compound shall be fuel and heat resistant type complying to grade B of IS 1834. It shall be capable of adhering to the concrete without cracking, spalling and disintegration.

#### **1.9.1.3 Construction Procedure**

Expansion joints shall be provided as shown in the drawing and as per directions of Engineer-In-Charge. All joints shall be constructed true to line with their faces perpendicular to the surface. The joint shall be 20 mm wide. The depth of the non-extruding filler pad shall be 25 mm less than the depth of the concrete slab.

Before the provision of expansion joint, the face of the already laid concrete slab shall be painted with primer at the rate of 2.6 liters per 10 square meters. The expansion pad shall be properly cut to shape and shall then be placed in position abutting the painted face of the already laid concrete slab. The adjacent slab shall then be concreted. The face of the pad against which the new concrete slab is to be laid shall also be painted with primer before laying the concrete, while concreting a neat groove of size 20 mm x 25 mm as per drawing shall be formed on top of the pad taking care that the edges are absolutely straight and that the groove so made does not get filled with any material like concrete,



mortar and other rubbish. Before the curing process is started, the top of expansion joint shall be filled with bitumen sand mixture in order to ensure that no foreign material used in curing enters into the joint. This filling shall be removed before filling the joints with sealing compound.

The treatment of expansion joint system related with floor location as per drawings and direction of Engineer-In -Charge. The joints system will be of extruded aluminum base members, self-aligning / self -centering arrangement and support plates etc. as per ASTM B221-02. The system shall be such that it provides floor to floor /floor to wall expansion control system for various vertical locations in load application areas that accommodates multi directional seismic movement without stress to its components. System shall consist of metal profiles with a universal aluminum base member designed to accommodate various project conditions and finish floor treatments. The cover plate shall be designed of width and thickness required to satisfy projects movement and loading requirements and secured to base members by utilizing manufacturer's pre - engineered self-centering arrangement that freely rotates / moves in all directions. The Self - centering arrangement shall exhibit circular sphere ends that lock and slide inside the corresponding aluminum extrusion cavity to allow freedom of movement and flexure in all directions including vertical displacement. Provision of Moisture Barrier Membrane in the Joint System to have watertight joint is mandatory requirement all as per the manufactures design and as approved by Engineer -in- Charge. (Material shall conform to ASTM 6063).

## **1.9.2 Floor/Roof Joint**

### **1.9.2.1 Application Procedure**

Provide continuous frame on each side of the joint, designed to support gasket and center plate where required. After installing the frames at both sides, place the center plate in between the two frames and finally flush the gasket on the top of the frames.

Fixing of the joint after proper assembly of the components should be through the proper stainless steel counter skunked screws, which should be drilled to the base concrete slab beams with a bonding agent.

## **1.10 Stainless Steel Kitchen Sink**

Stainless steel kitchen sink shall be of sizes as specified and shall be conforming to IS 13983. The kitchen sink shall be of one piece construction with or without rim but without overflow.

They shall be Stainless steel of best quality and shall be supported on necessary brackets. Each sink shall be provided with waste coupling, waste pipe, wall flanges, connection pipe, angle valve, long nose bibcock etc. including all the fixing materials.

## **1.11 Stainless Steel Railings and Stainless Steel Shutter with Stainless Steel Jali Fabrication**

The scope of the work includes preparation of the shop drawings (based on the architectural drawings), fabrication, supply, installation and protection of the stainless steel railing and Stainless Steel shutter with stainless steel Jali till completion and handing over of the work.

The stainless steel work shall be got executed through specialized fabricator having experience of similar works. The Contractor shall submit the credentials of the fabricator for the approval of the Engineer-In-Charge.

The Contractor shall submit shop drawings, for approval of the Engineer-in-Charge, for fabricating stainless steel railing and Stainless Steel shutter with stainless steel Jali with detailing of M.S stiffener frame work backing along with the fixing details of the M.S. frame work to the R.C.C columns or frame. The details of the joints in the stainless steel work including location, etc. shall also be shown in the shop drawings.

The Contractor shall procure and submit to the Engineer-In-Charge, samples of various materials for the railing work and jali Shutter with its fixtures, for approval. After approval of samples, the Contractor shall prepare a mock up for approval of Engineer-In-Charge. The material shall be procured and the mass work taken up only after the approval of the mock up by the Engineer-In-Charge. The mock-up shall be dismantled and removed by the contractor as per the directions of the Engineer-in-Charge.

The stainless steel shall be of grade 316 with brushed steel satin finish and procured from the approved manufacturer. It shall be without any dents, waviness, scratches, stains etc.

The required joints in the S.S Work shall be provided as per the architectural drawings, shall be welded in a workmanlike manner including grinding, polishing, buffing etc. all complete and compacted. The temporary clamps provided and fixed to hold the stainless steel railing, in position shall be removed after the concrete has set properly. The junction of the flooring and the cladding shall be neatly filled with weather silicone sealant of approved colour and shade.

One test (three specimens) for each lot shall be conducted for the stainless steel pipe in the approved laboratory. Therefore, the material shall preferably be procured in one lot from one manufacturer.

The finished surface shall be free of any defects like dents, waviness, scratches, stains etc. and shall have uniform brushed steel satin finish.

Any defective work shall be rejected and redone by the Contractor. The finished surface shall therefore be protected using protective tape which shall be removed at the time of completion of the work. The surface shall then be suitably cleaned using nonabrasive approved cleaner for the material.

The item includes all inputs of labour, materials (including stainless steel pipes, welding, brazing, concrete, protective film, weather silicone sealant etc. including providing and fixing M.S. frames), T & P other incidental charges, wastages etc. The items also included providing and fixing stainless steel anchor fasteners for fixing railing.

The railing shall be fixed in position using stainless steel pipes, stainless steel posts of required diameters and thickness as shown on drawing and polished to satin finish including cutting, welding, grinding, bending to required profile and shape, hoisting, butting, polishing etc. The Jali shutter shall be fixed in position using stainless steel rectangular pipes of required thickness & size and SS Jali as specified, including hinges, latching and locking arrangements, and polished to satin finish including cutting, welding, grinding, bending to required profile and shape, hoisting, butting, polishing etc.

The item includes all inputs of labour, materials, T&P, other incidental charges, wastage etc. The entire work shall be carried out to the satisfaction of Engineer-In-Charge.

### **1.12 GRC Jali**

Glass Reinforced Concrete G.R.C. Screens (Jali) 30 mm thk. in approved size, pattern, design, thickness and color.

The screens should be made from '53 grade' approved White portland cement, quartz, fine silica sand, alkali resistant glass fiber manufactured.

Polymers manufactured by approved manufacturer or equivalent, super plasticizers manufactured by approved manufacturer or equivalent with UV resistant synthetic inorganic pigments made by approved manufacturer or equivalent.

The material casting should be done in synthetic rubber / FRP.

The fixing of screens should be done with galvanized M.S. / S.S. "L" shaped clamps, dash fasteners and pins etc. complete as per requirement, approved shop drawing and instructions duly approved by Engineer- in- charge.

### **1.13 Melamine Polish**

Melamine polish of approved brand shall be used & as approved by Engineer-in- charge following steps shall be followed to get a smooth finish.

- Cleaning of veneer/Wood surface with moist cloth for removing dust / excess glue on surface etc.
- Sanding of veneer surface with Emery Paper (80 No.).
- Repairing and filling of nails etc. With chalk soil & polish color matching to the veneer.
- Sanding of veneer surface with sand paper (100 no.)
- Spirit polish (2 coats): mixture of lakh dana and spirit to match the color.

- Sanding of veneer surface with sand paper (120 no.)
- Apply sealer on wood surface.
- Sanding of veneer surface with sand paper (120 no.)
- Melamine coating with spray gun (First coat).
- Sanding of veneer surface with sand paper (320 no.)
- Melamine coating with spray gun (second coat).
- Sanding of veneer surface with sand paper (320 no.)
- Rubbing and waxing.

#### **1.14 False Ceiling:**

The work shall be executed in accordance to relevant CPWD Specification, or the best practice recommended by reputed manufacturers, or the best Public Works Department practices or to the recommendations of relevant Indian Standard/ International Practice or accordance to the instructions of the IRCON.

#### **1.15 Marble Work**

##### **1.15.1 General**

Marble shall be hard, sound, dense and homogeneous in texture with crystalline texture as far as possible. It shall generally be uniform in colour and free from stains, cracks, decay and weathering.

##### **1.15.2 Classification**

The marble blocks, slabs and tiles shall be classified broadly in the following two categories:

##### **1.15.2.1 White Marble**

###### **Raj Nagar (plain white) Marble:**

It shall be plain white marble with coarse grains predominantly showing mica particles giving reflection in light.

##### **1.15.2.2 Coloured Marble**

- Plain Black Marble

- Black Zebra Marble
- Green Marble
- Grey Marble
- Brown Marble

Brown marble having teak wood shades available at Narnaul.

## 1.16 Granite

It shall be of any colour and size as directed by Engineer-In-Charge. Granite shall be plain machine cut and mirror polished. It shall be smooth and of even surface without holes or pits.

### 1.16.1 Sizes And Tolerances

The size of blocks, slabs and tiles shall be as mentioned in Table below.

#### 1.16.1.1 Tolerance

The following tolerances shall be allowed in the dimension of blocks, slabs and tiles:

##### *Blocks*

- Length + 2 percent
- Width + 2 percent
- Thickness + 2 percent

##### *Slabs*

- Length + 2 percent
- Width + 2 percent
- Thickness + 3 percent

##### *Tiles*

- Linear dimension +3 percent
- Thickness + 1 percent

The sizes other than those mentioned above may be provided as directed by the Engineer-In-Charge.

#### 1.16.1.2 Physical Properties

The physical properties of marble for blocks, slabs and tiles and method of tests are mentioned in Table below.

TABLE			
Physical Properties of Marble & Granite			
		Marble	Granite

Characteristic	Marble Requirements	Method of test as per	Granite Requirement	Method of test as
(1) Moisture absorption after 24 hrs by weight immersion in cold water	- Max. 0.4%	IS 1124	Max. 0.50%	IS 1124
(2) Hardness	Min. 3	Mohs scale		
(3) Specific Gravity	Min. 2.5	IS 1122	Min. 2.6	IS 1122

#### 1.16.1.3 Approval of Sample

Before starting the work, the contractor shall get samples of marble approved by the Engineer-In-Charge. Approved samples shall be kept in the custody of the Engineer-In-Charge and the marble supplied and used on the work shall conform to samples with regard to soundness, colour, veining and general texture.

#### 1.16.1.4 Sampling

In any consignment all the blocks/slabs/tiles of the same group, size and finish shall be grouped together to constitute a lot. Sample shall be selected and tested separately for each lot for determining its conformity or otherwise to the requirements of the specification. The number of blocks/slabs/tiles to be selected for the samples shall depend upon the size of the lot and shall be in accordance with the Table below.

**TABLE Sample Size and Criteria for Conformity**

Number of Blocks slabs/Tiles in the lot	Number of blocks slabs/ Tiles to be selected in sample	Permissible number	Sub sample size in no.
(1)	(2)	(3)	(4)
Up to 25	3	0	2
26 to 100	5	0	2
101 to 200	8	0	3
201 to 500	13	0	4
501 to 1000	20	1	5

**Note:** The blocks/slabs/tiles in the sample shall be taken at random and in order to ensure to randomness of selection, random tables may be used.

#### 1.17 Marble Work - Table Rubbed and Polished (Plain Work)

Marble work in steps, jambs, columns and other plain work shall be as specified below: Joints in staircase treads, kitchen platforms shall be permitted only at curvature or when width/length is more than 0.6/2 mtrs respectively. Number of joints in each direction shall not be more than one number for

every 2 mtrs length beyond the initial 2.00 m length. Additional joints due to curvature or for providing fixture shall be provided judiciously.

#### **1.17.1 Dressing, Cutting and Rubbing**

Every marble stone shall be gang saw/machine cut to the required size and shape, chisel dressed machine finished on all beds and joints, so as to be free from any waviness and to give truly vertical, horizontal, radial or circular joints as required. The exposed faces and sides of stones forming joints up to 6mm. from the face shall be fine tooled machine cut such that a straight edge laid along the face of the stone is in contact with every point on it. All window sills, tread of steps, counters vanities moulding edges etc. shall be machine cut & polished to give high gloss mirror finish as per direction of Engineer-in- Charge. These surfaces shall then be rubbed smooth. All visible angles and edges shall be true, square and free from chipping. Beyond the depth of 6 mm from face, the joints shall be dressed with a slight splay so that the thickness of joint increases, in an inverted V shape. The surfaces of the stones coming in contact with backing need not be chisel dressed.

A sample of dressed and rubbed stone shall be prepared for approval and it shall be kept on worksite after being approved by the Engineer-in Charge.

#### **1.17.2 Mortar**

The mortar used for jointing shall be as specified.

#### **1.17.3 Laying**

All marble stones shall be wetted before placing in position. These shall then be floated on mortar and bedded properly in position with wooden mallets without the use of chips or under pinning of any sort.

The walls and pillars shall be carried up truly in plumb or battered as shown in the drawings. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical.

In case of work without backing of brick work or coursed rubble masonry, face stone shall be laid in headers and stretchers alternatively unless otherwise directed. The headers shall be arranged to come as nearly as possible in the middle of stretchers above and below. Stone shall be laid in regular courses of not less than 15 cm in height and all courses shall be of the same height unless otherwise specified. The matching of grains shall be carried out as directed by the Engineer-In-Charge.

#### **1.17.4 Bond Stone**

Bond or through stones running right through the thickness of walls, shall be provided in walls up to 60 cm thick and in case of wall above 60 cm thickness a set of two or more bond stones overlapping each other by at least 15 cm shall be provided in a line from face to back.

At least one bond stone or a set of bond stones shall be provided for every 0.5 sqm of the wall surface. All bond stones shall be marked suitably as directed by the Engineer-In-Charge.

### **1.17.5 Joints**

The depth of joints 6 mm from the face shall be uniform and as fine as possible but shall be not more than 1.5 mm thick on the exposed face. Beyond the depth of 6 mm from face, the thickness of joints shall increase in an inverted V shape so as to give good mortar bond between two stones. The inverted portion of the joints shall be filled with bedding mortar and the face 6 mm portion with pointing mortar.

### **1.17.6 Curing**

The work shall be kept constantly moist on all faces for a period of at least seven days.

### **1.17.7 Finishing**

After the marble work is cured, it shall be rubbed with carborandum stone of different grades no. 60, 120 and 320 in succession or with electrical rubbing machines rubbed with carborandum items 0 to 6 nos.in succession, so as to give a plane true and highly smooth surface. It shall then be cleaned with a solution of oxalic acid, washed and finished clean.

### **1.17.8 Protection**

Green work shall be protected from rain by suitable coverings. The work shall also be suitably protected from damage during construction.

### **1.17.9 Scaffolding**

Double scaffolding having two sets of vertical supports shall be provided where necessary. The supports shall be sound and strong, tied together by horizontal pieces over which the scaffolding plank shall be fixed.

### **1.17.10 Tolerances**

As specified above.

## **1.18 Wall Lining/Veneer Work**

Unless and otherwise specified in the indicative item, the marble slabs used for wall lining/veneer work shall be gang saw cut (polished & machine cut) and conform to dimensions given.

Back shall not be polished/ cut in order to ensure a good grip with the hearting of backing. The cut slabs shall be of the thickness as specified with a tolerance permissible the tolerance in wall lining when straight edge of 3 m length is placed should not be more than 2 mm.



### 1.18.1 Laying

The stone shall be wetted before laying. They shall then be fixed with mortar in position without the use of chips or under pinning of any sort. Care shall be taken to match the grains of veneer work as directed by the Engineer-In-Charge. For purpose of matching the grains, the marble slabs shall be selected judiciously having uniform pattern of veins/streaks. Preferably the slabs shall be those got out of the same block from the quarry. The area to be veneered shall be reproduced on the ground and the marble slabs laid in position and arranged in the manner to give the desired matching of grains. Any adjustment needed for achieving the best results shall be then carried out by replacing or interchanging the particular slabs. Special care shall be taken to achieve the continuity of grains between the two slabs one above the other along the horizontal joints. This shall then be got approved by the Engineer-in- Charge and each marble slabs numbered properly and the same number shall be marked on a separate drawing as well as on the surface to be actually veneered, so as to ensure the fixing of the particular slabs in the correct location.

For the facing of the columns also the same procedure as mentioned above shall be followed.

Where so desired, the adjoining stones shall be secured to each other by means of copper pins 75 mm long and 6 mm diameter or as specified.

The stones shall be secured to the backing by means of cramps. The material for cramps shall have high resistance to corrosion under conditions of dampness and against the chemical action of mortar or concrete in which cramps are usually embedded.

Cramps shall be of 25\*6 mm and 30 cm long in case of backing of stone masonry walls and brick masonry walls thicker than 230 mm. In case of backing with brick masonry walls 230 mm or less thick or RCC members' cramps shall be of 25\*6 mm and length as per requirement made out of gun metal or any other metal (i.e. copper alloyed with zinc, tin, nickel, lead or stainless steel). Generally the outer length of cramp in half brick work backing shall be 115 mm and in one brick work backing it shall be 150 mm. Cramps shall be spaced not more 60 cm apart horizontally. Alternatively the stone may be secured to the backing by means of stone dowels 10 x 5 x 2.5 cm as per shape mentioned.

The adjoining stones shall be secured to each other by means of gun metal cramps or copper pins of the specified size. Cramps may be attached to its sides or top and bottom. The actual number of cramps and their sections, however, shall be as per requirements of design to carry the loads.

Where cramps are used to hold the unit in position only, the facings shall be provided with a continuous support on which the stones rest at the ground level and other storey levels, the support being in the form of projection from or recess into the concrete floor slab, or a beam between the columns or a metal angle attached to the floor slab or beams. These supports shall preferably be at vertical intervals not more than 3.5 m apart and also over the heads of all openings. Such supports shall also be provided where there is transition from thin facing below to thick facings above.

Alternatively cramps may be used to hold the units in position and in addition to support the units thus transferring the weight of the units to the backing. Such cramps should be properly designed as per IS 4101 (Part 1).

The pins, cramps and dowels shall be laid in cement mortar 1:2 (1 cement: 2 fine sand) and their samples got approved by the Engineer-In-Charge and kept at site.

### **1.18.2 Joints**

All joints shall be full of mortar. Special care shall be taken to see that groundings for veneer work are full of mortar. If any hollow groundings are detected by tapping the face stones, these shall be taken out and re-laid. The thickness of the face joints shall be uniform, straight and as fine as possible, not more than 1.5 mm and in the face joint, the top 6 mm depth shall be filled with mortar specified for the pointing.

### **1.18.3 Mortar**

The mortar used for jointing slabs shall be as specified.

## **1.19 Structural Steel Frame Work For Dry Stone Cladding**

Specification for structural frame work for dry stone cladding are same specifications as for steel work.

### **1.19.1 Fixing of Frame**

The properly designed structural frame for withstanding the weight of stone slab are fixed/supported on wall surface with the help of M.S. brackets/lugs of angle iron/flat etc. which is welded at each junctions of member of frame and also embedded in cement concrete block 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) of size 300 x 230 x 300 mm. The concrete block can be made by cutting the hole of size as mentioned in brick wall and filling the hole with cement concrete including provision of necessary centering/shuttering for holding of concrete. The frame can also be supported on RCC surface with the help of approved expansion hold fastener by drilling the holes in RCC surface.

Steel cramps are either welded or bolted to the frame (by making necessary holes in frame work) for holding of stone. Laying shall be done as mentioned above.

## **1.20 Marble Stone Flooring and Marble Stone in Risers of Steps and Skirting**

### **1.20.1 Marble Stone Flooring**

#### **1.20.1.1 Marble Stone**

It shall be as specified and approval of Engineer-In-Charge.

### 1.20.1.2 Dressing of Slabs

Every stone shall be cut to the required size and shape, fine chisel dressed on all sides to the full depth so that a straight edge laid along the side of the stone shall be fully in contact with it. The top surface shall also be fine chisel dressed to remove all waviness. In case machine cut slabs are used, fine chisel dressing of machine cut surface need not be done provided a straight edge laid anywhere along the machine cut surfaces is in contact with every point on it. The sides and top surface of slabs shall be machine rubbed or table rubbed with coarse sand before paving. All angles and edges of the marble slabs shall be true, square and free from chippings and the surface shall be true and plane. The thickness of the slabs shall be 18, 30 or 40 mm or as specified in the description of the item.

Tolerance of + 3% shall be allowed for the thickness. In respect of length and breadth of slabs a tolerance of + 2% shall be allowed.

### 1.20.1.3 Laying

Base concrete or the RCC slab on which the slabs are to be laid shall be cleaned, wetted and mopped. The bedding for the slabs shall be with cement mortar 1:4 (1 cement: 4 coarse sand) or as given in the description of the item.

The average thickness of the bedding mortar under the slab shall be 20 mm and the thickness at any place under the slab shall be not less than 12 mm.

The slabs shall be laid in the following manner:

Mortar of the specified mix shall be spread under the area of each slab, roughly to the average thickness specified in the item. The slab shall be washed clean before laying. It shall be laid on top, pressed, tapped with wooden mallet and brought to level with the adjoining slabs. It shall be lifted and laid aside. The top surface of the mortar shall then be corrected by adding fresh mortar at hollows. The mortar is allowed to harden a bit and cement slurry of honey like consistency shall be spread over the same at the rate of 4.4 kg of cement per sqm. The edges of the slab already paved shall be buttered with grey or white cement with or without admixture of pigment to match the shade of the marble slabs as given in the description of the item.

The slab to be paved shall then be lowered gently back in position and tapped with wooden mallet till it is properly bedded in level with and close to the adjoining slabs with as fine a joint as possible.

Subsequent slabs shall be laid in the same manner. After each slab has been laid, surplus cement on the surface of the slabs shall be cleaned off. The flooring shall be cured for a minimum period of seven days. The surface of the flooring as laid shall be true to levels, and, slopes as instructed by the Engineer-In-Charge. Joint thickness shall not be more than 1 mm.

Due care shall be taken to match the grains of slabs which shall be selected judiciously having uniform pattern of Veins/streaks or as directed by the Engineer-In-Charge.

The slabs shall be matched as shown in drawings or as instructed by the Engineer-In-Charge.

Slabs which are fixed in the floor adjoining the wall shall enter not less than 12 mm under the plaster skirting or dado. The junction between wall plaster and floor shall be finished neatly and without waviness.

Marble slabs flooring shall also be laid in combination with other stones and/or in simple regular pattern/design as described in item of work and/or drawing.

#### **1.20.1.4 Polishing and Finishing**

Slight unevenness at the meeting edges of slabs shall then be removed by fine chiseling and finished in the same manner as specified except that cement slurry with or without pigments shall not be applied on the surface before each polishing.

#### **1.20.2 Marble Stone in Risers of Steps and Skirting**

Marble Stone Slabs and Dressing of Slabs shall be as specified, except that the thickness of slabs shall be 18 mm. A tolerance of + 3% mm shall be allowed, unless otherwise specified in the description of the item.

##### **1.20.2.1 Preparation of Surface**

It shall be as specified; the wall surface shall be cut uniformly to the requisite depth so that the skirting face shall have the projection from the finished face of wall as required by the Engineer-In-Charge. In no case the skirting should project by more than thickness of stone.

##### **1.20.2.2 Laying**

The risers of steps and skirting shall be in grey or white cement admixed with or without pigment to match the shade of the stone, as specified in the description of the item, with the line of the slab at such a distance from the wall that the average width of the gap shall be 12 mm and at no place the width shall be less than 10 mm, if necessary, the slabs shall be held in position by temporary M.S. hooks fixed into the wall at suitable intervals. The skirting or riser face shall be checked for plane and plumb and corrected.

The joints shall thus be left to harden then the rear of the skirting or riser slab shall be packed with cement mortar 1:3 (1 cement: 3 coarse sand) or other mix as specified in the description of the item. The fixing hooks shall be removed after the mortar filling the gap has acquired sufficient strength.

The joints shall be as fine as possible but not more than 1 mm. The top line of skirting and risers shall be truly horizontal and joints truly vertical, except where otherwise indicated.

The risers and skirting slab shall be matched as shown in drawings or as instructed by the Engineer-In-Charge.

##### **1.20.2.3 Curing, Polishing and Finishing**

It shall be as specified, except that cement slurry with or without pigment shall not be applied on the surface and polishing shall be done only with hand. The face and top of skirting shall be polished.

## **1.21 Kota Stone Flooring**

### **1.21.1 Kota Stone Slabs**

The slabs shall be of selected quality, hard, sound, dense and homogeneous in texture free from cracks, decay, weathering and flaws. They shall be hand or machine cut to the requisite thickness. They shall be of the colour indicated as instructed by the Engineer-In-Charge.

The slabs shall have the top (exposed) face polished before being brought to site, unless otherwise specified. The slabs shall conform to the size required. Before starting the work the contractor shall get the samples of slabs approved by the Engineer-In-Charge.

### **1.21.2 Dressing**

Every slab shall be cut to the required size and shape and fine chisel dressed on the sides to the full depth so that a straight edge laid along the side of the stone shall be in full contact with it. The sides (edges) shall be table rubbed with coarse sand or machine rubbed before paving. All angles and edges of the slabs shall be true, square and free from chippings and the surface shall be true and plane.

The thickness of the slab after it is dressed shall be 20, 25, 30 or 40 mm as specified in the description of the item. Tolerance of  $\pm 2$  mm shall be allowed for the thickness. In respect of length and breadth of slabs Tolerance of  $\pm 5$  mm for hand cut slabs and  $\pm 2$  mm for machine cut slabs shall be allowed.

### **1.21.3 Preparation of Surface and Laying**

The specification shall be as described, except that the edges of the slabs to be jointed shall be buttered with grey cement, with admixture of pigment to match the shade of the slab. The thickness of the joints should be minimum as possible. In any location, it shall not exceed 1 mm.

### **1.21.4 Polishing and Finishing**

The specifications shall be as described, except that (a) first polishing with coarse grade carborundum stone shall not be done, (b) cement slurry with or without pigment shall not be applied on the surface before polishing.

### **1.21.5 Kota Stone in Risers of Steps, Skirting and Dado**

Kota Stone Slabs and Dressing shall be as specified, except that the thickness of the slabs shall be 25 mm or as specified in the description of the item or as specified in schedule of finishes. The slabs may be of uniform size if required.

Preparation of surface shall be as specified.

Laying shall be as specified, except that the joints of the slabs shall be set in grey cement mixed with pigment to match the shade of the slabs.

Curing, Polishing and Finishing shall be as specified, except that first polishing with coarse grade carborundum stone shall not be done.

## **1.22 Mirror Polishing and Finishing (Stone & Marble)**

### **Procedure**

For leveling of floor, use No.'0' while level. Grinding of magnisite and synthetic abrasive after operation of No.- '0' repairing to be done on floor.

Use No.1 Brown Fine Grinding of magnisite and synthetic abrasive which removes minor level difference as well as the scratches of No.0 (First two stones is to be used for leveling). Then No.2 Green Smooth Grinding of magnisite and synthetic abrasive, after this operation practically no scratches remains.

After above operation use No.3 yellow pre polish of magnisite and synthetic abrasive, after this operation dull shine appears. A sharp reflection will be visible of any illuminated object. This must be achieved for sharp final finish.

Then use No.4 Red Polish of magnisite and synthetic abrasive, after this operation sharpness improves, true colour of the object appears.

Then use No.5 Orange Super Polish of magnisite and synthetic abrasive after this operation full true colour appears.

Then finally use No.6 Yellow and Black coating of magnisite and synthetic abrasive it creates a water like effect on the surface and enhances the colour of the mosaic kota/marble/granite.

Skirting shall also be polished using hand held grinding machine with the grinding stone indicated above.

**Mirror polish shall be carried out using bar no.1 to 7**

**Diamond polish wherever specified shall be carried out using bar 300 to 3000 and final buffing using tin oxide powder complete.**

## **1.23 Cement Concrete Flooring**

### **1.23.1 Cement Concrete**

Cement concrete of specified mix grade shall be used and it shall generally conform to the specifications.

### **1.23.2 Base Concrete**

Flooring shall be laid on base concrete where so provided. The base concrete shall be provided with the slopes required for the flooring.

Floors in water closet portion shall have slope of 1:30 or as decided by the Engineer-In-Charge to drain off washing water. Further, necessary drop in flooring ranging from 6 mm to 10 mm will also be provided to avoid spread of water. Necessary margin to accommodate this drop shall be made in base concrete. Plinth masonry off set shall be depressed so as to allow the base concrete to rest on it.

The flooring shall be commenced preferably within 48 hours of the laying of base concrete. The surface of the base shall be roughened with steel wire brushes without disturbing the concrete.

Immediately before laying the flooring, the base shall be wetted and a coat of cement slurry @ 2 kg of cement spread over an area of one sqm so as to get a good bond between the base and concrete floor.

If the cement concrete flooring is to be laid directly on the RCC slab, the top surface of RCC slab shall be cleaned and the laitance shall be removed and a coat of cement slurry @ 2 kg of cement spread over an area of one sqm so as to get a good bond between the base and concrete floor.

#### 1.23.3 Thickness

The thickness of floor shall be as specified.

#### 1.23.4 Laying

**Panels:** Flooring of specified thickness shall be laid in the pattern including the border as given in the drawings or as directed by the Engineer-In-Charge. The border panels shall not exceed 450 mm in width and the joints in the border shall be in line with panel joints. The panels shall be of uniform size and no dimension of a panel shall exceed 2 m and the area of a panel shall not be more than 2 sqm.

The joints of borders at corners shall be mitred for provision of strips.

#### 1.23.5 Laying of Flooring with Strips:

Normally cement concrete flooring shall be laid in one operation using glass/ aluminium/PVC/brass strips/stainless steel strips or any other strips as required as per drawing or instructions of the Engineer-In-Charge, at the junction of two panels. This method ensures uniformity in colour of all the panels and straightness at the junction of the panels. 4 mm thick glass strips or 2 mm PVC strips or 2 mm aluminium or brass strips shall be fixed with their tops at proper level, giving required slopes. Use of glass and metallic strips shall be avoided in areas exposed to sun.

#### 1.23.6 Concreting:

Cement concrete shall be placed in the panels and be levelled with the help of straight edge and trowel and beaten with thapy or mason's trowel. The blows shall be fairly heavy in the beginning but as consolidation takes place, light rapid strokes shall be given. Beating shall cease as soon as the surface is found covered with a thin layer of cream of mortar. The evenness of the surface shall be tested with straight edge. Surface of flooring be true to required slopes. While laying concrete, care shall be taken to see that the strips are not damaged/disturbed by the labourers. The tops of strips shall be visible clearly after finishing with cement slurry.

#### **1.23.7 Laying of Flooring without Strips:**

Laying of cement concrete flooring in alternate panels may be allowed by the Engineer-In-Charge in case strips are not to be provided.

#### **1.23.8 Shuttering:**

The panels shall be bounded by angle iron or flats. The angle iron/flat shall have the same depth as the concrete flooring. These shall be fixed in position, with their top at proper level giving required slopes. The surface of the angle iron or flats, to come in contact with concrete shall be smeared with soap solution or non-sticking oil (Form oil or raw linseed oil) before concreting. The flooring shall butt against the unplastered masonry wall.

#### **1.23.9 Concreting:**

The concreting shall be done in the manner as described below.

The angle iron/ flats used for shuttering, shall be removed on the next day of the laying of cement concrete. The ends thus exposed shall be repaired, if damaged with cement mortar 1: 2 (1 cement: 2 coarse sand) and allowed to set for minimum period of 24 hours. The alternate panels shall then be cleaned of dust, mortar, droppings etc. and concrete laid. While laying concrete, care shall be taken to see that the edges of the previously laid panels are not damaged and fresh mortar is not splashed over them. The joints between the panels should come out as fine straight lines.

#### **1.23.10 Finishing**

The finishing of the surface shall follow immediately after the cessation of beating. The surface shall be left for some time, till moisture disappears from it or surplus water can be mopped up. Use of dry cement or cement and sand mixture stiffening the concrete to absorb excessive moisture shall not be permitted. Excessive trowelling shall be avoided.

Fresh cement shall be mixed with water to form a thick slurry and spread @ 2 kg of cement over an area of one sqm of flooring while the flooring concrete is still green. The cement slurry shall then be properly processed and finished smooth.

The edges of sunk floors shall be finished and rounded with cement mortar 1:2 (1 cement: 2 coarse sand) and finished with a floating coat of neat cement.



The junctions of floor with wall plaster, dado or skirting shall be rounded off where so specified.

The men engaged on finishing operations shall be provided with raised wooden platform to sit on so as to prevent damage to new work.

#### **1.23.11 Curing**

The curing shall be done for a minimum period of ten days. Curing shall not be commenced until the top layer has hardened. Covering with empty gunnies bag shall be avoided as the colour of the flooring is likely to be bleached due to the remnants of cement dust from the bags.

#### **1.23.12 Precautions**

Flooring in lavatories and bath room shall be laid only after fixing of water closet and squatting pans and floor traps. Traps shall be plugged while laying the floors and opened after the floors are cured and cleaned. Any damage done to W.C.'s squatting pans and floor traps during the execution of work shall be made good.

During cold weather, concreting shall not be done when the temperature falls below 4°C. The concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone. During hot weather, precautions shall be taken to see that the temperature of wet concrete does not exceed 38° C. No concreting shall be laid within half an hour of the closing time of the day, unless permitted by the Engineer -In-Charge. To facilitate rounding of junction of skirting, dado and floor, the skirting/dado shall be laid along with the border or adjacent panels of floor.

#### **1.24 Cement Concrete Pavement in Courtyard, Ramp and Terrace Etc.**

Specifications described shall hold good as far as applicable except that:

- The panels shall be of uniform size and no dimension of a panel shall exceed 1.25 m and the area of panel should not exceed 1.25 sqm for the thickness of panel's upto 50 mm.
- Concreting shall be done in alternate panels only and no glass/asbestos strips shall be provided.

##### **1.24.1 Finishing**

The finishing of the surface shall follow immediately after the cessation of beating. The surface shall be left for some-time, till moisture disappears from it or surplus water can be mopped up.

Use of dry cement or cement and sand mix on the surface to stiffen the concrete or to absorb excessive moisture shall not be permitted. Excessive troweling shall be avoided. When the surface becomes fairly stiff, it shall be finished rough with wooden floats or where so specified chequered uniformly by pressing a piece of expanded metal of approved size.

## **1.25 Tile Flooring**

### **1.25.1 Ceramic Tile Flooring**

#### **1.25.1.1 Ceramic Tiles**

The tiles shall be of approved make and shall generally conform to IS 15622. They shall be flat, and true to shape and free from blisters crazing, chips, welts, crawling or other imperfections detracting from their appearance. The tiles shall be tested as per IS 13630. Classification and Characteristics of ceramic tiles shall be as per IS 13712.

The tiles shall be square or rectangular of nominal size. Table 1, 3, 5, and 7 of IS 15622 give the modular preferred sizes and table 2, 4, 6 and 8 give the most common non modular sizes. Thickness shall be specified by the manufacturer. It includes the profiles on the visible face and on the rear side.

Manufacturer/supplier and party shall choose the work size of tiles in order to allow a nominal joint width up to 2mm for unrectified floor tiles and up to 1mm for rectified floor tiles. The joint in case of spacer lug tile shall be as per spacer.

The top surface of the tiles shall be glazed. Glaze shall be either glossy or matt as specified. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be preferably free from glaze. However, any glaze if unavoidable, shall be permissible on only up to 50 per cent of the surface area of the edges.

#### **1.25.1.2 Coloured Tiles**

Only the glaze shall be coloured as specified. The sizes and specifications shall be the same as for the white glazed tiles.

#### **1.25.1.3 Decorative Tiles**

The type and size of the decorative tiles shall be as follows:

- **Decorated white back ground tiles**

The size of these tiles shall be as per IS 15622.

- **Decorated and having coloured back-ground**

The sizes of the tiles shall be as per IS 15622.

#### **1.25.1.4 Preparation of Surface and Laying**

Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tile shall be with cement mortar 1:4 (1 cement: 4 coarse sand) or as specified.

The average thickness of the bedding shall be 20 mm or as specified while the thickness under any portion of the tiles shall not be less than 10 mm.

Mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it.

Over this mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of cement per square meter over an area up to one square meter. Tiles shall be soaked in water washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.

The surface of the flooring during laying shall be frequently checked with a straight edge about 2 m long, so as to obtain a true surface with the required slope. In bath, toilet W.C. kitchen and balcony/verandah flooring, suitable tile drop or as shown in drawing will be given in addition to required slope to avoid spread of water. Further tile drop will also be provided near floor trap.

Where full size tiles cannot be fixed these shall be cut (sawn) to the required size, and their edge rubbed smooth to ensure straight and true joints. Tiles which are fixed in the floor adjoining the wall shall enter not less than 10 mm under the plaster, skirting or dado.

After tiles have been laid surplus cement slurry shall be cleaned off.

#### **1.25.1.5 Pointing and Finishing**

The joints shall be cleaned off the grey cement slurry with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigment if required to match the colour of tiles. Where spacer lug tiles are provided, the half the depth of joint shall be filled with polysulphide or as specified on top with under filling with cement grout without the lugs remaining exposed. The floor shall then be kept wet for 7 days. After curing, the surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

### **1.25.2 Vitrified Tile Flooring**

#### **1.25.2.1 Vitrified Tiles**

The tiles shall be of approved make and shall generally conform to IS 15622. They shall be flat, and true to shape and free from blisters crazing, chips, welts, crawling or other imperfections detracting from their appearance. The tiles shall be tested as per IS 13630. Classification and Characteristics of Vitrified tiles shall be as per IS 13712.

The tiles shall be square or rectangular of nominal size. as per IS 15622 give the modular preferred sizes (Tiles with water absorption  $E < 0.08$  percent Group B1a) and the joint thickness in flooring

shall not be more than 1mm. Thickness shall be specified by the manufacturer. It includes the profiles on the visible face and on the rear side.

Manufacturer/supplier and party shall choose the work size of tiles in order to allow a nominal joint width shall not be more than 1mm for rectified floor tiles. IS 15622 give the modular preferred sizes (Tiles with water absorption  $E < 0.08$  per cent Group B1a) and the joint thickness in flooring shall not be more than 1mm.

The top surface of the tiles shall be glazed. Glaze shall be either glossy or matt as specified. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be preferably free from glaze. However, any glaze if unavoidable, shall be permissible on only up to 50 percent of the surface area of the edges.

#### **1.25.2.2 Coloured Tiles**

Only the glaze shall be coloured as specified. The sizes and specifications shall be the same as for the white glazed tiles.

#### **1.25.2.3 Decorative Tiles**

The type and size of the decorative tiles shall be as follows:

- **Decorated white back ground tiles**  
  
The size of these tiles shall be as per IS 15622.
- **Decorated and having coloured back-ground** The sizes of the tiles shall be as per IS 15622.

#### **1.25.2.4 Preparation of Surface and Laying**

Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tile shall be with cement mortar 1:4 (1 cement: 4 coarse sand) or as specified. The average thickness of the bedding shall be 20 mm or as specified while the thickness under any portion of the tiles shall not be less than 10mm.

Mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it.

Over this mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of cement per square meter over an area up to one square meter. Tiles shall be soaked in water washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.

The surface of the flooring during laying shall be frequently checked with a straight edge about 2 m long, so as to obtain a true surface with the required slope. In bath, toilet W.C. kitchen and balcony/verandah flooring, suitable tile drop will be given in addition to required slope to avoid spread of water. Further tile drop will also be provided near floor trap.

Where full size tiles cannot be fixed these shall be cut (sawn) to the required size, and their edge rubbed smooth to ensure straight and true joints. Tiles which are fixed in the floor adjoining the wall shall enter not less than 10 mm under the plaster, skirting or dado.

After tiles have been laid surplus cement slurry shall be cleaned off.

#### **1.25.2.5 Pointing and Finishing**

The joints shall be cleaned off the grey cement slurry with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigment if required to match the colour of tiles. Where spacer lug tiles are provided, the half the depth of joint shall be filled with polysulphide or as specified on top with under filling with cement grout without the lugs remaining exposed. The floor shall then be kept wet for 7 days. After curing, the surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

#### **1.26 Fixing of Tile Flooring with Cement Based High Polymer Modified Quick Set Adhesive (Water Based)**

When tile flooring is to be laid over the existing flooring without dismantling old flooring it can be laid with adhesive. The old flooring shall be thoroughly cleaned and checked for undulations, if any shall be rectified with cement mortar 1:3 (1 cement: 3 coarse sand). Old cement concrete surface shall be hacked and cleaned off to have proper bond with the old surface.

High polymer modified quick set tile adhesive (conforming to IS 15477) shall be thoroughly mixed with water and a paste of zero slump shall be prepared so that it can be used within 1.5 to 2 hours. It shall be spread over an area not more than one sqm at one time. Average thickness of adhesive shall be 3 mm. The adhesive so spread shall be combed using suitable trowel. Tiles shall be pressed firmly in to the position with slight twisting action checking it simultaneously to ensure good contact gently being tapped with wooden mallet till it is properly backed with adjoining tiles. The tiles shall be fixed within 20 minutes of application of adhesive. The surplus adhesive from the joints, surface of the tiles shall be immediately cleaned.

The surface of the flooring shall be frequently checked during laying with straight edge of above 2m long so as to attain a true surface with required slope.

Where spacer lugs tiles are provided these shall be filled with grout with lugs remaining exposed.

Where full size tile cannot be fixed these shall be cut (sawn) to the required size and edges rubbed smooth to ensure straight and true joints. Tiles which are fixed in floor adjoining to wall shall enter not less than 10 mm under plaster, skirting or dado.

### **1.27 Ceramic Tiles in Skirting and Dado**

The tiles shall be of approved make and shall generally conform to IS 15622. The tiles shall be pressed ceramic covered by a glaze thoroughly matured and fitted to the body. The tiles shall be sound, true to shape, flat and free from flaws and other manufacturing defects affecting their utility.

The top surface of the tiles shall be glazed. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be free from glaze, however, any glaze if unavoidable shall be permissible on only up to 50 per cent of the surface area of edges.

The glaze shall be free from welts, chips, craze, specks, crawling or other imperfections detracting from the appearance when viewed from a distance of one meter. The glaze shall be either glossy or matt as specified. The glaze shall be white in colour except in the case of coloured tiles when colours shall be specified by the Engineer-In-Charge. There may be more than one colour on a tile.

#### **1.27.1 Dimensions and Tolerances**

Glazed pressed ceramic tiles shall be made square or rectangular in sizes Table 1, 3, 5 & 7 of IS 15622 give the modular sizes and table 2, 4, 6 & 8 of IS 15622 gives the sizes of non-modular tiles. The tiles shall conform to IS 15622 for dimensional tolerance, physical and chemical properties.

Half tiles for use as full tiles shall have dimensions which shall be such as to make the half tiles when jointed together (with 1 mm joint) match with dimensions of full tiles. Tiles may be manufactured in sizes other than those specified above.

The thickness of the tiles shall be 5 mm or 6 mm or as specified. The dimensions of fittings associated with the glazed tiles namely cover base, round edge tile, angles corner cups, ridge and legs, cornices and capping beads shall be of the shape and dimensions as required and the thickness of fittings shall be the same as the thickness of tiles given above.

#### **1.27.2 Preparation of Surfaces**

The joints shall be raked out to a depth of at least 15 mm in masonry walls.

In case of concrete walls, the surface shall be hacked and roughened with wire brushes. The surface shall be cleaned thoroughly, washed with water and kept wet before skirting is commenced.

#### **1.27.3 Laying**

12 mm thick plaster of cement mortar 1:3 (1 cement: 3 coarse sand) mix or as specified shall be applied and allowed to harden. The plaster shall be roughened with wire brushes or by scratching diagonal at closed intervals.

The tiles should be soaked in water, washed clean, and a coat of cement slurry applied liberally at the back of tiles and set in the bedding mortar. The tiles shall be tamped and corrected to proper plane and lines. The tiles shall be set in the required pattern and jointed. The joints shall be as fine as possible. Top of skirting or dado shall be truly horizontal and joints truly vertical except where otherwise indicated. Odd size/cut size of tile shall be adjusted at bottom to take care of slope of the flooring.

Skirting and dado shall rest on the top of the flooring. Where full size tiles cannot be fixed these shall be cut (sawn) to the required size and their edges rubbed smooth. Skirting /dado shall not project from the finished "surface of wall" by more than the tile thickness, undulations if any shall be adjusted in wall.

#### **1.27.4 Curing and Finishing**

The joints shall be cleaned off the grey cement grout with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigments if required to match the colour of tiles. The work shall then be kept wet for 7 days.

After curing, the surface shall be washed and finished clean. The finished work shall not sound hollow when tapped with a wooden mallet.

#### **1.28 Floor Hardener:**

Provide and install all equipment, material, and labour to complete work of this section in accordance with the details herein over all vacuum dewater surfaces.

##### **Products**

##### Floor Hardener (FH)

Manufacturer as per approved list.

##### Execution

The form works should be erected and levelled as per designed bays.

The base should be cast of RCC concrete having water cement ratio of not more than 0.4 incorporating a high early strength super plasticizer and the concrete should be properly vibrated by screed vibrators.

The cement content should be minimum of 300 kg/cu.m.

When the surface is free from residual bleed water and is sufficiently hardened to allow light foot traffic and when the surface leaves an impression of about 2 to 3mm the try shake, surface hardener like floor hardener (FH) can be broadcasted. The broadcasting should be done in two operations which are perpendicular to each other.

The surface can then be power floated and power trowelled to achieve desired finished.

Floor hardener (FH) should be used @ 6 Kg/sq.m or as specified.

The floors can be cured in a normal way.

After complete curing the surface should be well prepared and free from oil, grease and remnants of form oil or curing compound. The surface should be free from dust, laitance and completely dried. Surface driers can be used if residual moisture is observed on the surface.

### **1.29 Engineered Wood in Door**

Wood should meet following property & should be best available in the market duly approved by Engineer-in charge.

- Density range: 600 - 750 Kg/ m<sup>3</sup>
- Adhesive - As per IS : 848 BWP Grade
- Technical Specification As Per IS: 14616:1999

#### **1.29.1 Panelled Glazed or Panelled and Glazed Shutters**

Paneled or glazed shutters for doors, windows, ventilators and cupboards shall be constructed in the form of timber frame work of stiles and rails with panel inserts of timber, plywood, block board, veneered particle board, fiber board wire gauze or float glass. The shutters may be single or multi-paneled as directed by the Engineer-In-Charge. Timber for frame work, material for panel inserts and thickness of shutters shall be as specified. All members of the shutters shall be straight without any warp or bow and shall have smooth well planned face at right angles to each other.

Any warp or bow shall not exceed 1.5 mm for door shutter and 1 mm for window and ventilator shutter. The right angle for the shutter shall be checked by measuring the diagonals and the difference between the two diagonals should not be more than 3 mm. Generally paneled glazed or paneled and glazed shutter shall conform to IS 1003 (Pt. 1 &2).

#### **1.29.2 Frame Work**

Timber for stiles and rails shall be of the same species and shall be sawn in the directions of grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the



required dimensions. The stiles and rails shall be joined to each other by plain or haunched mortise and tenon joints and the rails shall be inserted 25 mm short of the width of the stiles. The bottom rails shall have double tenon joints and for other rails single tenon joints shall be provided. The lock rails of door shutter shall have its center line at a height of 800 mm from the bottom of the shutters unless otherwise specified. The thickness of each tenon shall be approximately one-third the finished thickness of the members and the width of each tenon shall not exceed three times its thickness.

### 1.29.3 Gluing of Joints:

The contact surfaces of tenon and mortise shall be treated, before putting together, with bulk type synthetic resin adhesive conforming to IS 851 suitable for construction in wood or synthetic resin adhesive (Phenolic and amino plastic) conforming to IS 848 or polyvinyl acetate dispersion based adhesive conforming to IS 4835 and pinned with 10 mm dia hardwood dowels or bamboo pins or star shaped metal pins; after the frames are put together and pressed in position by means of press.

Stiles and bottom rail shall be made out of one piece of timber only. Intermediate rail exceeding 200 mm in width may be of one or more pieces of timber. The width of each piece shall be not less than 75 mm. Where more than one piece of timber is used for rails, they shall be joined with a continuous tongued and grooved joint glued together and reinforced with metal dowels at regular intervals not exceeding 200 mm.

## 1.30 Door Shutters

Finished dimensions and tolerances of components of door shutters has been given in Table-1 below.

**TABLE-1 Dimensions and Tolerances of Components of Door Shutters**

S. No.	Description	Width mm	Thickness mm
(a)	Vertical Stile, top and freeze rail	100 $\pm$ 3	35 $\pm$ 1 or 40 $\pm$ 1
(b)	Lock rail	50 $\pm$ 3	35 $\pm$ 1 or 40 $\pm$ 1
(c)	Bottom rail	200 $\pm$ 3	35 $\pm$ 1 or 40 $\pm$ 1
(d)	Muntin	100 $\pm$ 3	35 $\pm$ 1 or 40 $\pm$ 1
(e)	Glazing bar	40 $\pm$ 3	35 $\pm$ 1 or 40 $\pm$ 1

**1.30.1 Size and Types:** Size and types of the timber panels and glazed shutters shall generally conform to modular sizes specified in Table-2 below.

**TABLE-2 Dimension of Door Shutters**

SI. No.	Designation of Doors	Width mm	Height mm
(i)	8DS20	700	1905 (1945)
(ii)	8DS21	700	2005 (2045)
(iii)	9DS20	800	1905 (1945)
(iv)	9DS21	800	2005 (2045)
(v)	10DS20	900	1905(1945)

(vi)	10DS21	900	2005 (2045)
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**Notes:**

The designation refers to modular sizes of door openings. First number stands for width and the last for height in modules (M = 100 mm). Alphabet D refers to doors, 'S' to single and T to double leaf shutter.

- Standard sizes of door frames are covered in IS 4021 and IS 4351.
- The standard widths and heights for panel doors are arrived at as shown in Fig. 6 of IS 1003 (Pt. 1).

In case the modular height is taken from the finished floor level, the height of the door shall be the one given in bracket. In the case of double leave shutters, the rebate in the shutter shall be as given in 6.15 of IS 1003 (Pt. 1).

**1.30.2 Paneling**

The panel inserts shall be either framed into the grooves or housed in the rebate of stiles and rails. Timber, plywood, and particle board panels as given under sub head and shall be fixed only with grooves. The depth of the groove shall be 12 mm and its width shall accommodate the panel inserts such that the faces are closely fitted to the sides of the groove. Panel inserts shall be framed into the grooves of stiles and rails to the full depth of the groove leaving space of 1.5 mm. Width and depth of the rebate shall be equal to half the thickness of stiles and rails. Glass panels, asbestos panels wire gauze panels and panel inserts of cupboard shutters shall be housed in the rebates of stiles and rails.

**1.30.3 Timber Panels;**

Timber panels shall be preferably made of timber of large width; the minimum width and thickness of the panel shall be 100 mm, and 15 mm respectively. When made from more than one piece, the pieces shall be jointed with a continuous tongued and grooved joint glued together and reinforced with headless nails at regular intervals not exceeding 100

Depth and thickness of such joint shall be equal to one-third of thickness of panel. The panels shall be designed such that no single panel exceeds 0.5 square metre in area. The grains of timber panels shall run along the longer dimensions of the panels. All panels shall be of the same species of timber unless otherwise specified.

**1.30.4 Plywood Panels:**

Plywood boards used for paneling of shutters shall be BWP type or grade as specified. Each panels shall be a single piece of thickness, 9 mm for two or more panel construction and 12 mm thickness for single panel construction unless otherwise specified.

**1.30.5 Veneered Particle Board Panels:**

Veneered Particle board used for paneling of shutters shall be Exterior Grade bonded with BWP type synthetic resin adhesive as specified. Each panel shall be a single piece of thickness 12 mm unless otherwise specified.

**1.30.6 Fiber Board Panels;**

Fiber board used for paneling of shutters shall be Exterior Grade bonded with BWP type synthetic resin adhesive, each fiber board panel shall be a single piece unless otherwise specified.

**1.30.7 Wire Gauze Panels:**

Wire Gauze used for paneling of shutters shall be woven with 0.63 mm dia galvanized mild steel wire to form average aperture size of 1.40 mm as specified. Wire gauze shall be securely housed into the rebates of stiles and rails by giving right angles bend turned back and fixed by means of suitable staples at intervals of 75 mm and over this wooden beading shall be fixed. The space between the rebate and the beading shall be fixed with putty to give a neat finish. Each wire gauze panel shall be a single piece, and the panels shall be so designed that no single panels exceeds 0.5 sqm in area. However, care shall be taken to prevent sagging of wire gauge, of panel by providing and fixing 20 x 20 mm square or equivalent beading to the external face to the required patterns as decided by the Engineer-In-Charge.

**1.30.8 Glass Panels:**

Glass paneling (Glazing) shall be done as specified. Glazing in the shutters of doors, windows and ventilators of bath, WC and Lavatories shall be provided with frosted glass the weight of which shall be not less than 10 kg/sqm. Frosted glass panes shall be fixed with frosted face on the inside. Glass panels shall be fixed by providing a thin layer of putty conforming to IS 419 applied between glass pane and all along the length of the rebate and also between glass panes and wooden beading.

Putty can be prepared by mixing one part of white lead with three parts of finely powdered chalk and then adding boiled linseed oil to the mixture to form a stiff paste and adding varnish to the paste at the rate of 1 liter of varnish to 18 kg of paste. Fixing of glass panes without beading shall not be permitted. Glazing shall be done after the shutters have been primed and prepared for painting, so that wood may not draw oil out of putty.

**1.30.9 Finish:**

Panels of shutters shall be flat and well sanded to a smooth and level surface.

**1.30.10 Beading**

Beadings in paneled shutter shall be provided where specified in architectural drawings or directed by the Engineer -In-Charge. Each length of beading shall be single piece. Joints at the corners shall

be mitered and exposed edges shall be rounded. Beading shall be fixed with headless nails at 75 mm intervals. For external shutters, the beading shall be fixed on the outside face.

#### **1.30.11 Machine/Factory made Shutters**

Machine made shutters, where specified, shall be procured from an approved factory. For machine made shutters, operations like sawing, planning, making tongue and tenons, cutting grooves, mortises and rebates, drilling holes and pressing of joints shall be done by suitable machines. Machines made shutters shall be brought to the site fully assembled but without any priming coat. Panel inserts of sheet glass and wire gauze may, however, be fixed at site.

#### **1.30.12 Fixing of Shutters**

For side hung shutters of height up to 1.2 m, each leaf shall be hung on two hinges at quarter points and for shutter of height more than 1.2 m, each leaf shall be hung on three hinges one at the center and the other two at 200 mm from the top and bottom of the shutters. Top hung and bottom hung shutters shall be hung on two hinges fixed at quarter points of top rail or bottom rail. Centre hung shutter shall be suspended on a suitable pivot in the center of the frame. Size and type of hinges and pivots shall be as specified. Flap of hinges shall be neatly counter sunk into the recesses cut to the exact dimensions of flap. Screws for fixing the hinges shall be screwed in with screw driver and not hammered in. Unless otherwise specified, shutters of height more than 1.2 mm shall be hung on butt hinges of size 100 mm and for all other shutters of lesser height butt hinges of size 75 mm shall be used. For shutter of more than 40 mm thickness butt hinges of size 125 \* 90 \* 4 mm shall be used. Continuous (piano) hinges shall be used for fixing cup-board shutters where specified.

#### **1.30.13 Fittings**

Fittings shall be provided as per schedule of fittings decided by Engineer-In-Charge. The fittings shall confirm to specifications.

#### **1.30.14 Wooden Cleats and Blocks**

Wooden cleats and blocks shall be fixed to doors and windows as directed by Engineer-In-Charge, as per size and shape approved.

#### **1.31 Flush Door Shutters**

Flush door shutters shall have a solid core and may be of the decorative or non-decorative (Paintable type as per IS 2202 (Part I). Nominal thickness of shutters may be 25, 30 or 35 mm. Thickness and type of shutters shall be as specified.

Width and height of the shutters shall be as shown in the drawings or as indicated by the Engineer-In-Charge. All four edges of the shutters shall be square. The shutter shall be free from twist or warp in its plane. The moisture content in timbers used in the manufacture of flush door shutters shall be not more than 12 per cent when tested according to IS 1708.

### **1.31.1 Core**

The core of the flush door shutters shall be a block board having wooden strips held in a frame constructed of stiles and rails. Each stile and rail shall be a single piece without any joint. The width of the stiles and rails including lipping, where provided shall not be less than 45 mm and not more than 75 mm. The width of each wooden strip shall not exceed 30 mm. Stiles, rails and wooden strips forming the core of a shutter shall be of equal and uniform thickness. Wooden strips shall be parallel to the stiles.

End joints of the pieces of wooden strips of small lengths shall be staggered. In a shutter, stiles and rails shall be of one species of timber. Wooden strips shall also be of one species only but it may or may not be of the same species as that of the stiles and rails. Any species of timber may be used for core of flush door. However, any non-coniferous (Hard wood) timber shall be used for stiles, rails and lipping.

### **1.31.2 Face Panel**

The face panel shall be formed by gluing, by the hot-press process on both faces of the core, either plywood or cross-bands and face veneers. The thickness of the cross bands as such or in the plywood shall be between 1.0 mm and 3.0 mm. The thickness of the face veneers as such or in the plywood shall be between 0.5 mm and 1.5 mm for commercial veneers and between 0.4 mm and 1.0 mm for decorative veneers, provided that the combined thickness of both is not less than 2.2 mm. The direction of the veneers adjacent to the core shall be at right angles to the direction of the wooden strips. Finished faces shall be sanded to smooth even texture. Commercial face veneers shall conform to marine grade plywood and decorative face veneers shall conform to type I decorative plywood in IS 1328.

### **1.31.3 Lipping**

Lipping, where specified, shall be provided internally on all edges of the shutters. Lipping shall be done with battens of first class hardwood or as specified of depth not less than 25 mm. For double leaved shutters, depth of the lipping at meeting of stiles shall be not less than 35 mm. Joints shall not be permitted in the lipping.

### **1.31.4 Rebating**

In the case of double leaves shutters the meeting of stiles shall be rebated by 8 mm to 10

The rebating shall be either splayed or square type as shown in drawing where lipping is provided. The depth of lipping at the meeting of stiles shall not be less than 30 mm.

### **1.31.5 Opening for Glazing**

When required by the purchaser opening for glazing shall be provided and unless otherwise specified the opening for glazing shall be 250 mm in height and 150 mm or 200

in width unless directed otherwise. The bottom of the opening shall be at a height of 1.4 m from the bottom of the shutter. Opening for glazing shall be lipped internally with wooden batten of width not less than 25 mm.

Opening for glazing shall be provided where specified or shown in the drawing.

#### **1.31.6 Venetian Opening**

Where specified the height of the Venetian opening shall be 350 mm from the bottom of the shutter. The width of the opening shall be as directed but shall provide for a clear space of 75 mm between the edge of the door and Venetian opening but in no case the opening shall extend beyond the stiles of the shutter. The top edge of the opening shall be lipped internally with wooden battens of width not less than 25 mm. Venetian opening shall be provided where specified or shown in the drawing.

#### **1.31.7 Tolerance**

Tolerance on width and height shall be + 3 mm and tolerance on nominal thickness shall be  $\pm 1.2$  mm. The thickness of the door shutter shall be uniform throughout with a permissible variation of not more than 0.8 mm when measured at any two points.

#### **1.31.8 Adhesive**

Adhesive used for bonding various components of flush door shutters namely, core, core frame, lipping, cross-bands, face veneers, plywood etc. and for bonding plywood shall conform to BWP type, phenol formaldehyde synthetic resin adhesive conforming to IS 848.

#### **1.31.9 Tests**

Samples of flush door shutters shall be subjected to the following tests:

- End Immersion Test
- Knife Test
- Glue Adhesion Test

One end of each sample shutter shall be tested for End Immersion Test. Two specimens of 150 x 150 mm size shall be cut from the two corners at the other end of each sample shutter for carrying out Glue Adhesion Test. Knife Test shall be done on the remaining portion of each sample shutter.

#### **1.31.10 Sample Size**

Shutters of decorative and non-decorative type from each manufacturer, irrespective of their thickness, shall be grouped separately and each group shall constitute a lot. The number of shutters (sample size) to be selected at random from each lot for testing shall be as specified in below Table.

If the total number of shutters of each type in a work (and not the lot) is less than twenty five, testing may be done at the discretion of the shutter provided the sample does not fail in any of the test specified.

For knife test, glue adhesive test, slamming test, the end immersion test, the number of shutters shall be as per col. 4 of below Table.

**TABLE Sample Size and Criteria for Conformity**

<i>Lot Size</i>	<i>Sample Size</i>	<i>Permissible no. of defective</i>	<i>Sub. Sample size</i>
[1]	[2]	[3]	[4]
Upto 26 to 50	8	0	1
51 – 100	13	1	2
101 -150	20	1	2
151 – 300	32	1	3
301 – 500	50	2	4
501 and above	80	2	5

#### **1.31.11 Criteria for Conformity**

All the sample shutters when tested shall satisfy the requirements of the tests laid down as specified. The lot shall be declared as conforming to the requirements when numbers of defective sample does not exceed the permissible number given in col. 3 of table above. If the number of sample shutters found unsatisfactory for a test IS one, twice the number of samples initially tested shall be selected and tested for the test. All sample shutters so tested shall satisfy the requirement of the test. If the number of samples found unsatisfactory for a test is two or more, the entire lot shall be considered unsatisfactory.

#### **1.31.12 Fixing**

This shall be as per CPWD Specifications.

#### **1.31.13 Shelves**

Shelves and vertical partitions of cupboards shall be of timber planks fiber board, particle board, block board or veneered particle board as specified. Thickness and type of planks or boards shall be as specified. Each shelf shall be a single piece and vertical partitions between two consecutive shelves shall be without any joint. Exposed edges of boards having particle board core shall be sealed with 3 mm thick single piece teak wood strips of width equal to the thickness of board with headless pins. The arrangement of shelves and vertical partitions shall be as per drawings or as directed by the Engineer-in-Charge.

#### **1.31.14 Fixing**

Planks for shelves shall be planed on all faces and edges. In case of boards they shall be sawn to the required size truly straight and square. Timber battens 25 x 40 mm unless otherwise specified shall be planed smooth and fixed inside the cupboard with wooden

plugs and screws. Shelves shall be fixed to the battens and vertical portions shall be held in position by fixing them to the battens and shelves using screws. Teakwood strips for edge sealing of the boards shall be planed smooth and fixed with headless nails. Tolerance in width shall be  $\pm 1.5$  mm and in thickness 1 mm.

#### 1.31.15 Hold Fast

These shall be made from mild steel flat 40 \* 5 mm size conforming to IS 7196 without any burns or dents. 5 cm length of M.S. flat at one end shall be bent at right angle and one hole 11 mm dia shall be made in it for fixing to wooden frame with 10 mm dia nut bolt. The bolt head shall be sunk into the wooden frame, 10 mm deep and plugged with wooden plug. At the other end 10 cm length of the hold fast flat shall be forked and bent of length as specified at right angle in opposite direction and embedded in cement concrete block of size 30 x 10 x 15 cm of mix 1:3:6 (1 cement: 3 coarse sand : 6 graded stone aggregate, 20 mm nominal size) or as specified.

#### 1.31.16 Fittings

Fitting shall be of mild steel brass, aluminium or as specified. Some mild steel fittings may have components of cast iron. These shall be well made, reasonably smooth, and free from sharp edges and corners, flaws and other defects. Screw holes shall be counter sunk to suit the head of specified wood screws. These shall be of the following types according to the material used.

- **Mild Steel Fittings:** These shall be bright finish black stone enameled or copper oxidized (black finish), nickel chromium plated or as specified.
- **Brass Fittings:** These shall be finished bright satin finish or nickel chromium plated or copper oxidized or as specified.
- **Aluminium Fittings:** These shall be anodized to natural matt finish or dyed anodic coating not less than grade AC 10 of IS 1868.
- **Stainless Steel Fittings:** These shall be of SS grade 316.

The fittings generally used for different type of doors and windows are indicative and shall be used as specified. The fittings to be actually provided in a particular work shall, however, be decided by the Engineer-In-Charge.

Screws used for fittings shall be of the same metal, and finish as the fittings. However, chromium plated brass screws or stainless steel screws shall be used for fixing aluminium fittings.



Fittings shall be fixed in proper position as shown in the drawings or as directed by the Engineer-in-Charge. These shall be truly vertical or horizontal as the case may be. Screws shall be driven home with screw driver and not hammered in. Recesses shall be cut to the exact size and depth for the counter sinking of hinges.

#### 1.31.16.1 Butt Hinges

These shall be of the following types according to the material used.

- Mild steel butt hinges (Medium).
- Cast brass butt hinges light/ordinary or heavy.
- Extruded aluminium alloy butt hinges.
- Stainless steel Grade 316

#### 1.31.16.2 Mild Steel (Medium):

These shall be medium type manufactured from M.S. sheet.

These shall be well made and shall be free from flaws and defects of all kinds. All hinges shall be cut clean and square and all sharp edges and corners shall be removed. These shall generally conform to IS 1341.

#### 1.31.16.3 Hinge Pin:

Hinge pin shall be made of mild steel wire. It shall fit inside the knuckles firmly and riveted head shall be well formed so as not to allow any play or shake, and shall allow easy movement of the hinge, but shall not cause looseness.

#### 1.31.16.4 Knuckles:

The number of knuckles in the hinges of different sizes shall be as per IS 1341. The size of knuckles shall be straight and at right angle to the flap. The movement of the hinges shall be free and easy and working shall not have any play or shake.

#### 1.31.16.5 Screw Holes:

The screw holes shall be clean and counter sunk. These shall be suitable for counter sunk head wood screws and of the specified size for different types, and sizes of hinges. The size of the holes shall be such that when it is counter sunk it shall be able to accommodate the full depth of counter sunk head of the wood screws. The nos. of screw holes shall as specified in IS 1341.

#### 1.31.16.6 Sampling and Criteria for Conformity.

The number of butt hinges to be selected from a lot shall be depend on size of lot and shall be in accordance with Table below. Butt hinges for testing shall be selected at random from at least 10 per cent of the randomly selected packages subjected to minimum of three equal number of hinges being selected from each package. All butt hinges selected shall be checked for dimensions and tolerance requirements. Defects in manufacture and finish shall also be checked and lot shall be considered conforming to the requirement of this specification, if the number of defective hinges among those tested does not exceed the corresponding number given in Table.

**TABLE Scale of Sampling and Criteria for Conformity**

<i>Sl. No.</i>	<i>Lot size</i>	<i>Sample Size</i>	<i>Permissible No. of Defective hinges</i>
1.	Upto 15050	5	0
2.	151 to 300 20 1	20	1
3.	301 to 500 32 2	32	2
4.	501 to 1000 50 3	50	3
5.	1001 and above 80 5	80	5

**1.31.16.7 Cast Brass;** These shall be light/ordinary or heavy as specified. These shall be well made and shall be free from flaws and defects of all kinds. These shall be finished bright or chromium plated or oxidized or as specified. These shall generally conform to IS 205.

**1.31.16.8 Hinge Pin:** Hinge pin shall be made of brass or of stainless steel. The hinge pins shall be firmly riveted and shall be properly finished. The movement of the hinge pin shall be free, easy and square and shall not have any play or shake.

**1.31.16.9 Knuckles:** The number of knuckles in each hinge shall not be less than five. The number of knuckles in case of sizes less than 40 mm shall be three. The sides of the knuckles shall be straight and at right angle to the flap. The movement of the hinge pin shall be free and easy and working shall not have any play or shake.

**1.31.16.10 Screw Holes;** The screw holes shall be clean and counter sunk and of the specified size for different types and size of hinges. The size of the holes shall be such that when it is counter sunk it shall be able to accommodate the full depth of counter sunk head of wood screw specified.

**1.31.16.11 Extruded Aluminium Alloy;** These shall be manufactured from extruded sections. These shall be well made and free from flaws and defects of all kinds. These shall generally conform to IS 205.

**1.31.16.12 Hinge Pin:** Hinge pin shall be made of mild steel (galvanized or aluminium alloy). The aluminium alloy hinge pin shall be anodized. The hinge pin shall be finally riveted and shall be properly finished. The movement of hinges shall be free easy and square and shall not have any play or shake.

**1.31.16.13 Knuckles:** Number of knuckles in each hinge pin shall not be less than 5. The number of knuckles in case of sizes less than 40 mm be straight and at right angle to the flap. The movement of the hinge pin shall be free and easy and working shall not have any play or shake.

**1.31.16.14 Screw Holes;** The screw holes shall be suitable for counter sunk head wood screws, and of specified sizes for different type of hinges. The size of the holes shall be such that when it is counter sunk it shall be able to accommodate the full depth of counter sunk head of wood screw specified.

Sampling and Criteria for Conformity; The number of butt hinges to be selected from a lot shall depend on the size of lot and shall be in accordance with below Table. Butt hinges for testing shall be taken at random from at least 10 per cent of the package subject to a minimum of three, equal number of hinges being selected from each package. All butt hinges selected from the lot shall be checked for dimensional and tolerance requirements. Defects in manufacture and finish shall also be checked. A lot shall be considered conforming to the requirements of this specification if the number of defective hinges among those tested does not exceed the corresponding number given in Table.

<b>TABLE Scale of Sampling and Criteria for Conformity</b>			
<i>SI. No.</i>	<i>Lot size</i>	<i>Sample size</i>	<i>Permissible No. of defective hinges</i>
1	Upto 200	15	0
2	201 to 300	20	1
3	301 to 500	30	2
4	501 to 800	40	2
5	801 and above	55	3

Note: Any hinge which fails to satisfy the requirements of any one or more of the characteristics shall be considered as defective hinge.

#### **1.31.16.15 Parliament Hinges**

These shall be of SS/ mild steel cast brass or as specified, and shall generally conform to IS 362. The size of parliament hinges shall be taken as the width between open flanges. Mild steel parliament hinges shall be copper oxidized (thick finish) or as specified. The brass parliament hinges shall be finished bright, chromium plated or oxidized or as specified.

The hinge pin shall be made of mild steel in the case of brass hinges. The hinge pin shall be mild steel (galvanized) in the case of aluminium alloy hinges. The hinge pin shall be firmly riveted and shall be properly finished. The movement of the hinges shall be free, easy and square, and shall not have any play or shake.

All screw holes shall be clean and counter sunk to suit the counter sunk head of wood screws specified.

#### **1.31.16.16 Sampling Criteria for and Conformity;**

The number of parliament hinges to be selected from a lot shall depend on the size of lot and shall be in accordance with Table below. Parliament hinges for testing shall be taken at random. All hinges selected from the lot shall be checked for dimensional and tolerance requirements. Defects in manufacture and finish shall also be checked. A lot shall be considered conforming to the requirements of this specification if the number of defective hinges among those tested does not exceed the corresponding number given in Table below.

	TABLE	
<i>Lot Size</i>	<i>Sample Size</i>	<i>Permissible No. of Defective hinges</i>
Upto 150	13	0
151 to 300	20	1
301 to 500	32	2
501 to 1000	50	3
1001 and above	80	5

**Note:** Any hinge which fails to satisfy the requirements of any one or more of the characteristics shall be considered as defective hinge.

#### 1.31.16.17 Spring Hinges (Single or double acting)

These shall be single acting when the shutter is to open on one side only or double acting when the shutter opens on both sides. These shall be made of SS/ M.S., brass or as specified, and shall generally conform to IS 453.

Hinges shall work smoothly and shall hold the door shutter truly vertical in closed position. Each double-acting spring hinge shall withstand the following tests which shall be carried out after fixing it to a swing door in the normal manner.

- When the door is pushed through 90° and released 2000 times on each side in quick succession the hinge shall show no sign of damage or any appreciable deterioration of the components during or on completion of the test.
- The door shall require a force of  $2.0 \pm 0.5$  kg for 100 mm hinges and  $3.0 \pm 0.5$  kg for 125 mm and 150 mm hinges at a distance of 45 cm from the hinge pin to move the door through 90°.
- The size of spring hinge shall be taken as the length of the plate.

**1.31.16.18 Mild Steel ;** The cylindrical casing shall be made either from M.S. sheet of 1.60 mm thickness, lap jointed and brazed, welded and riveted, or from solid drawn tube of thickness not less than 1.60 mm; or from mild sheet of 1.60 mm thickness pressed to form the two casing and the distance piece. It shall be stove enameled black or copper oxidized or as specified.

**1.31.16.19 Cast Brass;** The cylindrical casing shall be made either from brass sheet of 1.60 mm thickness, lap jointed and brazed, or from solid drawn brass tube of not less than 1.60 mm thickness. It shall be satin, bright nickel plated or copper oxidized or as specified.

**1.31.16.20 Sampling:** The number of spring hinges shall be selected from the lot and this number shall depend on the size of the lot and shall be in accordance with Table below.

TABLE
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<i>Lot size</i>	<i>Sample size</i>	<i>Permissible No. of defective spring hinges</i>
Upto 100	13	0
101 to 300	20	1
301 to 500	32	2
501 to 1000	50	3
1001 and above	80	5

#### 1.31.16.21 Rising Hinges

These shall be made of brass, finished bright or chromium plated or oxidized or as specified. Its shape and pattern shall be approved by the Engineer-In-Charge. The size of the rising hinge shall be taken as the length of its plate.

#### 1.31.16.22 Continuous Piano Hinges

These shall be made from Stainless steel / mild steel or aluminium alloy sheet, these shall generally conform to IS 3818. All screw holes shall be clean and counter sunk. Piano hinges shall be fixed in the entire length of the cupboard shutters. Its size will be the width of the two flaps when open.

#### 1.31.16.23 M.S. Piano Hinges; These shall be made from 1 mm or 0.80 mm thick M.S. sheets and shall be protected with anti-corrosive treatment, such as bright polished, chromium plated or oxidized finish.

Hinge pin shall be of galvanized mild steel. It shall fit in the knuckle firmly so as not to allow any play or shake and shall allow easy movement of hinge, but shall not cause looseness.

The sides of the knuckles shall be straight and at right angles to the flap. The movement of the hinge shall be free and easy and working shall not have any play and shake.

#### 1.31.16.24 Aluminium Piano Hinges; These shall be made of aluminium alloy sheet and shall be anodized or as specified. The anodic coating shall not be less than the grade AC 15 of IS 1868.

Hinge pin shall be made of aluminium alloy with anodic coating not less than the grade of AC-15 of IS 1868. The hinge pin shall fit in the knuckle firmly so as not to allow any play or shake and shall allow easy movement of hinge but shall not cause looseness. The sides of the knuckles shall be straight and at right angles to the flap. The movement of the hinge shall be free and easy, and working shall not have any play and shake.

**Sampling and Criteria for Conformity:** It shall be same as specified in CPWD Specifications.

#### 1.31.16.25 Tee Hinges

These shall be made from M.S. sheets and shall be either bright finished or stove enameled black or as specified. These shall generally conform to IS 206 (Tee hinges shall be well made, free from

burrs, flaws, and defects of any kind. The movement shall be square, and the working shall be free and easy without any play or shake. The hole for the hinge shall be central to the bore and shall be square.

The hinge pin shall be firm and riveted over, so that the heads are well formed. All screw holes shall be clear and counter sunk and shall be suitable for the counter sunk head of wood screws.

**Sampling and Criteria for Conformity:** It shall be same as specified in CPWD specification.

**1.31.16.26 Sliding Door Bolts (Aldrops).**

These shall be of SS / mild steel, cast brass, aluminium or as specified, and shall be capable of smooth sliding action.

**1.31.16.27 M.S. Sliding Door Bolts;** These shall be made of M.S. sheets and M.S. rods and shall generally conform to IS 281. M.S. sliding door bolts shall be copper oxidized (black finish) or as specified.

**1.31.16.28 Cast Brass Sliding Door Bolts:** These shall be made from rolled brass and shall generally conform to IS 2681. The hasp shall be of cast brass and secured to the bolt. Alternatively, the hasp and the bolt may be cast in one piece. The fixing and staple bolts shall be cast with 6 mm studs. Bolts shall be finished to shape and have threaded ends and provided with robs washers and nuts of square or hexagon type. All components shall be finished smooth and polished before assembly.

Cast brass sliding bolts shall be finished bright or chromium plated or oxidized or as specified.

**1.31.16.29 Aluminium Sliding Door Bolts;** These shall be made of aluminium alloy and shall generally conform to IS 2681. Aluminium sliding door bolts shall be anodized. All screw holes shall be counter sunk to suit the counter sunk head of screws of specified sizes. All edges and corners shall be finished smooth. In case of single leaf door, when iron socket plate or a brass or aluminium fixing bolts (or sliding door bolt) cannot be fixed, hole of suitable size shall be drilled in the door frame and an iron or brass plate cut to shape shall be fixed at the face of the hole. The leading dimensions of the sliding door bolts are illustrated.

**1.31.16.30 Sampling and Criteria for Conformity;** The number of sliding door bolt to be selected from a lot shall depend on the size of lot and shall be in accordance with Table given below. For testing shall be taken at random from at least 10 percent of the package subject to a minimum of three, equal number of door bolts being selected from each package. All door bolts selected from the lot shall be checked for dimensional and tolerance requirements. Defects in manufacture and finish shall also be checked. A lot shall be considered conforming to the requirement of this specification if the number of defects sliding door bolts among those tested does not exceed the corresponding number given in Table below.

TABLE		
<i>Lot. Size</i>	<i>Sample Size</i>	<i>Permissible speed Decorative sliding door bolts</i>
Upto 150	5	0

151 to 300	20	1
301 to 500	32	2
501 to 1000	50	3
1001 and above	81	5

### 1.31.16.31 Tower Bolts

These shall generally conform to IS 204 (Part. I) & IS 204 (Part. II). Tower bolts shall be well made and shall be free from defects. The bolts shall be finished to the correct shape and shall have a smooth action. All tower bolts made with sheet of 1.2 mm thickness and above shall have counter sunk screw holes to suit counter sunk head of wood screws. All sharp edges and corners shall be removed and finished smooth.

The height of knob of tower bolt when the door, window etc. is in closed position from the floor level shall be not more than 1.9 meter.

Tower bolts shall be of the following types:

- Aluminium barrel tower bolts with barrel and bolt of extruded sections of aluminium alloy. The knob shall be properly screwed to the bolt and riveted at the back.
- Brass tower bolts with cast brass barrel and rolled or cast brass bolt. Or Brass tower bolts with barrel of extruded sections of brass and rolled or drawn brass bolt.
- The knobs of brass tower bolts shall be cast and the bolt fixed with knob, steel spring and ball shall be provided between the bolt and the barrel.
- Mild steel barrel tower bolts with mild steel barrel and mild steel bolt, or Mild steel tower bolts with mild steel barrel and cast iron bolts.
- Stainless steel barrel tower bolts with mild SS barrel and SS steel bolt, or Stainless steel tower bolts with SS barrel and SS bolts of specified grades.
- The plates and straps after assembly shall be firmly riveted or spot welded. The rivet head shall be properly formed and the rivet back shall be flush with the plate. These shall be made in one piece.

Unless otherwise specified bolt shall have finish as given below:

- Mild steel tower bolts (Types 1 and 2) Bolts bright finished or plated as specified and barrel and socket stove enameled black.
- Brass tower bolts (type 3 to 5) Bolt and barrel polished or plated as specified.

- Aluminium alloy tower bolts (type 6) Bolt and barrel anodized.

The anodic film may be either transparent or dyed as specified. The quality of anodized finish shall not be less than grade AC-10 of IS 1868.

**Sampling and Criteria for Conformity;** It shall be same as specified.

#### **1.31.16.32 M.S. Locking Bolt with Holes for Pad Locks**

This shall conform to IS 7534.

This shall be of mild steel polished bright or copper oxidized batch electro galvanized or stove enameled. In case of stove enameled locking bolts, the bolt may be finished bright.

#### **1.31.16.33 Pull Bolt Locks**

These shall be of M.S. cast brass or aluminium as specified. M.S. pull bolt locks shall be copper oxidized (black finish) or as specified.

Brass pull bolt locks shall be finished bright, chromium plated or oxidized as specified. Aluminium pull bolt locks shall be anodized and the anodic coating shall not be less than grade A.C. 10 of IS 1868. The bolt shall be 10 mm in diameter and the fixing plate 3 mm thick. The stop block shall be screwed to the fixing plate by a small ball and spring over which the bolt shall slide.

The fixing plate shall have four holes for fixing it to the door leaf, two of which shall be square to receive 6 mm dia. bolts with round heads, the remaining two shall receive machine screwed with lock nuts. The receiving plate shall be of the same width and thickness as the fixing plate and shall have 3 counter sunk holes.

Where the bolt slides into wooden members, like the chowkhat, which have a rebate, the receiving plate shall also be correspondingly shaped so as to fit into the rebate. The screws and bolts shall have the same finish as the main bolt. The leading dimensions of pull bolt locks will be as per standards. The denominating size of the pull bolt locks shall be length of the fixing plate between guides plus the thickness of the guides.

#### **1.31.16.34 Door Latch**

This shall be of mild steel, cast brass, or as specified and shall be capable of smooth sliding action. In case, of mild steel latch, it shall be copper oxidized (black finish) or as specified and in case of brass, it shall be finished bright, chromium plated or oxidized or as specified. The size of door latch shall be taken as the length of the latch.

#### **1.31.16.35 Indicating Bolt (Vacant/Engaged;**



These shall be of **SS**, cast brass finished bright chromium plated, or oxidized or as specified. The shape and pattern shall be approved by the Engineer-In-Charge.

#### **1.31.16.36 Mortice Lock and Latch**

This should generally conform to IS 2209.

The size of the mortice lock shall be denoted by the length of the body towards the face and it shall be 65 mm, 75 mm and 100 mm as specified. The measured length shall not vary more than 3 mm from the length specified.

#### **1.31.16.37 Non-interchangeable Keys; Testing of non-interchangeable keys shall be as per IS 2209.**

The clear depth of the body shall not be more than 15 mm. The fore end shall be firmly fitted to the body suitably by counter sunk head screw. The latch bolt shall be of specified material and of section not less than 12 x 16 mm for all sizes of locks. If made of two piece construction both parts shall be riveted. Ordinary lever mechanism with not less than two levers shall be provided. False levers shall not be used. Lever shall be fitted with one spring of phosphor bronze or steel wire and shall withstand the tests as provided in IS 2209.

Locking bolts, spring and strike plate shall conform to IS 2209.

#### **1.31.16.38 Handles:** These shall conform to IS 4992.

**1.31.16.39 Keys:** Each lock shall be provided with two keys. Sampling, Criteria for Conformity; It shall be the same as specified. Tests: The finally assembled locks shall be tested as prescribed.

#### **1.31.16.40 Mortice Latch (with Locking Bolt)**

These are generally used in doors of bath rooms, WC's and private rooms.

Mortice latch shall, in respect of shape, design and mechanism of the latch and its components parts, generally conform to IS 5930. The material used for the different component parts of the latch shall comply with Tables 1 and 2 of IS 5930, unless otherwise specified.

The size of the latch shall be denoted by the length of the body towards the face and shall be 65 mm, 75 mm or 100 mm as specified. The depth of the body shall not be more than 15 mm.

The latch shall be of size 10 x 18 mm of shape as shown in Fig. 1 of IS 5930. The locking bolt shall be of section not less than 8 x 25 mm for all size of locks. The mechanism of the latch bolt, its spring, striking plate etc. shall be as described in IS 5930. The handles provided shall conform to IS 4992.

#### **1.31.16.41 Mortice Lock and Latch (Rebated)**

These are slightly different from mortice lock described in 2.30.16.40 and are designed for use in double leaved doors. These should generally conform to IS 6607.

**1.31.16.42 Handles, Keys, Sampling, Criteria for Conformity and Test; These shall be same as specified.**

**1.31.16.43 Mortice Night Latch**

This is a mortice lock having a single spring bolt withdrawn from the outside by using the key and from inside by turning the knob and with an arrangement whereby the lock can be prevented from being opened by its key from outside while the night latch is used from inside the room.

This should generally conform to IS 3847.

It shall be cast or sheet brass, cast or sheet aluminium alloy or Mild steel as specified and of best quality of approved make. These shall be bright finished or copper oxidized (black) finish as specified. Nominal size of the latch shall be denoted by the length of the face over the body in millimeters. These shall have not less than two levers. False (Dummy) levers shall not be allowed.

**Keys:** Each latch shall be provided with two keys which should work smoothly and without any appreciable friction in the lock.

**1.31.16.44 Cupboard or Wardrobe Lock**

This should generally conform to IS 729. The size of the cupboard lock shall be 40, 50, 65 & 75 mm. This shall be made of cast brass and shall be of the best make of approved quality. These shall be finished bright or chromium plated or oxidized or as specified. The size of the lock shall be denoted by the length of the face across the body in mm. These locks shall be fitted with four, five or six levers as specified. False (dummy) levers shall not be used.

**1.31.16.45 Kicking Plates**

This shall be of brass (finished bright or chromium plated or oxidized) bronze, stainless steel, aluminium or as specified. Aluminium kicking plates shall be anodized and the anodic coating shall not be less than grade AC-10 of IS 1868. It shall be made from a plate of minimum thickness 3.0 mm & 1.5 mm in case of stainless steel. Shape of the plate shall be as specified. This shall have beveled or straight edges and shall be fixed by means of counter sunk or rounded screws of the same material and finish as that of the plate. The shape and pattern shall be as approved by the Engineer-In-Charge.

**1.31.16.46 Door Handles (Doors and Windows)**

These should generally conform to IS 208. The door handles shall be well made and free from defects. These shall be finished correct to shape and dimensions. All edges and corners shall be removed and finished smooth so as to facilitate easy handling. Cast handle shall be free from casting defects. Where the grip portion of the handle is joined with the base piece by mechanical

means, the arrangement shall be such that the assembled handle shall have adequate strength comparable to that of integrally cast type handles.

Door handles shall be of the following types according to the material used:

- **Cast or Sheet Aluminium Alloy Handles;** These shall be of aluminium of specified size, and of shape and pattern as approved by the Engineer-in-Charge. The size of the handle shall be determined by the inside grip of the handle. Door handles shall be of 100 mm size and window handles of 75 mm size unless, otherwise specified. These shall be fixed with 25 mm long wood screws of designation No. 6. Aluminium handles, shall be anodized and the anodic coating shall not be less than grade AC 15 - IS 1868 as specified. The finish can be bright natural, matt or satin or dyed as specified.
- **Cast Brass Handles;** These shall be of cast brass of specified size and of the shape and pattern as approved by the Engineer-In-Charge. The size of the handle shall be determined by the inside grip of the handle. Door handles shall be of 100 mm size and window handles of 75 mm size, unless otherwise specified. These shall be fixed with 25 mm long wood screws of designation No 6. Brass handles shall be finished bright satin or nickel chromium plated or copper oxidized or as specified.
- **Mild Steel Handles;** These shall be of mild steel sheet, pressed into oval section. The size of the handles will be determined by the inside grip of the handle. Door handles shall be 10 mm size and window handles of 75 mm size unless otherwise specified. These shall be fixed with 25 mm long wood screws of designation No. 6., Iron handles shall be copper oxidized (black finish) or stove enameled black or as specified.

**Sampling and Criteria for Conformity;** The number of handles to be selected from a lot shall depend on the size of lot and shall be in accordance with below Table. Handles for testing shall be selected at random for at least 10 percent of packages. Subject to a minimum 3, equal number of door handles being selected from each such package. All door handles shall be checked for dimensional requirement and finish. Any door handle which fails to satisfy the requirement of dimensions or finish or both shall be considered as defective.

A lot shall be considered as conforming to requirement of this specification, if the number of defective handles among those tested does not exceed the corresponding number of defectives is greater than or equal to rejection number given in column 4 of Table below, the lot shall be deemed as not meeting the requirements of this specification.

**TABLE Scale of Sampling and Criteria for Conformity**

Lot size	Sample size	Acceptance no.	Rejection no.
[1]	[2]	[3]	[4]
Upto 50	8	0	1
51 to 90	13	1	2

91 to 150	20	1	2
151 to 280	32	2	3
281 to 500	50	3	4
501 to 1200	80	5	6
1201 and above	125	7	8

#### 1.31.16.47 Floor Door Stopper

The floor door stopper shall conform to IS 1823. This shall be made of cast brass of overall size as specified and shall have rubber cushion. The shape and pattern of stopper shall be approved by the Engineer-In-Charge. It shall be of brass finished bright, chromium plated or oxidized or as specified.

The size of floor stopper shall be determined by the length of its plate. It shall be well made and shall have four counter sunk holes for fixing the door stoppers to the floor by means of wood screws. The body for housing of the door stopper shall be cast in one piece and it shall be fixed to the cover plate by means of brass or mild steel screws and cover plate shall be of casting or of sheet metal. The spring shall be fixed firmly to the pin. Tongue which would be pressed while closing or opening of the door shall be connected to the lower part by means of copper pin. On the extreme end a rubber piece shall be attached to absorb shock. All parts of the door stopper shall be of good workmanship and finish, burrs and sharp edges removed. It shall be free from surface and casting defects. Aluminium stopper shall be anodized and anodic film shall not be less than grade AC-10 of IS 1868.

**Sampling and Criteria for Conformity;** The number of floor door stoppers to be selected from each lot shall depend on the size of the lot and shall be in accordance with col. 1 and 2 of Table below.

These stoppers shall be selected at random from at least 10 percent of the randomly selected packages subject to a maximum of three equal number of stoppers being selected from each such package.

All the floor stoppers selected shall be checked for dimensional requirement, material, manufacture and finish. Any of door stopper which fails to satisfy any one or more of these requirement shall be considered as defective door stopper.

A lot shall be considered as conforming to the requirements of this specifications if the number of defective floor door stoppers among these tested does not exceed the corresponding number given in col. 3 of Table-A below. Otherwise it shall be considered as not conformity to the requirements of this specification.

Scalel	Sampling and Criteria for Conformity	
<i>Lot Size</i>	<i>Sample Size</i>	<i>Permissible number of defective floor Door stoppers</i>

[1]	[2]	[3]
Upto 100	5	0
101 to 300	0	1
301 to 500	32	2
501 to 1000	50	3
1001 and above	80	5
<b>Requirements for Rubber for Use in Floor Door Stoppers</b>		
<i>Particulars</i>	<i>Requirements</i>	<i>Testing Procedure</i>
Relative density Max.	1.3	IS 3400 (Part IX)
Hardness	60 + 5	IS 3400 (Part 2)
Ageing for 24 hours	(a) Change in initial hardness	IS 3400 (Part II) -
at 100°C±	(b) Shall not develop brittleness + 5,-0	do-

**1.31.16.48 Hanging Rubber Door Stopper**

These shall be of cast brass, finished bright, chromium plated or as specified. Aluminium stopper shall be anodized and the anodic coating shall not be less than grade AC-10 of IS 1868. The size and pattern of the door stopper shall be approved by the Engineer-In-Charge. The size shall be determined by its length.

**1.31.16.49 Universal Hydraulic Door Closer (Exposed Type)**

These shall be made of cast iron/aluminium alloy/zinc alloy and of shape and pattern as approved by the Engineer-in-Charge. These shall generally conform to IS Specifications for door closers (Hydraulically regulated) IS 3564. The door closers may be polished or painted and finished with lacquer to desired colour. Aluminium alloy door closer shall be anodized and the anodic coating shall not be less than grade AC 15 of IS 1868. All dents, burrs and sharp edges shall be removed from various components and they shall be pickled, scrubbed and rinsed to remove grease, rust, scale or any other foreign elements. After pickling, all the M.S. parts shall be given phosphating treatment in accordance with IS 3618. The nominal size of door closers in relation to the weight and the width of the door size to which it is intended to be fitted shall be given in Table below.

**Type and Designation of Door Closers**

<i>Designation of closers</i>	<i>Mass of the door (kg)</i>	<i>Width of the door(mm)</i>	<i>Remarks</i>
1.	Upto 35	Upto 700	For light doors such as double leaved and toilet doors.
2.	36 to 60	701 to 850	Interior doors, such as of bed rooms, kitchen and store
3.	61 to 80	851 to 1000	Main doors in a building, such as entrance doors

**Sampling and Criteria for Conformity;** All the door closer of the same nominal size and shape and from the same batch of manufacture, in one consignment shall constitute a lot. The number of door closers to be taken at random from a lot shall depend upon the size of the lot. The sample shall be tested for construction, finish, dimensions, interchangeability of parts and performance in accordance of Table below. Any door closer failing in any one or more of these characteristics shall be considered as defective. If in the first sample, the number of defective door closer is less than or equal to corresponding acceptance number, the lot shall be declared as conforming to the requirement of these characteristics. If the number of defective door closer is greater than or equal to the rejection number, the acceptance number but less than the rejection number, lot shall be deemed as not meeting with requirements of these characteristics. If the number of defectives is greater than the acceptance number, but less than the rejection number, a second sample of the size equivalent to that of the first shall be taken to determine the conformity or otherwise of the lot. The number of defective door closers found in the first and the second sample shall be combined and if the combined number of defective thus obtained is less than or equal to the corresponding acceptance number, the lot shall be declared as conforming to the requirements of these characteristics.

- 1.31.17 Endurance Test-** Two door closer in case of lot size 280 or less and five door closers in case of lot size more than 280 shall be selected from those already found satisfactory. These door closers shall be tested for the endurance test. If all the door closers tested for endurance test satisfy the requirement of this standard, the lot shall be deemed as having satisfied the requirements of endurance test, otherwise not.

<i>No. of door closers in the Lot</i>	<i>Sample</i>	<i>Sample size</i>	<i>Cumulative sample size</i>	<i>Acceptance Number</i>	<i>Rejection Number</i>
Upto 50	First Second	8 8	8 16	0 1	2 2
51 to 90	First Second	13 13	13 26	0 1	2 2
91 to 150	First Second	20 20	20 40	0 3	3 4
151 to 280	First Second	32 32	32 64	1 4	4 5
281 to 500	First Second	50 50	50 100	2 6	5
501 to 1200	First Second	80 80	80 160	3 8	7 9
1201 to 3200	First Second	125 125	125 250	5 12	9 13
3201 and Above	First Second	200 200	200 400	7 18	11 19

- 1.31.18 Performance Requirements:** After being fitted in its position when the door is opened through 90°, the same should swing back to angle of 20° ± 5° with nominal speed but thereafter, the speed should get automatically retarded and in case of doors with latches, it should be so regulated that in its final position the door smoothly negotiates with the latch.

### **1.32 Laminated Veneer Lumber (LVL)**

Laminated Veneer Lumber door frames and shutters shall conform to IS 14616.

### 1.32.1 Material

#### 1.32.1.1 Laminated Veneer Lumber (LVL)

Laminated Veneer Lumber is made of rubber wood silver oak, eucalyptus, Poplars, acacias etc. veneers glued together having grains of all the veneers in one direction under high temperature and pressure to develop high Modulus of Rapture & Modulus of elasticity. Veneers for LVL shall be of thickness between 1.5 to 2.5 mm.

Veneers shall be free from knot holes, decayed knots except pin knots, unfilled splits wider than 3 mm, concentrated borer holes, shakes, objectionable decay or termite attack, except that for the face veneers none of these defects nor cross grain exceeding 1 in 10 shall be permitted. The nominal thickness of all the veneers used shall be identical and uniform within a tolerance of + 5 percent.

**Adhesives:** Only BWP grade adhesive conforming to IS 848 shall be used for making LVL.

**Preservatives;** Veneers used for LVL shall be given suitable preservative treatment before lamination, with a preservative that is compatible with the adhesive to be used. Only fixed type of water-soluble preservatives, CCA or CCB, or non-leachable, solvent soluble preservatives as per IS 401 shall be used for treating the veneers. Retentions of preservatives shall be as per IS 401 depending upon the proposed end use.

All the Veneers shall be given preservative treatment by one of the water soluble fixed type treatment, Copper Chrome-Boron Composition. (CCB) as per IS 401. The treated Veneers shall then be dried having moisture content less than 6%. The Veneers shall be glued together, by keeping all the grains in one direction, with BWP grade synthetic resin adhesive conforming to IS 848. The Veneers having moisture content less than 6% so glued, shall be pressed in hot press at high temperature of 140 degree C to 180 degree C. and pressure 1.4 to 1.8 MPa. The net absorption of preservative in LVL when tested as per IS 2753 shall not be less than 8.0 kg/m<sup>3</sup> Veneers shall be scarf jointed only length wise and not in the direction of width with EWP type synthetic resin adhesive. However, the length of individual Veneer shall not be less than 600 mm.

### 1.32.2 Moisture Content

The average moisture content of three test specimens, when determined in accordance with IS 1734 (Part 1) shall be between 5 to 15%.

### 1.32.3 Tests

The tests as per Table-1 of IS 14616 shall be carried out by the manufacturer on the LVL (Laminated Veneer Lumber) sections on each batch.

The manufacturer shall get the tests done on at least three samples of each batch by the standard method of test to ensure quality and performance of the material as per para 8.2 of IS 14616.

The manufacturer shall provide a certificate with the delivery challan indicating that the material conforms to IS 14616 along with the copy of the test report of the relevant batch.

#### **1.32.4 Laminated Veneer Lumber (LVL) Door Shutters**

This specification lays down requirements regarding types, sizes, material, construction, workmanship and finish, performance evaluation, sampling and testing of Laminated

Veneer Lumber (LVL) door shutter for use in domestic buildings, offices, schools, hospitals etc. This specification does not cover large size door shutters for industrial and special buildings such as workshops, garages, godowns etc.

The material of each lot shall be supported by a certificate to that effect:

Each lot of LVL materials shall be accompanied by the test reports. Fabricator shall take up manufacturing of shutters only if required provisions in Technical Specifications are fulfilled; failing which, shutters so manufactured are liable for rejection.

#### **1.32.5 Paneling Materials**

Plain Particle Board: Plain particle boards used for panels shall be FPT-1 conforming to IS 3087 and shall have been bonded with BWP type of synthetic resin adhesive as per IS 848.

Pre-laminated Particle Board: Pre-laminated particle boards used for panels shall conform to IS 12823.

Medium Density Fibre Board: Medium density fibre board used for panels shall conform to exterior grade as per IS 12406 made from agro-forest products or agricultural wastes or natural fibers.

Pre-laminated Medium Density Fiber Board. Pre-lamination in pre-laminated medium density fiber board shall conform to the requirements such as Abrasion Resistance, Resistance to Steam, Crack Resistance, Resistance to Cigarette Burn and Resistance to Stain as specified in IS 12823. The medium density fiber board used in pre-laminated medium density fiber board.

**1.32.6 Glass;** Glass for glazing shall conform to IS 2835 or IS 2553. The use of other types of glass, such as frosted glass, wired glass and coloured glass may also be specified by the Engineer-in- Charge.

**1.32.7 Wire Gauze:** Wire gauze shall generally conform to IS 1568 and shall be regularly woven with equally spaced galvanized mild steel wires of 0.63 mm nominal diameter in both warp and weft directions to form aperture of average width 1.40 mm.

##### **1.32.7.1 Construction and Workmanship**



Laminated Veneer Lumber (LVL) paneled, glazed and paneled and glazed shutter shall be constructed in the form of LVL framework of stiles and rails with panel inserts of plain or perlaminated particle board, plain or prelaminated medium density fibre board, wire gauze or glass. The panels shall be fixed by either providing grooves in stiles and rails and beading as specified. The stiles, top rails, lock rails and bottom rails shall be jointed to each other by mortice and tenon joints. Rails having width of 150 mm or more shall have plain double tenon joints. Other rails shall have single tenon joints. The bottom lock and top rails shall be inserted 25+3 mm short of the width of stiles to form a stub mortice & tenon joint. After assembling shutter complete with panels, Bamboo pins of 6 mm dia shall be fitted on each tenon & mortice joint by drilling suitable size of holes (2 pins per joint for rail width upto 150 mm and 3 pins for rails of greater width). All the four edges of shutter shall be beaded with 12 mm thick rubber wood /plantation wood lipping. Lipping shall be seasoned and chemically treated. Lipping on top and bottom rails shall be of one piece and lipping on stiles may be in two pieces. All lippings shall be glued to shutter with water resisting glue (Synthetic rubber passed adhesive) at the rate of 0.15 kg/m<sup>2</sup>.

All members of the shutters shall be straight, smooth and with well-planned faces at right angles to each other. Any warp or bow shall not exceed 1.5 mm. The right angle for the shutters shall be checked by measuring the two diagonals from one extreme corner to the opposite one and the difference between the two diagonals shall not be more than 3 mm.

- 1.33 Beading:** All the panels except glass and wire gauze shall be fixed with grooves, but additional beading may be provided either on one side or on both the sides, if so specified. In so far as glass and wire gauze panels are concerned, beading shall be provided without grooves. In such a case where beading is provided without the grooves, the beading shall be only on one side, the other side being supported by rebate from stiles. The beading shall have a size not less than 15 mm x 10 mm.

It can be fixed by suitable headless nailing or screwing. The beading shall be of plantation timber section, preservative chemically treated of fixed type as per IS 401-1982.

Stiles, top rails, bottom rails and lock rails of shutters shall each be made in one piece of LVL, only. Mullions and glazing bars shall be stub tenoned to the maximum depth which the size of the member would permit or to a depth of 25 mm, whichever is less.

Two common methods for jointing of panels with stiles/rails. The minimum depth of grooves of stiles and rails shall be 12 mm for all types of panelling. The panels shall be framed into grooves to the full depth of groove leaving an air space of 1.5 mm and the faces shall be closely fitted to the sides of the groove. LVL Shutters shall be manufactured in factories under controlled conditions.

#### **1.34 UPVC Doors Windows**

Material of defined formulation in granular or powder form, which has not been processed, earlier other than required for its manufacture is virgin material. No re-process able or recyclable material has been added.

All the uPVC windows shall be made up of extruded profile, frames & sash will be mitered cut & fusion welded at all corners.

UPVC Windows should be fabricated with "Fusion welded corners". The Mullion / Transom can be either Fusion welded or mechanically joined with desired sealing.

Windows / doors must conform to the strength requirements based on wind load as per IS 875-3.

Appropriate thickness of steel reinforcement should be selected to meet the desired strength. The reinforcement must be installed within 6 to 50mm distance from the face of the weld.

All window frames and sashes shall be manufactured from white uPVC profile, which shall have 3 hollow chambers from front to back. The outer profile shall have a front to back depth of 56 /118 mm.

All sections of the frame and sash shall be reinforced in accordance with the system supplier's recommendations using galvanized mild steel in a single continuous length.

Water drainage / ventilation slot should be provided in sash / frames.

Min Gap of 3mm should be maintained per face between aperture and window to allow expansion / contraction of UPVC windows

The gap between window and its aperture should be filled with weather able & elastic material to allow expansion / contraction of PVC and performance over period of years.

UPVC windows should meet the codal provision for following condition,

- Air Permeability
- Water tightness
- Resistance to wind

The profile is to be extruded from a compound that has been blended to ensure window grade UPVC and must be colorfast and conform to BS 7413 code. The profile shall be a hollow 3-chamber (across depth) profile with an outer wall thickness of 2.4mm only. The outer profile shall have a front to back depth of 65/118mm. The profile shall be uniform and free from foreign bodies, cracks or marks.

### 1.35 MS FIRE CHECK DOOR OF 120 MINUTES FIRE RATING

#### 1.35.1 Scope:

This specification covers the design, supply of materials, Manufacture and installation of factory made metal fire doors of approved make and ISO 9001-2000 Certified Company and the

manufacturer has to be approved manufacturer of supply and fixing of CE/UL certified metal steel fire doors at all levels with all accessories and including supply and installation of hardware.

### 1.35.2 APPLICABLE CODES AND STANDARDS:

All standards, specifications, acts, and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions.

List of certain important Indian Standards, Acts and Codes applicable to this work is given below. However, the applicable standards and codes shall be as per but not limited to the list given below:

IS: 277 Galvanised steel sheet (plain and corrugated) of GPL Grade with Z 120 Coating.

IS: 3614 Metallic and non-metallic fire check doors–Resistance test and Part – 2 performance criteria.

### 1.35.3 MATERIAL:-

Door frame shall be Single rebate Grooved profile of size 125 x 60 mm made out of 1.60mm (16gauge) minimum thick galvanized steel sheet confirming to IS 2260 & 4351 with grooved seal. Frames shall be Mitered and field assembled with self tabs. All provision should be mortised, drilled and tapped for receiving appropriate hardware. Rubber door silencers should be provided on the striking jamb. Frames should be provided with back plate bracket and anchor fasteners for installation on a finished plastered masonry wall opening. Once frame installed should be grouted with cement & sand slurry necessary for fire doors on the clear masonry opening.

Door leaf shall be 46mm thick fully flush double skin door with or without vision lite. Door leaf shall be manufactured from 1.2mm (18gauge) minimum thick galvanised steel sheet. The internal construction of the door should be rigid reinforcement pads for receiving appropriate hardware. The infill material shall be resin bonded honeycomb core with fire rated propriety insulation filler bonded to both faces of sheet with lock seam joints at style edges. All doors shall be factory prepped for receiving appropriate hardware and provided with necessary reinforcement for hinges, locks, and door closers. The edges should be interlocked with a bending radius of 1.4mm. For pair of doors astragals has to be provided on the meeting stile for both active and inactive leaf. Vision lite wherever applicable should be provided as per manufacturers recommendation with a bedding and screws from inside.

The door frames and door shutters shall be primed with 'H' primer and finished with PU/Powder coated. The shutter would be mounted with SS Ball Bearing Hinges of size 100mm x 75mm x 3.0mm of Becker Fire Solutions ( 4 Nos per leaf ),appropriate openings for vision panel glass. Prototype Test certificate for a test carried out earlier at CBRI Roorkee for fire rating of doors, shall be attached along with manufacturers test certificate.

All door shall be factory made and rate to include installation, hardware's like hinges, panic bar, door closer, Vision Panel 300x 200, Glass, lock, handles, coordinator etc. as desired with necessary reinforcement and direction of Engineer in charge.

The following information shall be submitted by the contractor for obtaining approval of the Engineer-in-charge before start of work.

<b>Product Data</b>	:	Manufacturer's data sheets on each product to be used, including preparation instructions and recommendations. Storage and handling requirements and recommendations. Details of construction and fabrication. Installation methods.
<b>Shop Drawings</b>	:	Detailed plans and elevations, details of framing members, anchoring methods, clearances, hardware, and accessories clearly shown.
<b>Manufacturer's Certificates</b>	:	Certifying that products meet or exceed specified requirements.
<b>Operation and Maintenance Data</b>	:	Submit lubrication requirements and frequency, and periodic adjustments required.
<b>Name of installer</b>	:	Approved by the manufacturer, specializing in performing work of this section with minimum three years experience.
<b>Manufacturer's warranty</b>	:	For all parts and components of the fire rated door set system except counterbalance spring and finish for 5 years

#### 1.35.4 Delivery, Storage, and Handling:-

Fire rated door set shall be delivered and stored in manufacturer's unopened packaging until ready for installation. It shall be protected from exposure to moisture and shall be stored in a dry, warm, ventilated weather tight location.

#### 1.35.5 Installation:-

The Contractor shall furnish all materials, labour, operations, equipment, tools & plant, scaffolding and incidentals necessary and required for the completion of all metal work in connection with steel doors, as called for in the drawings, specifications and bill of quantities which cover the major requirements only. Anything called for in the tender documents shall be considered as applicable to the items of work concerned. The supply and installation of additional fastenings, accessory features and other items not specifically mentioned, but which are necessary to make a complete functioning installation shall form a part of this contract.

The Contractor shall submit the details of manufacturers from the list of approved makes from which he intends to procure the doors. The contractor shall procure the doors only after the approval of the manufacturer from the Engineer-in-charge.

All metal work shall be free from defects, impairing strength, durability and appearance and shall be of the best quality for purposes specified made with structural properties to withstand safety

strains, stresses to which they shall normally be subjected to. All fittings shall be of high quality and as specified and as per approval. The Contractor shall strictly follow, at all stages of work, the stipulations contained in the Indian Standard Safety Code or its Equivalent British Standard and the provisions of the safety code and the provision of the safety rules as specified in the General

Conditions of the Contract for ensuring safety of men and materials. Any approval, instructions, permission, checking, review, etc by Engineer-in- Charge, shall not relieve the Contractor of his responsibility and obligation regarding adequacy, correctness, completeness, safety, strength, quality, workmanship,

- i. Door closer confirming to CE & EN 1154 and B.S. – 476, Part-22, two hours fire door.
- ii. Panic Exit Device – Single / Double leaf confirming to CE & EN 1154 and B.S. – 476, Part-22, two hours fire rated.
- iii. Mortice Lock with lever handle confirming to CE & EN 122090 / DIN 18251 and B.S.- 476, Part-22 , two hours fire rated.
- iv. Stainless steel ball bearing hinges 4 nos. on each side of shutters size 100 mm x 100 mm x 3 mm with screws etc. complete.
- v. Vision panel: 6 mm thick borosilicate toughened glass 120 min fire rated glass on each leaf of size 300 x 200 mm.

#### **1.35.6 Testing:-**

The fire doors shall be tested by CBRI/ International Test House or any Test Lab approved by the competent authority in accordance with BS 476 part 22. Galvanized steel to be used conforming to IS 277. Testing charges shall be paid by the department.

#### **1.35.7 Mock- Up:-**

Before proceeding for mass production of all units, the contractor should fix typical mock-up units of each type to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution. The contractor should proceed for mass production only after approval of Mock-ups by Engineer-in-Charge or his authorized representative.

### **1.36 TOILET CUBICLES**

#### **1.36.1 SCOPE: -**

Providing and fixing Toilet cubical as under with door, pilaster and divider of 18mm thick board both side decorative compact laminate of required colour, shade and sizes including stainless steel accessories ( SS-304 grade) like square top rail, box, knob, thumb turn and indicator, twin coat hook, door stopper, gravity hinges, and locking arrangement, SS channel etc. as desired. all complete as per drg. and direction of Engineer in charge.

#### **1.36.2 APPLICABLE CODES: -**

IS: 2046 for Compact Laminate.

### 1.36.3 MATERIAL: -

The Modular Toilet cubical shall be of size and shape as shown on drawings for a unit of 3/4/5 WCs, erected at locations enclosed by corner masonry walls. Division, frontal and nib panels shall be of 18 mm thick solid grade compact high pressure laminate as per IS:2046 and BS-476 class 1 fire retardant in Suede finish, manufactured under high specific pressure > 5 MPa and temperature >120° C with bunch of kraft papers impregnated with thermosetting phenolic resin and decorative papers made of Alpha cellulose fiber impregnated with thermosetting melamine resin which provide superior scratch, abrasion, heat, chemical, impact, graffiti & moisture resistance along with anti-bacterial properties. Panels have a black core that when machined, presents a distinctive black edge. Panel is anchored to the wall with SS 304 grade U & F Channel. The top fitting should consist of SS square top rail which will get fixed with pilasters. All screws will be of SS 304 Grade in stainless steel. All pilasters are supported with Adjustable Palm Design Pedestal Footing made from Stainless steel grade 316 giving a clearance height of 150 mm from the floor. The base will be anchored to the floor. Compact laminate should be Green guard and IGBC certified.

The following stainless steel (SS 304) accessories to be used : Door Knob; coat hook with rubber stopper; self closing (gravity) hinges; privacy Thumb turn with occupancy indicator, top rail and Adjustable Palm Design Pedestal Footing SS 316 Grade.

Design no. as specified by Arch. / Engineer-in-charge in suede finish. Size of panels to be as per drawing.

The mock-up shall be approved by the Engineer-in-Charge before starting the installation of toilet cubicles. Vendor shall submit the certificate of warranty for a term of 5 years on moisture related damages (partitions), 1 years for toilet cubicles workmanship and accessories. All the material supplied and installed shall be as per the description and specifications in the item. The following information shall be submitted by the contractor for obtaining approval of the Engineer-in-charge before start of work.

<b>Product Data</b>	:	Manufacturer's data sheets on each product to be used, including preparation instructions and recommendations. Storage and handling requirements and recommendations. Details of construction and fabrication. Installation methods.
<b>Shop Drawings</b>	:	Detailed plans and elevations, details of framing members, anchoring methods, clearances, hardware, and accessories clearly shown.
<b>Name of fabricator / installer</b>	:	Approved by the manufacturer, specializing in performing work of this section with minimum two years experience.
<b>Manufacturer's Warranty</b>	:	Components of the toilet cubical for 5 years against breakage, corrosion, and defects in factory workmanship.

**1.36.4 Delivery, Storage and Handling:-**

Toilet cubical material and hardware shall be delivered and stored in manufacturer's unopened packaging until ready for fabrication and installation. It shall be protected from damage.

**1.36.5 Fabrication:-**

The substrates shall be prepared including but not limited to blocking and supports in walls and ceilings at points of attachment using methods recommended by the manufacturer for achieving the best result. Area shall be inspected to receive toilet cubicles for correct dimensions, plumbness of walls, and soundness of surfaces that would affect installation of mounting brackets. Spacing of plumbing fixtures shall also be verified to assure compatibility with installation of compartment. Installations shall not be preceded until substrates have been properly prepared with blocking and supports in walls and ceilings at points of attachment and deviations from manufacturer's recommended tolerances are corrected. All the fabrication work shall be carried out as per approved shop drawings.

**1.36.6 Installation:-**

All installation shall be carried out by the fabricator/installer approved by the IRCON. Installation shall be in accordance with manufacturer's written instructions approved by the Engineer-in-charge.

Blocking and supports in walls and ceilings shall be verified that they have been installed properly at points of attachment. Location should not interfere with door swings or use of fixtures. Installation of cubical units should be rigid, straight, true to plumb, and level.

Evidences of drilling, cutting, and fitting to room finish shall be concealed by capping / shoe box plate etc. U-channels and noise deafening tapes shall be provided as per drawing. All the units shall be tested for proper operation. The following fittings shall be provided in each toilet cubical.

1. Gravity hinge – 3 Nos.
2. Coat hook cum Door stopper – 1 No.
3. Door knob cum vacant / engaged position showing device – 1 No.
4. Lock set – 1 No.

**1.36.7 Installation:-**

Adjustment of hardware for proper operation after installation may be permitted provided it does not **damage** the unit either structurally or aesthetically. Hinge cam may be set on in-swinging doors to hold doors open when unlatched and on out-swinging doors to hold unlatched doors in closed position.

Touch-up, repair or replacement of damaged products shall be done with prior approval of the **Engineer-in-charge**, whose decision shall be final and binding.

Exposed surfaces of compartments, hardware, and fittings shall be cleaned thoroughly.

**1.36.8 Testing:-**

Required numbers of tests shall be performed on Decorative Thermosetting Synthetic Resin Bonded Compact Laminated Sheets as per provision of IS: 2046. Hardware and fittings shall be of grade 304 stainless steel shall also be tested based on relevant IS codes as decided by the Engineer-in-Charge. Testing charges shall be paid by the department.



## FAÇADE WORK

### 1.0 Glass & Glazing

#### General

### 1.1 Scope

Work as shown shall be specified for all glass and glazing components within the Specification Section. All material and workmanship shall be in accordance with the requirements of the contract documents.

### 1.2 Work Included

The work of this Section includes all labour, material, equipment and services necessary to complete related trades with glazing components as per DBR or specified herein, including but not limited to Semi Unitized structural glazing, entrance glazing etc.

### 1.3 Description

Glass and glazing shall be comprised glass panels as per Schedule of Finishes is fabricated to specific size as determined by the facade manufacturer to fit within framing elements allowing for proper movement, performance and loading. Façade fabricator shall be responsible for the application of said glazing and shall accommodate limitations in regard to fabricated sizes, installation and protection of work in accordance with the design intent.

#### Design Drawings

The Consultants/Architect's Drawings indicate the design concept and relation to adjacent construction together with specified "Performance Criteria" tolerances, materials, finishes and standards.

### 1.5 Standards

- i. AAMA Glazing Specification Manual"
- ii. FGMA "Glazing Sealing Systems Manual" and "Glazing Manual"

### 1.6 Quality Assurance

- i. The glazing elements shall be installed by a firm well experienced in the fabrication and installation of glazing within the glazed scope of work.
- ii. The work of this section, specifically the application of glazing accessories and glass, determination of size of lites, and installation practices shall be the responsibility of the vendor utilizing the glass specified.

iii. Performance

- a) Tempered glass shall be subject to a maximum spontaneous lite breakage of 8 lites per 1000. Manufacturer shall warrant against breakage exceeding 8 lites per 1000.
- b) Systems incorporating glazed elements shall limit deflection of glass as per the manufacturer's recommendations.
- c) Glass shall be designed to withstand glazed element performance criteria times 1.5.

**1.7 Warranty**

- i. Submit manufacturer's warranty certifying that, except where specifically noted, the glass has been furnished and installed in accordance with the Contract Documents.
- ii. Certify that the glazing including, insulated glass shall be free of defects in material and workmanship for a period of ten (10) years from the date the glass is accepted by the Project manager/ Consultant.
- iii. The glass shall be warranted against defective materials, delaminating, seal failure, condensation and other defects.

**1.8 Submittals**

- i. Product data: For each glass product and glazing material indicated.
- ii. Samples: For the following products in the form of 300mm x 300mm long samples for sealants. Install sealant samples between strips of material representative in color of the adjoining framing system.
- iii. Glazing Schedule: Use same designations indicated on drawings for glazed openings in preparation a schedule listing glass types and thickness for each size opening and location
- iv. Product Certificates: signed by manufacturers of glass products certifying that products finished comply with requirements for the Insulated glass.
- v. Qualification data; for firms and persons specified in "Quality Assurance "Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- vi. Pre construction Adhesion and Compatibility Test Report: From glazing sealant manufacturer indicating sealants were tested for adhesion to glass and glazing channel substrates and for compatibility with glass.

- vii. Product Test Reports: From a qualified testing agency indicating the following products comply with requirements, based on comprehensive testing of current products.

## 1.9 Materials

- i. Insulated Glass Units (6mm + 16mm gap + 6mm = 28mm thick)
- ii. 16-24 mm insulated hollow Ceramic Panels with 1200 mm customized cladding System
- iii. Fire Rated ACP Cladding

1	<b>ALL GLASS USED FOR EXTERNAL APPLICATION ON FAÇADE SHALL BE HEAT SOAKED &amp; TOUGHENED GLASS</b>
2	<b>ALL INSULATED GLASS UNITS SHALL BE 6mm THICK + 16mm GAP + 6mm THICK (SOLAR CONTROL GLASS = 28mm THICK UNITS)</b>
3	<b>ALL EXTERNAL SOLAR CONTROL GLASS SHALL BE AS PER FOLLOWING SPECIFICATIONS:-</b>
	<b>LIGHT TRANSMISSION <math>\geq 45\%</math></b>
	<b>INTERNAL REFLECTION <math>\leq 20\%</math></b>
	<b>U VALUE <math>\leq 1.0 / m^2 K</math></b>
	<b>SOLAR SHADING FACTOR <math>\leq 0.25</math></b>
4	<b>ENTIRE FAÇADE - FOR ALL MATERIALS - SHALL BE DESIGNED AS PER WIND LOAD OF 2.50 KPA FOR ALL FLOORS &amp; FOR 3.00 KPA AT PARAPET LEVELS</b>
5	<b>ALUMINUM POWDER COATING TO BE OF INTERPON COLLECTION FUTURA OR EQUIVALENT AS APPROVED</b>

## 1.10 Fabrication

- A. Fabricate glass units in accordance with industry standards.
- B. Provide certification to glass make up and tempering in lieu of etching glass make up on lites.
- C. Fabrication tolerances shall be as per FGMA.

## 1.11 Elastomeric Glazing Sealants

General: Provide products of type indicated, complying with the following requirements:

- i. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of laminated glass units and glazing channel substrate, under conditions of service and applications ,as demonstrated by sealant

manufacturer based on testing and field experience. Primer application to be determined by the sealant manufacturer.

- ii. Suitability, comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
- iii. Colors of exposed glazing sealants: As selected by architect from manufacturer's full range for this characteristic. Electrometric Glazing sealant standard: Comply with ASTM C 920 and other requirements indicated for each liquid – applied, chemically curing sealant in the glazing schedule.
- iv. Additional Movement Capability: Where additional movement capability is specified in the glazing sealant schedule, provide products with the capability, when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, to withstand the specified percentage change in the joint width existing at time of installation and remain in compliance with other requirements in ASTM C 920 for uses indicated.

#### 1.12 Glazing Gaskets

- i. **Dense Compression Gaskets:** Molded or extruded gaskets of material indicated below, complying with standard referenced with name of Elastover indicated below, and of profile and hardness required to maintain watertight seal:
  - 1. Silicone, ASTM C 1115
- ii. **Soft Compression Gaskets:** Extruded or Moulded, Close -cell, integral–skinned gaskets of material indicated below; complying with ASTM C 509, Type II, black; and of profile hardness required to maintain water tight seal.
  - 1. Silicone ASTM C 1115.

#### 1.13 Miscellaneous Glazing Materials

- i. General : Provide products of material ,size and shape complying with referenced glazing standards, requirements of manufacturers of glass and other glazing materials for application indicated ,and with a proven record of compatibility with surfaces contacted in installation.
- ii. Cleaners, primers and sealers: Types recommended by sealant or gasket manufacturers
- iii. Setting Blocks: Elastomeric material with a Shore A durometer hardness of 85 ,plus or minus 5
- iv. EPDM gaskets continuous along extrusions with a Shore A durometer hardness of 65 plus or minus 5 A required by glass manufacturer to maintain glass lites in place for installation indicated.
- v. Edge Blocks; Elastomeric material of hardness needed to limit glass lateral movement.

#### 1.14 Fabrication of Glass and Other Glazing Products

- i. Fabricate glass and other glazing products in sizes required to glaze openings indicated for project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of the product manufacturer and referenced glazing standards, to comply with the system performance requirements.
- ii. Clean – cut or flat – grind vertical edges of butt – glazed monolithic lites in a manner that produces square edges with slight kerfs at junctions with indoor and outdoor faces.
- iii. Grind smooth and polished exposed glass edges

## **1.15 Installation**

### **1.15.1 Factory Inspection**

Inspect all windows prior to installation of glass to ensure glazing pockets are the appropriate size and free of obstructions. Utilize proper setting blocks.

### **1.15.2 Installation**

- i. Install all glazing components in accordance with FGMA standards by experienced installers, in a clean and workmanlike manner.
- ii. Apply all sealing materials in strict compliance with the sealant manufacturer's recommendations. Before application, remove dirt, dust, moisture and other foreign matter from contact surfaces. Mask adjoining surfaces to maintain a clean and neat appearance. Tool the sealant to fill the joint and provide a smooth finish.
- iii. Protect all installed material to ensure continuity of finishes, sealant joints and glazing.

### **1.15.3 Cleaning & Protection**

- i. Install the glazing elements so as to avoid soiling or smudging of the face of glass.
- ii. Provide protective tape of low tack for alum/glass etc to be peeled off after completion.
- iii. Clean glass at the time of the installation. Final cleaning shall be conducted prior to final acceptance by Architect/ consultant.

## **2.0 Glazed Aluminium Curtain Wall**

### **2.1 Related Documents**

- i. Drawings and general provisions of the Contract, including General and Supplementary Conditions

apply to this Section.

## 2.2 Summary

- i. This Section includes the following:
  - a. Glazed aluminum curtain wall with semi unitized or unitized glazed units with Insulated glass or Monolithic glass.

## 2.3 System Description

- A. General: Provide Glazed Aluminium curtain wall system that has the following capabilities based on testing, manufacturer's standard units in assemblies similar to those indicated for this Project:
  - i. Withstands loads and thermal and structural movement requirements indicated without failure. Failure includes the following:
    - a. Air infiltration and water penetration exceeding specified limits.
    - b. Framing members transferring stresses, including those caused by thermal and structural movement, to glazing units.
- B. Wind Loads: Provide Glazed Aluminium curtain wall system, including anchorage, capable of withstanding wind-load design pressures calculated according to requirements of authorities having jurisdiction or the American Society of Civil Engineers' ASCE 7, "Minimum Design Loads for Buildings and Other Structures," "Analytical Procedure," whichever are more stringent.
  - i. Sides way (Story Drift): Accommodate building story drift when wind loads effect maximum overturning moment. Calculate story drift according to requirements of authorities having jurisdiction.
  - ii. Deflection of framing members in a direction normal to wall plane is limited to  $L/240$  for DGU and  $L/175$  for Single glazing of clear span or 19mm, whichever is smaller, unless otherwise indicated.
  - iii. Deflection of framing members overhanging an anchor point is limited to 2 times the length of the cantilevered member, divided by 175.
  - iv. Test Performance: Provide Glazed Aluminium curtain wall system that does not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of clear span when tested according to ASTM E 330.
    - a. Test Pressure: 150 percent of inward and outward wind-load design pressures.
    - b. Duration: As required by design wind velocity; fastest 1 mile of wind for relevant exposure category.

- C. **Seismic Loads:** Provide Glazed Aluminium curtain wall, including anchorage, capable of withstanding the effects of earthquake motions calculated according to requirements of authorities having jurisdiction or ASCE 7, "Minimum Design Loads for Buildings and Other Structures," "Earthquake Loads," whichever are more stringent.
- D. **Dead Loads:** Provide Glazed Aluminium curtain wall system members that do not deflect an amount which will reduce glazing bite below 75 percent of design dimension when carrying full dead load. Provide a minimum 3mm clearance between members and top of fixed panels, glazing, or other fixed part immediately below. Provide a minimum 1.5mm clearance between members and operable windows and doors.
- E. **Live Loads:** Provide Glazed Aluminium curtain wall system, including anchorage that accommodates supporting structure's deflection from uniformly distributed and concentrated live loads indicated without failure of materials or permanent deformation.
- F. **Air Infiltration:** Provide Glazed Aluminium curtain wall system with permanent resistance to air leakage through system of not more than 0.06 cfm/sq. ft. of fixed wall area when tested according to ASTM E 283 at a static-air-pressure difference of 30.5kg/m.
- G. **Water Penetration:** Provide Glazed Aluminium curtain wall system that does not evidence water leakage when tested according to ASTM E 331 at minimum differential pressure of 20 percent of inward acting wind-load design pressure as defined by ASCE 7, "Minimum Design Loads for Buildings and Other Structures," but not less than 58.5kg/m
- H. **Water Penetration:** Provide Glazed Aluminium curtain wall system that does not evidence water leakage when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of inward acting wind-load design pressure as defined by ASCE 7, "Minimum Design Loads for Buildings and Other Structures," but not less than 49kg/m (479 Pa). Water leakage is defined as follows:
- i. According to AAMA 501.1.
  - ii. Uncontrolled water infiltrating system or appearing on system's normally exposed interior surfaces from sources other than condensation. Water controlled by flashing and gutters that is drained back to the exterior and cannot damage adjacent materials or finishes is not water leakage.
- I. **Thermal Movements:** Provide Glazed Aluminium curtain wall system, including anchorage, that accommodates thermal movements of system and supporting elements resulting from the following maximum change (range) in ambient and surface temperatures without buckling, damaging stresses on glazing, failure of joint sealants, damaging loads on fasteners, noise or vibration, and other detrimental effects.
- i. Temperature Change (Range): 20°C, ambient; 45°C, material surfaces.
- J. **Structural Support Movement:** Provide Glazed Aluminium curtain wall system that accommodates structural movements including, but not limited to, sway, twist, column shortening, long-term creep, and deflection.

- K. **Average Thermal Conductance:** Provide Glazed Aluminium curtain wall system with an average U-value of not more than 0.66 Btu/sq. ft. x h x deg F when tested according to AAMA 1503.1.
- L. **Sound Transmission:** Provide Glazed Aluminium curtain wall system with average sound transmission loss through system of not less than 34 decibels (dB) when tested according to ASTM E 90.
- M. **Dimensional Tolerances:** Provide Glazed Aluminium curtain wall system, including anchorage that accommodates dimensional tolerances of building frame and other adjacent construction.

## 2.4 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Technical Specification.
- B. Product Data for each product specified, including details of construction relative to materials, dimensions of individual components, profiles, and finishes.
- C. Shop Drawings showing fabrication and installation of the Glazed aluminium curtain wall either semi unitized or unitized system to create a Glazed Aluminium curtain wall system including plans, elevations, sections, details of components, and attachments to other units of Work.
- i. For installed products indicated to comply with certain design loadings, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Samples for initial selection in the form of manufacturer's color charts showing the full range of colors available for components with factory-applied color finishes.
- E. Samples for verification of each type of exposed finish required in manufacturer's standard sizes. Where finishes involve normal color and texture variations, include Sample sets showing the full range of variations expected.
- F. Cutaway Sample of each vertical-to-horizontal intersection of system, made from (300-mm) lengths of full-size components and showing details of the following:
- i. Joinery.
- ii. Anchorage.
- ii. Expansion provisions.
- iv. Glazing.
- v. Flashing and drainage.
- G. Welder certificates indicating that welders comply with requirements specified as per "Quality Assurance Manual".
- H. Installer certificates signed by manufacturer certifying that installers comply with requirements as



per "Quality Assurance Manual".

- I. Preconstruction test reports from a qualified independent testing agency indicating and interpreting test results relative to compliance with performance requirements of glazed aluminum curtain wall system.
- J. Product test reports from a qualified independent testing agency evidencing compliance of glazed aluminum curtain wall system with requirements based on comprehensive testing of manufacturer's current system.
- K. Field test reports from a qualified independent inspecting and testing agency indicating and interpreting test results relative to compliance with performance requirements of glazed aluminum curtain wall system.

## 2.5 Quality Assurance

- A. **Testing Agency Qualifications:** To qualify for approval, an independent testing agency must demonstrate to Architect's satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.
- B. **Professional Engineer Qualifications:** A professional engineer who is legally qualified to practice in the jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of Glazed Aluminium curtain wall system that are similar to those indicated for this Project in material, design, and extent.
- C. **Installer Qualifications:** Engage an experienced installer to assume engineering responsibility and perform work of this Section who has specialized in installing Glazed Aluminium curtain wall system similar to those required for this Project and who is acceptable to manufacturer.
  - i. **Engineering Responsibility:** Engage a qualified professional engineer to prepare or supervise the preparation of data for Glazed Aluminium curtain wall system, including drawings, testing program development, test-result interpretation, and comprehensive engineering analysis that shows systems' compliance with specified requirement.
  - ii. **Engineering Responsibility:** Prepare data for Glazed Aluminium curtain wall system, including drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- D. **Source Limitations:** Obtain each type of Glazed Aluminium curtain wall system from one source and by a single manufacturer.
- E. **Product Options:** Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to

sight lines and relationships to one another and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, or in-service performance.

- F. **Product Options:** Drawings indicate size, profiles, and dimensional requirements of the Glazed Aluminium curtain wall system and are based on the specific system indicated. Other manufacturers' systems with equal performance characteristics may be considered.
- i. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval and only to the extent needed to comply with performance requirements. Where modifications are proposed, submit comprehensive explanatory data to Architect for review.
- G. **Preconstruction Testing:** Comply with the following requirements:
- i. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform the preconstruction testing indicated.
- ii. Preconstruction Testing Service: Engage a qualified independent testing agency to perform the preconstruction testing indicated.
- iii. Test Glazed Aluminium curtain wall system for compliance with requirements specified for performance and test methods. Conduct tests using specimen representative of proposed materials and construction including perimeter components according to AAMA 501 recommendations.
- H. **Welding Standards:** Comply with applicable provisions of AWS D1.2, "Structural Welding Code-Aluminum."
- i. Engage welders who have satisfactorily passed AWS qualification tests for welding processes involved and who are currently certified for these processes.
- I. **Mockups:** Prior to installing Glazed Aluminium curtain wall system, construct mockups for each form of construction and finish required to verify selections made under Sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for Work.
- i. Locate mockups on-site in the location and of the size indicated or, if not indicated, as directed by Architect.
- ii. Notify Consultant 7 days in advance of the dates and times when mockups will be constructed.
- iii. Demonstrate the proposed range of aesthetic effects and workmanship.
- iv. Obtain Architect's approval of mockups before start of Work.
- v. Retain and maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

- a. When directed, demolish and remove mockups from Project site.
  - b. Approved mockups in an undisturbed condition at the time of Substantial Completion may become part of the completed Work.
- J. **Pre-installation Conference:** Conduct conference at Project site to comply with requirements specified. Review methods and procedures related to Glazed Aluminium curtain wall system including, but not limited to, the following:
  - i. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
  - ii. Review structural loading limitations.
  - iii. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - iv. Review required inspecting, testing, and certifying procedures.
  - v. Review weather and forecasted weather conditions and procedures for coping with unfavorable conditions.
  - vi. Manufacturers of said materials shall approve the material applications of this product in accordance with the industry practices.

## 2.6 Project Conditions

- A. **Field Measurements:** Verify dimensions by field measurements before fabrication and show recorded measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
  - i. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabrication without field measurements. Coordinate construction to ensure that actual dimensions correspond to guaranteed dimensions.

## 2.7 Warranty

- A. **General Warranty:** The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. **Special Warranty:** Submit a written warranty executed by the manufacturer agreeing to repair or replace components of Glazed aluminium curtain wall system that fail in materials or workmanship within the specified warranty period. Failures include, but are not limited to, the following:

- i. Structural failures including, but not limited to, excessive deflection.
- ii. Noise or vibration caused by thermal movements.
- iii. Failure of system to meet performance requirements.
- iv. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- v. Failure of operating components to function normally.
- vi. Water leakage.
- vii. Glazing breakage.
- viii. Bad Workmanship

C. Warranty Period: 10 years from date of Completion.

## **2.8 Products**

### **2.8.1 Manufacturers**

- i. This scope shall be considered design Build. All aspects of the system shall meet nominal dimensions and site lines illustrated in the contract documents and meet the performance standards noted herein. Design is based on using standard components.

### **2.8.2 Materials**

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated complying with the requirements of standards indicated below.
  - i. Sheet and Plate: ASTM B 209.
  - ii. Extruded Bars, Rods, Shapes, and Tubes: ASTM B 221.
  - iii. Extruded Structural Pipe and Tubes: ASTM B 429.
  - iv. Welding Rods and Bare Electrodes: AWS A5.10.
- B. Glazing as specified in the above clauses.
- C. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers; in hardness recommended by manufacturer.

- D. Glazing sealants and fillers as specified in this sub head
- E. Framing system gaskets and joint fillers as recommended by manufacturer for joint type.
- F. Sealants and joint fillers for joints within Glazed aluminium curtain wall system as specified in below sub heads.

### **2.8.3 Components**

- A. Exterior Trim – Extruded Aluminum 6063 T6 with PVDF finish of minimum 45microns.
- B. Brackets and Reinforcements: Provide manufacturer's standard high-strength aluminum brackets and reinforcements. Provide non staining, nonferrous shims for aligning system components.
- C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, no staining, no bleeding fasteners and accessories compatible with adjacent materials. Finish exposed portions to match glazed aluminum curtain wall.
  - i. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended by manufacturer.
  - ii. Where fasteners anchor into aluminum less than 3mm thick, provide reinforcement to receive fastener threads.
  - iii. Use exposed fasteners with countersunk screw heads finished to match framing members, unless otherwise indicated.
- D. Anchors: 3-way adjustable anchors that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
  - i. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123 or ASTM A 153 requirements.
- E. Concealed Flashing: Manufacturer's standard corrosion-resistant, no staining, no bleeding flashing, compatible with adjacent materials, and of type recommended by manufacturer.
- F. System shall include provisions for countersunk stainless steel fasteners attached to horizontal and or vertical aluminum mullions. Stainless steel fasteners shall have appropriate grommets for a weather tight application.

### **2.8.4 Fabrication**

- A. General: Fabricate Glazed Aluminium curtain wall system according to Shop Drawings. Fabricate components that, when assembled, will have accurately fitted joints with ends coped or mitered to

produce hairline joints free of burrs and distortion. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

- B. Forming: Form shapes with sharp profiles, straight and free of defects or deformations, before finishing.
- C. Prepare components to receive concealed fasteners and anchor and connection devices.
- D. Fabricate components to drain water passing joints, condensation occurring in glazing channels, condensation occurring within framing members, and moisture migrating within the system to the exterior.
- E. Welding: Weld components to comply with referenced standard and Shop Drawings, unless otherwise indicated. Weld before finishing components. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- F. Glazing Pockets: Provide minimum clearances for thickness and type of glass indicated according to FGMA's "Glazing Manual."
- G. Metal Protection: Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

#### **2.8.5 Aluminum Finishes**

- A. General: Provide PVDF Coating of minimum 45 microns for all exposed aluminium extrusions.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

#### **2.8.6 Steel Priming**

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to applying primer.
- B. Surface Preparation: Perform manufacturer's standard cleaning operations to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel.
- C. Priming: Apply manufacturer's standard corrosion-resistant primer immediately after surface preparation and pretreatment.

## **2.9 Examination**

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of Glazed Aluminium curtain wall system. Do not proceed with installation until unsatisfactory conditions have been corrected or accommodations acceptable to Architect have been made.

### **2.9.1 Installation**

- A. General: Comply with manufacturer's written instructions for protecting, handling, and installing Glazed Aluminium curtain wall system. Do not install damaged components. Fit joints to produce hairline joints free of burrs and distortion. Rigidly secure non movement joints. Seal joints watertight, unless otherwise indicated. Provide means to drain water to the exterior to produce a permanently weatherproof system.
- B. Metal Protection: Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Install components to drain water passing joints, condensation occurring in glazing channels, condensation occurring within framing members, and moisture migrating within the system to the exterior.
- D. Install framing members plumb and true in alignment with established lines and grades.
- E. Anchorage: After system components are positioned, fix connections to building structure as indicated on Shop Drawings.
- i. Provide separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
- F. Welding: Weld components to comply with referenced standard and Shop Drawings, unless otherwise indicated. Weld in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
- G. Install glazing according to Shop Drawings. Comply with requirements of above clauses of "Façade Work" unless otherwise indicated.
- I. Erection Tolerances: Install glazed aluminum curtain wall system to comply with the following maximum tolerances:
- i. Plumb: 3mm in 3m; 6mm in 12m.
- ii. Level: 3mm in 6m; 6mm in 12m.

iii. Alignment: Where surfaces abut in line, limit offset from true alignment to 1.5mm; where a reveal or protruding element separates aligned surfaces by less than 50mm, limit offset to 6mm.

iv. Location: Limit variation from plane or location shown on Shop Drawings to 3mm in 3.6m; 12mm over total length.

### **2.9.2 Field Quality Control**

- A. Testing Agency: Owner will engage a qualified independent testing agency to perform testing indicated.
- B. Testing Agency: Engage a qualified independent testing agency to perform testing indicated.
- C. Air Infiltration: Test areas of installed system indicated on Drawings for compliance with system performance requirements according to ASTM E 783.
- D. Water Penetration: Test areas of installed system indicated on Drawings for compliance with system performance requirements according to ASTM E 1105 at minimum differential pressure of 20 percent of inward acting wind-load design pressure as defined by ASCE 7, "Minimum Design Loads for Buildings and Other Structures," but not less than 6.24 lbf/sq. ft. (299 Pa).
- E. Water Spray Test: After completing the installation of 75-foot- (23-m-) by-2-story minimum area of glazed aluminum curtain wall system, test system for water penetration according to AAMA 501.2 in a 2bay area directed by Architect.
- F. Repair or remove Work that does not meet requirements or that is damaged by testing; replace to conform to specified requirements.

### **2.9.3 Protection**

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure glazed aluminum curtain wall system is without damage or deterioration at the time of Substantial Completion.

## **2.10 Finish Hardware**

### **2.10.1 Work Included**

Provide material, labour, equipment, services, and perform operations in connection with the furnishing and delivering of Finish Hardware and related work as indicated and specified herein.

The work shall include, but not be limited to, the following:

Furnish finish hardware in accordance with the DBR, and as specified herein.



Keying requirements shall be as per owner. Furnish keying schedule.

Templates to the various trades for accurate setting and fitting.

Screws, bolts, expansion shields and other devices necessary for the proper application of the hardware.

Cabinet to hold finish hardware keys, as specified herein.

Construction master key.

### **Related Work Specified Elsewhere**

All wooden flush/Hollow Metal Doors and Frames

## **2.10.2 Quality Assurance**

### **Code and Regulations**

Except as otherwise indicated on the drawings or specified herein, work under this section shall conform to the applicable requirements of the local Building Code and regulations of governmental authorities having jurisdiction.

Where requirements indicated on the drawings or specified herein differ from the Building Code or the requirements of the governmental authorities having jurisdiction, the more stringent requirements shall govern.

Provide mock-up of whole doors with proper hardware installed.

## **2.10.3 Submittals**

- **Product Data:**

Submit to the Owner's Representative for approval manufacturer's catalog cuts on items specified herein and obtain approval prior to delivery.

- **Samples**

Prior to submittal of the final hardware schedule and prior to the final ordering of materials, submit one sample of each type of hardware unit, finish as required for project, and tagged with full description for coordination with schedule.

Samples will be returned upon the request and at the expense of the Contractor.

Additional samples of each type of door hardware requiring machining of doors shall be delivered to the door manufacturers. Samples will be returned at completion of factory machining.

- Schedule

Hardware: Immediately after the award of the contract, the Contractor shall prepare, and submit for approval hardware schedule listing showing requirements of each door.

Keying: Immediately after the approval of the Hardware Schedule, the Contractor shall prepare and submit for approval, complete keying schedule. Co-ordinate with Owner's representative.

Approval of hardware schedule shall not relieve the Contractor of necessity of furnishing finish hardware designated to be furnished under this contract.

Templates: Furnish hardware templates to each fabricator of doors and frames for hardware required in order to make proper provisions for accurate setting and fitting of such hardware. Upon request, check shop drawings of such other work, to confirm that adequate provisions are made for proper location and installation of hardware.

#### **2.10.4 Delivery, Storage and Handling**

Deliver hardware in manufacturer's original packages. Hardware shall have the required screws, bolts and fastenings necessary for its installation packed in the same package with the hardware, including instructions. Each package shall be legibly marked and adequately labelled, indicating the part of the work for which it is intended. Each marking shall correspond to the number shown on the approved Hardware Schedule, including door number.

Wrapping furnished by the manufacturer on knobs, handles, push plates and pulls shall be of adhesive coated paper, of a type easily removed without marring the finish of the hardware.

Inventory hardware jointly with representatives of hardware supplier and hardware installer until each is satisfied that count is correct.

Provide secure lockup for hardware delivered to the project, but not yet installed. Control handling and installation of hardware items which are not immediately replaceable, so that completion of the work will not be delayed by hardware losses, both before and after installation.

#### **2.10.5 Material Requirements**

Prepare and submit hardware schedule for approval.

#### **2.10.6 Manufacture**

As approved.

- **Specification: Floor spring** Type I TS 500 NEN3,

closing force size 3 in accordance with EN 1154, load capacity up to 80 kg, and Door Width upto 900mm closing speed can be adjusted, with fixed back check, overall height 42 mm, for double and single-action internal doors,

**Hold-open device:**

( ) with hold-open device 85°

( Y ) with hold-open device 90°

**Cover plate:**

A. ( Y ) stainless steel

**Floor spring** Type II TS 500 NV,

closing force adjustable size 1 - 4 in accordance with EN 1154, load capacity up to 120 kg, and Door Width 1050mm latching action and closing speed adjustable, with fixed back check, overall height 42 mm, for double and single-action doors,

**Hold-open device:**

( ) without hold-open device

( ) with hold-open device 85°

( Y ) with hold-open device 90°

**Cover plate:**

( Y ) stainless steel

- **Floor spring**Type III TS 550 EN3,

for installation on fire and smoke protection doors, without hold-open device, load capacity up to 250 kg Door Width upto 1250mm closing force size 3 – 6 according to EN 1154, closing speed and latching action can be regulated, for single-action doors, closing effect from 180°,

**Cover plate:**

( Y ) stainless steel

**Frameless Doors:**

**Patch Fitting double action doors**

Patch fittings are an installation-friendly fitting system for multifarious and secure fitting solutions in all-glass door systems both indoors and outdoors.

Patch fittings shorten installation times due to rapid pre -fitting of all-glass fittings. The patch fittings range enables technically perfect and optically appealing implementation of all the

standard all-glass equipment. All fittings are constructed as modules and consist of the main body, function sets and clip-on covers.

Glass cut-outs and drill holes which are normally required can be carried out simply and quickly.

Patch fittings allow the easy adjustment to standard glass thickness of 10-12mm.

The elegant caps are manufactured from polished or ground stainless steel.

**Application:**

( Y ) double-action door

**Assembly:**

- ( ) single-leaf
- ( ) double-leaf
- ( ) fixed panel

(Y) left

( Y ) right

( ) fanlight

( ) continuous

(Y ) split

( Y ) assembly according to drawing (if available)  
subject to technical review

**Ceiling:**

( ) adequate load capacity guaranteed ( ) installation ceiling bearing possible

( Y ) yes

( ) yes

( ) no

( ) no

**Connection to ceiling, wall, floor:**

(Y ) fixed glazing with U profile rail

( ) PT fixed panel holder (point by point)

( ) PT fixed panel clamping rail

**Glass:**

( Y ) 12mm Clear Float Toughened glass with polished Grinding **Type**  
**of application:**

( Y ) double-action door system with floor springs

**Surface of fitting components:**

( Y) stainless steel matt

**Locks and accessories**

( ) universal lock

(Y) bottom

**With** (Y ) counter box

( Y) lock plate

( Y) floor socket

(Y ) handle rods in stainless steel for double-action doors (Y ) on both sides:

Height: 600 mm

Diameter : 32mm

**3.0 Joint Sealers****3.1 General Requirements**

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

**3.2 Section Includes**

- A. The Work of this Section includes all labour, materials, equipment and services necessary to complete the joint sealers work as shown on the drawings and/or specified herein, including but is not necessarily limited to the following.
- i. Exterior wall joints not specified to be sealed in other Sections of work.
  - ii. Interior wall joints not specified to be sealed in other Sections of work.
  - iii. Joints at wall penetrations.
  - iv. All other joints required to be sealed to provide a positive barrier against penetration of air and moisture.
  - v. Water repellency treatment for the stone.
  - vi. Non- staining silicone for the stone cladding grooves.

**3.3 Related Sections.**

Deleted

**3.4 Quality Assurance**

- A. Qualification of Installers: Use only personnel who are thoroughly familiar, skilled and specially trained in the techniques of sealant work, and who are completely familiar with the published

recommendations of the sealant manufacturer.

- B. Pre-Construction Field Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to project joint substrates according to the method in ASTM C1193 that is appropriate for the types of Project joints.
- C. Perform testing as per ASTM C510 on interior and exterior sealants to determine if sealants or primers will stain adjacent surfaces. No sealant work shall start until results of these tests have been submitted to the Architect and he has given his written approval to proceed with the work.
- D. Provide test results for the stone to ascertain the compatibility of the silicone sealant with the stone.

### 3.5 Submittals

- A. Shop Drawings: Submit shop drawings showing all joint conditions, indicating relation of adjacent materials, all sealant materials (sealant, bond breakers, backing, primers, etc.), and method of installation.
  - i. Submit joint sizing calculations certifying that movement capability of sealant is not being exceeded.
- B. Samples: Submit the following:
  - i. Color samples of structural silicone.
  - ii. Color samples of weather silicone.
  - iii. Color samples of non staining silicones.
  - iv. Sealant bond breaker and joint backing.
- C. Product Data: Submit manufacturer's technical information and installation instructions for:
  - i. Sealant materials have to be Dow corning 995 and 789.
  - ii. Non staining silicone from Dow corning 991
  - iii. Fire Stop silicone from Dow corning DC 700
  - iv. Dow corning primer DC 1200
  - v. HILTI Mastic Spray CFS-SP WB / STI Firestop – AS200 Series Elastomeric Spray
  - vi. Backing rods.
- D. Submit manufacturer's certification as required in Article 3.6

### 3.6 Manufacturer's Responsibility and Certification

- A. Contractor shall require sealant manufacturer to review the Project joint conditions and details for this Section of the work. Contractor shall submit to the Architect written certification from the sealant manufacturer that joints are of the proper size and design, that the materials supplied are compatible with adjacent materials and backing, that the materials will properly perform to provide permanent watertight, airtight or vapor tight seals (as applicable), and that materials supplied meet specified

performance requirements.

### 3.7 Environmental Conditions

- A. Temperature: Install all work of this Section when air temperature is above 20 degrees C. and below 40 degrees C, unless manufacturer submits written instructions permitting sealant use outside of this temperature range.
- B. Moisture: Do not apply work of this Section on surfaces which are wet, damp, or have frost.

### 3.8 Product Handling

- A. Protection: Use all means necessary to protect the materials of this Section, before, during and after installation and to protect the installed work and materials of all other trades.
- B. Replacements: In the event of damage, immediately make all repairs and replacements necessary.
- C. Storage
  - i. Store sealant materials and equipment under conditions recommended by their manufacturer.
  - ii. Do not use materials stored for a period of time exceeding the maximum recommended shelf life of the material.

### 3.9 Guarantee

- A. Provide a written, notarized guarantee from the manufacturer and the applicator stating that the applied sealants shall remain watertight for a period of ten (10) years.
- B. Guarantee shall be in a form acceptable to the Owner and executed by an authorized individual.
- C. Guarantee shall further state that installed sealant is guaranteed against:
  - i. Adhesive or cohesive failure of sealant joints.
  - ii. Crazing greater than 3 mils in depth developing on surface of material.
  - iii. Staining of surfaces adjacent to joints by sealants or primer by migration through building materials in contact with them.
  - iv. Chalking, or visible color change on surface of cured sealant.
  - v. Increase or decrease of "Shore A" durometer hardness (5 second reading) of sealant of more than 30 percent of 7 day value of "Shore A" durometer hardness of sealant.
- D. Include in guarantee provision, agreement to repair and/or replace, at Contractor's expense, sealant defects which develop during guarantee period, because of faulty labour and/or materials.

### 3.10 Sealant Materials

- A. Exterior Wall Sealant: Provide one part non-sag sealant equal to No. 995 or 795 made by Dow

Corning, Conforming to the minimum standards of ASTM C920, Type S, grade NS, Class 25.

- B. Water repellency Sealant for Stone Cladding: Provide a solvent free silane / siloxane Dow corning Z - 6689.
- C. Non – Staining silicone sealant for Stone cladding: Provide one part sealant DC991 Confirming to standards in ASTM C920
- D. Colors: Custom colors of sealants as selected by the Architect.

### **3.11 Miscellaneous Materials**

- A. Back-Up Materials: Provide back-up materials and preformed joint fillers, non-staining, non-absorbent, compatible with sealant and primer, and of a resilient nature, equal to "Soft-Rod", 25 percent wider than joint width. Materials impregnated with oil, bitumen or similar materials shall not be used. Provide back-up materials only as recommended by sealant manufacturer in writing.
- B. Provide bond breakers, where required, of polyethylene tape as recommended by manufacturer of sealant.
- C. Provide primers recommended by the sealant manufacturer for each material to receive sealant. Note that each exterior joint must be primed prior to sealing.
- D. Provide solvent, cleaning agents and other accessory materials as recommended by the sealant manufacturer.
- E. Materials shall be delivered to the job in sealed containers with manufacturer's original labels attached. Materials shall be used per manufacturer's printed instruction.

### **3.12 Inspection**

- A. Examine the areas and conditions where joint sealers are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

### **3.13 Installation**

- A. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications and conditions required by this Project where more stringent installation requirements are specified herein, such requirements shall apply.
- B. Sample Section of Sealant
  - i. During sealant installation work in exterior wall, the manufacturer of sealant shall send his representative to the site, under whose supervision a section of the wall (used as "control section") shall be completed for purposes of determining performance characteristics of sealant in joints. Architect shall be informed of time and place of such installation of control section.



- ii. Control section shall be installed according to specification given herein and shall not be considered as acceptable until written acceptance is provided by the Architect.
  - iii. Accepted control section shall be standard to which all other sealant work must conform.
- C. Supervision: Submit to the Architect/Owner written certification from the sealant manufacturer that the applicators have been instructed in the proper application of their materials. Use only skilled and experienced workmen for installation of sealant.
- D. Apply sealant under pressure with a hand or power actuated gun or other appropriate means. Gun shall have nozzle of proper size and provide sufficient pressure to completely fill joints as detailed. Neatly point or tool joint to provide the contour as indicated on the drawings.
- E. Preparation and Application
- i. Thoroughly clean all joints, removing all foreign matter such as dust, oil, grease, water, surface dirt and frost. Sealant must be applied to the base surface. Previously applied film must be entirely removed.
  - ii. Stone, masonry and concrete surfaces to receive sealant shall be cleaned where necessary by grinding, water blast cleaning, mechanical abrading, or combination of these methods as required to provide a clean, sound base surface for sealant adhesion.
    - a. Do not use any acid or other material which might stain surfaces.
    - b. Remove laitance by grinding or mechanical rading.
    - c. Remove loose particles present or resulting from grinding, abrading, or blast cleaning by blowing out joints with compressed air, oil and water free or vacuuming joints prior to application of primer or sealant.
- F. Clean non-porous surfaces such as metal and glass chemically. Remove protective coatings on metallic surfaces by solvent that leaves no residue and is compatible with sealant. Use solvent with clean, lint free paper towels, and wipe dry with clean, dry lint free paper towels. Do not allow solvent to air dry without wiping. Clean joint areas protected with masking tape or strippable films as above after removal of tape film.
- G. Do not seal joints until they are in compliance with drawings, or meet with the control section standard.
- H. Joint Size and Sealant Size: Joints to receive sealant shall be at least 6mm wide. In joint 6mm to 10mm wide, sealant shall be 6mm deep. In joints wider than 10mm and up to 25mm wide, sealant depth shall be one half the joint width. For joints wider than 25mm, sealant depth shall be as recommended by the sealant manufacturer. Depth of joint is defined as distance from outside face of joint to closest point of the filler.
- I. Primer: Thoroughly clean joints and apply primer to all surfaces that will receive sealant. Apply primer on clean, dry surfaces, and prior to installation of joint backing. Completely wet both inner faces of the joint with primer. Mask adjacent surfaces of joint with non-staining masking tape prior to priming.

- J. Joint Backing: In joints where depth of joint exceeds required depth of sealant, install joint backing (after primer is dry) in joints to provide backing and proper joint shape for sealant. Proper shape for sealant is a very slight "hourglass" shape, with back and front face having slight concave curvature.

Use special blunt T-shaped tool or roller to install joint backing to the proper and uniform depth required for the sealant. Joint backing shall be installed with approximately 25 percent compressions. Do not stretch, twist, braid, puncture, or tear joint backing. Butt joint backing at intersections.

- K. Bond Breaker: Install bond breaker smoothly over joint backing so that sealant adheres only to the sides of the joint and not backing.
- L. Sealant Application: Apply sealant in accordance with the manufacturer's application manual and manufacturer's instructions, using hand guns or pressure equipment, on clean, dry, properly prepared substrates, completely filling joints to eliminate air pockets and voids. Mask adjacent surfaces of joint with non-staining masking tape. Force sealant into joint in front of the tip of the "caulking gun" (not pulled after it) and force sealant against sides to make uniform contact with sides of joint and to prevent entrapped air or pulling of sealant off of sides. Fill sealant space solid with sealant.
- M. Tooling: Tool exposed joints to form smooth and uniform beds, with slightly concave surface. Finished joints shall be straight, uniform, smooth and neatly finished. Remove masking tape immediately after tooling of sealant and before sealant face starts to "skin" over. Neatly remove any excess sealant from adjacent surfaces of joint, leaving the work in a neat, clean condition.
- N. Replace sealant which is damaged during construction process.

#### **4.0 Aluminium Extruded Sections**

##### **4.1 SCOPE (Work to be carried out as per latest CPWD specifications of works):-**

The scope of the work is the fabrication, supply and erection at site of all types of glazed doors, windows and ventilators in accordance with the DBR and specifications.

It is the responsibility of the tenderer to inspect the site and obtain for himself all relevant information and details in respect of the work including access facilities for stacking and storage field work in making connections with self-tapping screw assembling etc and take into account all such things in working out his rates for the finished work.

The supply and erection will include all parts such as but not restricted to frames, tracks, guides, mullions, styles, rails, couplers, transoms, rails, plates glazing bars, glass, hinges, arrangement, spring catches, cord and pulley arrangements, spring catches, cord and pulley arrangements door closers floor springs etc., required for the whole work whether the parts/ items are individually and specifically referred to in the schedules/ specifications/drawings or not provided that the supply and installation of such parts can be inferred there from and are necessary to make the work complete, unless separate provision is made in the bills of quantities for supply to such parts/items.

The doors, windows, ventilators, will be fabricated to suit the finished clear openings in the building/structure which the tenderer will himself measure.

#### **4.2 Materials:-**

The members will be made out of aluminium alloy corresponding to IS:733 and will consist of extruded sections and of other shapes, and to sized gauges as shown in the drawings/ described in accordance with the relevant IS codes. The members shall be chosen to provide strength/ stability and maximum resistance to wear and tear.

The Sections will be as per approved makes, extruded sections. As indicated in DBR tenderer should specifically mention which sections he is using.

The weight of sections and the corresponding catalogue numbers are mentioned. The IS specifications are to be strictly adhered.

The alloy of extruded aluminium should be BS or IS old HE9, Alcon 50 SWP. to this effect test certificate has to be provided for the extruder.

#### **4.3 Finishing:-**

The extruded aluminium section has to be mechanically finished to remove all scratches; extrusion marks etc and subsequently thoroughly cleared in all alkali baths prior to anodizing.

The polyester powder coating should be of desired shade with minimum average thickness to 50 microns or other shades as required and to this effect the tenderer must have to produce test certificate from authorized institutions Bureau of Indian Standard.

The polyester powder coated material should be properly wrapped in gummed tape before fabrication to avoid scratches during fabricated and erection shall be kept protected till handing over.

#### **4.4 Fabrication:-**

Before commencing the fabrication the contractor shall submit to client for their approval detailed shop drawings, based on the Architects drawings and corresponding specification showing junctions, fittings, accessories such as hinges flush bolts, locks, latches, latching arrangements, peg stays, rotor arms, anodize pivots gaskets rubber packing door felts, mastic, sealant etc., including fixing and sealing arrangements . Type and method of scaffolding he intends to use, Fabrication is to be taken up only after approval by client and in accordance with the approved drawings. Sections for fabrication of door/ window/ventilators etc shall be as per architectural drawings or as approved by the client. A sample of finished door/windows/ ventilator / fire check door / railing etc. shall be fabricated as per the shop drawings approved by client for final approval before under taking mass production/ fabrication.

The doors, window, ventilators and partitions shall as per thickness given in the item specifications, Polyester Powder coating shall be as specified in the item specifications.

All materials shall conform to relevant IS. Codes and in the absence of IS code, they should correspond to the best engineering practice; decision of the Client/Consultant shall be final and binding on the contractor.

Fabrication shall be done true to the drawing/ sample approved and in correspondence to the finished openings at the site. All joints shall be mitred at the corners, true right angles, and joints to be finished neatly to hairlines, with concealed fasteners, wherever possible joints shall be made in concealed locations.

All fabricated/finished items shall be packed and carted properly to site to prevent any damage in transit. On receipt at site they shall be carefully stacked in protected storage to avoid distortion/damage.

Site installation shall be with concealed screws, self-tapping or other approved fasteners or may be by welding, due precautions shall be taken to avoid any distortion/discoloration/damage to the finished items.

Wood work faces/parts coming in contact with masonry shall before shifting to the site be given a heavy coat of alkali resistance bitumen paint. Steel items coming in contact with other incompatible materials shall be given a thick coat of zinc chromate primer.

## **5.0 Firestops and Smoke seals**

### **General**

#### **5.1 General Requirements**

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

#### **5.2 Section Includes**

- A. Work of this Section includes all labor, materials, equipment and services necessary to complete the fire stops and smoke seals as shown on the drawings and/or specified herein, including but not limited to, the following:
- i. Penetrations through fire-resistance-rated floor and roof construction including both empty openings and openings containing cables, pipes, ducts, conduits, and other penetrating items.
  - ii. Penetrations through fire-resistance-rated walls and partitions including both empty openings and openings containing cables, pipes, ducts, conduits, and other penetrating items.

- iii. Penetrations through smoke barriers and construction enclosing compartmentalized areas involving both empty openings and openings containing penetrating items.
- iv. Sealant joints in fire-resistance-rated construction.
- v. Penetrations at each floor level in shafts and/or stairwells.
- vi Construction joints, including those between top of fire rated walls and underside of floors above; and those between exterior curtain walls and the outer perimeter edge of floor assemblies.

### 5.3 Related Sections

- A. Joint sealers
- B. Aluminum curtain wall

### 5.4 References

- A. ASTM E 814 "Standard Method of Fire Tests of Through-Penetration Firestops".
- B. UL 1479, UBC 7-5
- C. ASTM E 119 "Standard Method of Fire Tests of Building Construction and Materials".
- D. UL 263, UBC 7-1
- E. UL 2079 "Tests For Fire Resistance of Building Joint Systems".
- F. ASTM E 1399 "Test For Dynamic Movement Conditions".
- G. ASTM E 1966
- H. Published Through-Penetration Systems by recognized independent testing agencies.
  - i. UL Fire Resistance Directory, Volume II of current year.
  - ii. Warnock Hersey Certification Listings, current year.
  - iii. Omega Point Laboratories, current year.

### 5.5 Submittals

- A. Submit manufacturer's product literature for each type of fire stop material to be installed. Literature shall indicate product characteristics, typical used, performance, limitation criteria, test data and indicate that products comply with specified requirements.
- B. Submit shop drawings detailing materials, installation methods, and relationships to adjoining construction for each fire stop system, and each kind of construction condition penetrated and

kind of penetrating item. Include fire stop design designation of qualified testing and inspection agency evidencing compliance with requirements for each condition indicated.

Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration fire stop configuration for construction and penetrating items.

- C. Material Safety Data Sheets: Submit MSDS for each fire stop product.
- D. Submit qualifications of fire stop installer, including letter from fire stop manufacturer of products proposed to be installed, wherein manufacturer approves or recognizes as trained / or certifies installer for installation of that manufacturer's products.

## 5.6 Quality Assurance

- A. General: Provide fire stopping systems that are produced and installed to resist the spread of fire, and the passage of smoke and other gases.
- B. Fire stopping materials shall conform to Flame (F) and Temperature (T) ratings as required by local building code and as tested by nationally accepted test agencies per ASTM E 814 or UL 1479. The F rating must be a minimum of one (2) hour but not less than the fire resistance rating of the assembly being penetrated. T rating, when required by code authority, shall be based on measurement of the temperature rise on the penetrating item(s). The fire test shall be conducted with a minimum positive pressure differential of 0.01 inches of water column.
- C. Fire stopping products shall be asbestos free and free of any PCBs.
- D. Do not use any product containing solvents or that requires hazardous waste disposal.
- E. Do not use fire stop products which after curing, dissolve in water.
- F. Do not use fire stop products that contain ceramic fibers.
- G. Fire stopping Installer Qualifications: Fire stop application shall be performed by a single fire stopping contractor who specializes in the installation of fire stop systems, whose personnel to be utilized have received specific training and certification or approval from the proposed respective fire stop manufacturer, and fire stop installer shall have a minimum of three years experience (under present company name) installing fire stop systems of the type herein specified.
- H. Mock-Up: Prepare job site mock-ups of each typical Fire stop System proposed for use in the project. Approved mock-ups will be left in place as part of the finished project and will constitute the quality standard for the remaining work.

- I. For fire stopping exposed to view, traffic, moisture, and physical damage, provides products that do not deteriorate when exposed to these conditions.
  - a. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration fire stop systems.
  - b. For floor penetrations with annular spaces exceeding 4 inches or more in width and exposed to possible loading and traffic, provide fire stop systems capable of supporting the floor loads involved either by installing floor plates or by other means.
  - c. For penetrations involving insulated piping, provide through-penetration fire stop systems not requiring removal of insulation.

### **5.7 Delivery, Storage and Handling**

- A. Deliver materials in manufacturer's original unopened containers with manufacturer's name, product identification, and lot numbers, as applicable.
- B. Store materials in the original, unopened containers or packages, and under conditions recommended by manufacturer.
- C. All fire stop materials shall be installed prior to expiration of shelf life.

### **5.8 Project Conditions**

- A. Verify existing conditions and substrates before starting work.
- B. Do not use materials that contain solvents, show sign of damage or are beyond their shelf life.
- C. During installation, provide masking and drop cloths as needed to prevent fire stopping products from contaminating any adjacent surfaces.
- D. Conform to ventilation requirements if required by manufacturer's installation instructions or Material Safety Data Sheet.
- E. Weather Conditions: Do not proceed with installation of fire stop products when temperatures are in excess or below the manufacturer's recommendations.
- F. Schedule installation of fire stop products after completion of penetrating item installation but prior to covering or concealing of openings.
- G. Coordinate this work as required with work of other trades.

### **5.9 Sequencing and Scheduling**

- A. Pre-Installation Conference: Convene a pre-installation conference to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work.
- B. Sequence: Perform work of this and other sections in proper sequence to prevent damage to the fire stop systems and to ensure that their installation will occur prior to enclosing or concealing work.
- C. Install all fire stop systems after voids and joints are prepared sufficiently to accept the applicable fire stop system.
- D. Do not cover fire stop systems until they have been properly inspected and accepted by the authority having jurisdiction.

#### **5.10 Acceptable Manufacturers**

- A. Subject to compliance with requirements, provide products of one of the following manufacturers:
  - i. Dow Corning
  - ii. Hilti

#### **5.11 Firestopping, General**

- A. Compatibility: Provide fire stopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the fire stopping under conditions of service and application, as demonstrated by fire stopping manufacturer based on testing and field experience.
- B. Accessories: Provide components for each fire stopping system that are needed to install fill materials. Use only components specified by the fire stopping manufacturer and approved by the qualified testing and inspecting agency for the designated fire-resistance-rated systems. Accessories include but are not limited to the following items:
  - i. Permanent backing materials including the following:
    - a. Rock wool insulation.
    - b. Fire-rated form board.
    - c. Joint fillers for joint sealants.
  - ii. Temporary forming materials.
  - iii. GI sheet.
- C. Applications: Provide fire stopping systems composed of materials specified in this Section that comply with system performance and other requirements.



- D. Smoke seals at top of partitions shall be flexible to allow for partition deflection.

### 5.12 Fire-Resistive Elastomeric Joint Sealants

- A. Elastomeric Sealant Standard: Provide manufacturer's standard chemically curing, elastomeric sealant of base polymer indicated that complies with ASTM C 920 requirements, including those referenced for Type, Grade, Class, and Uses, and requirements specified in this Section applicable to fire-resistive joint sealants.

Sealant Colors: Color of exposed joint sealants as selected by the Architect.

- B. Single-Component, Neutral-Curing Silicone Sealant: Exposure- related Use NT.

Additional Movement Capability: Provide sealant with the capability to withstand 33 percent movement in both extension and compression for a total of 66 percent movement.

- C. Multi-Component, Non-Sag, Urethane Sealant: Exposure-related Use NT,

Additional Movement Capability: Provide sealant with the capability to withstand 40 percent movement in extension and 25 percent in compression for a total of 65 percent movement in joint width existing at time of installation, when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, and remain in compliance with other requirements of ASTM C 920 for uses indicated.

- D. Single-Component, Non-Sag, Urethane Sealant: Use NT.

### 5.13 Rock Wool Non-Combustible Installation (Fire Safing)

- A. Provide min. 80 kg/m<sup>3</sup> Rock wool as approved or equal to suit conditions and to comply with fire resistance and fire stop manufacturer's requirements.
- B. Material shall be classified non-combustible per ASTM E119.

### 5.14 Mixing

- A. For those products requiring mixing prior to application, comply with fire stopping manufacturer's directions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other procedures needed to produce fire stopping products of uniform quality with optimum performance characteristics for application indicated.

### 1.15 Examination

- A. Examine substrates and conditions with Installer present, for compliance with requirements for opening configuration, penetrating items, substrates, and other conditions affecting

performance of fire stopping. Do not proceed with installation until unsatisfactory conditions have been corrected.

### 5.16 Preparation

Surface Cleaning: Clean out openings and joints immediately prior to installing fire stopping to comply with recommendations of fire stopping manufacturer and the following requirements:

- i. Remove all foreign materials from surfaces of opening and joint substrates and from penetrating items that could interfere with adhesion of fire stopping.
- ii. Clean opening and joint substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with fire stopping. Remove loose particles remaining from cleaning operation.
- iii. Remove laitance and form release agents from concrete.

### 5.17 Conditions Requiring Firestopping

#### A. Building Exterior Perimeters

- i. Where exterior facing construction is continuous past a structural floor and a space (i.e. construction joint) would otherwise remain open between the inner face of the wall construction and the outer perimeter edge of the structural floor, provide fire stopping to equal the fire resistance of the floor assembly.
  - a. If Rock wool is part of fire stop system, the Rock wool must be completely covered by Bison Board of appropriate thickness
  - b. Refer herein for description of fire safing insulation.
- ii. Fire stopping shall be provided whether or not there are any clips, angles, plates, or other members bridging or interconnecting the facing and floor systems, and whether or not such items are continuous.
- iii. Where an exterior wall of composite type construction passes a perimeter structural member, such as a girder, beam, or strut, and the finish on the interior wall face does not continue up to close with the underside of the structural floor above, thus interrupting the fire-resistive integrity of the wall system, and a space would otherwise remain open between the interior face of the wall and lower edge of the structural member, provide fire stopping to continuously fill such open space.

#### B. Interior Walls and Partitions

- i. Construction joints between top of fire rated walls and underside of floors above, shall be fire stopped.

- ii. Fire stop system used shall allow for deflection of floor above.
- C. Penetrations
  - i. Penetrations include conduit, cable, wire, pipe, duct, or other elements which pass through one or both outer surfaces of a fire rated floor, wall, or partition.
  - ii. Except for floors on grade, where a penetration occurs through a structural floor or roof and a space would otherwise remain open between the surfaces of the penetration and the edge of the adjoining structural floor or roof, provide fire stopping to fill such spaces in accordance with ASTM E-814.
  - iii. These requirements for penetrations shall apply whether or not sleeves have been provided, and whether or not penetrations are to be equipped with escutcheons or other trim. If penetrations are sleeved, fire stop annular space, if any, between sleeve and wall of opening.
- D. Provide fire stopping to fill miscellaneous voids and openings in fire rated construction in a manner essentially the same as specified herein before.

#### **5.18 Installing through Penetration Firestops**

- A. General: Comply with the through penetrations fire stop manufacturer's installation instructions and drawings pertaining to products and applications indicated.
- B. Install forming/damming materials and other accessories of types required to support fill materials during their application and in the position needed to produce the cross sectional shapes and depths required to achieve fire ratings of designated through penetration fire stop systems. After installing fill materials, remove combustible forming materials and other accessories.
- C. Install fill materials for through penetration fire stop systems by proven techniques to produce the following results:
  - i. Completely fill voids and cavities formed by openings, forming materials, accessories, and penetrating items.
  - ii. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
  - iii. For fill materials that will remain exposed after completing work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

#### **5.19 Installing Fire Resistive Joint Sealants**

- A. General: Comply with ASTM C-1193, and with the sealant manufacturer's installation instructions and drawings pertaining to products and applications indicated.
- B. Install joint fillers to provide support of sealants during application and at position required to produce the cross sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability and develop fire resistance rating required.
- C. Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross sectional shapes and depths relative to joint width that optimum sealant movement capability. Install sealants at the same time joint fillers are installed.
- D. Tool no sag sealants immediately after sealant application and prior to the time skinning or curing begins. Form smooth, uniform beads of configuration indicated or required to produce fire resistance rating, as well as to eliminate air pockets, and to ensure contact and adhesion of sealants with sides of joint. Remove excess sealant from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

#### **5.20 Installing Firesafing Insulation**

- A. Install fire safing Rock wool insulation utilizing welded or screw applied galvanized steel.
- B. Completely fill voids in areas where safing insulation is required. At spandrel conditions/floor edges, depth of insulation top to bottom shall be at least 102mm.
- C. Cover top of all safing insulation with fire stop sealant or spray.

#### **5.21 Field Quality Control**

- A. Inspecting agency employed and paid by the Owner will examine completed fire stopping to determine, in general, if it is being installed in compliance with requirements.
- B. Inspecting agency will report observations promptly and in writing to Contractor, Owner and Architect.
- C. Do not proceed to enclose fire stopping with other construction until reports of examinations are issued.
- D. Where deficiencies are found, Contractor must repair or replace fire stopping so that it complies with requirements.

#### **5.22 Cleaning**

- A. Clean off excess fill materials and sealants adjacent to openings and joints as work progresses by methods and with cleaning materials approved by manufacturers of fire stopping products and of products in which opening and joints occur.
- B. Protect fire stopping during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated fire stopping immediately and install new materials to product fire stopping complying with specified requirements.

## **2. Extruded Polysterene Rigid Insualtion**

Providing and fixing 75 mm thick extruded polystyrene rigid insulation board of required size between cavity wall, complying with ISO 4898:2008 & ASTM C 578-08b - type VI, having thermal conductivity of 0.0289 W/m K as per ASTM C 578 (measured as per IS 3346), compressive strength of > 350 kPa listed as per ASTM D 1621, density of 34-36 kg/cum as per ASTM D 1622, water absorption < 1% by volume as per ASTM D 2842, oxygen index of 24.1 to 28.1 listed as per ASTM D 2863, cell size 0.4 mm of dia (max) as per ASTM D 3576. Fire retardant property as per DIN 4102, Part 1 of class B2 and as per ASTM E84 class A, fixed with suitable water based adhesive and fastener, complete in all respect as per the directions of Engineer-in-Charge.-Charge.

### **6.1 Material**

Extruded Polystyrene boards to be manufactured from General Purpose polystyrene granules though an automated extrusion process free of CFC blowing agents : preferably with a blend of co2 & ethanol : low Global warming index : the boards are 100 % closed cell structure with a unique properties of high compressive strength & a stable thermal conductivity properties over the life cycle of building etc. The insulation boards complying with ISO 4898:2008 & ASTM C 578-08b/15b - type VI, having thermal conductivity of 0.0289 W/m K as per ASTM C 578 (measured as per IS 3346), compressive strength of > 350 kPa listed as per ASTM D 1621, density of 34-36 kg/m<sup>3</sup> as per ASTM D 1622, water absorption < 1% by volume as per ASTM D 2842, oxygen index of 24.1 to 28.1 listed as per ASTM D 2863, cell size 0.4 mm of dia (max) as per ASTM D 3576. Fire retardant property as per DIN 4102, Part 1 of class B2 and as per ASTM E84 class A.

### **6.2 APPROVED SYSTEM**

The boards of size 600mm width x 1250 mm length & 75 mm thickness with square edge to be laid in brick patterns with the help of suitable bituminous vapour barrier & mechanical fasteners of appropriate length with fixtures like rock wool sleeves, Fire stop, foam filler at the perimeter joints & wherever any opening etc are provided as per the instructions of Engineer in charge complete with all respects.

### **6.3 Finish**

Board to be finished with Fiber glass mesh as per manufacturer specifications.

## **6.4 Thermal Performance**

The extruded polystyrene insulation system improves the thermal efficiency of the building by reducing the U value as per the prescribed norms in the ECBC codes depending on the type of building in terms of hours of operations & geographical location. The thermal performance is very stable throughout the life cycle of the building. It improves the thermal comfort & also helps in optimizing the loads thereby reducing the capex & operating cost of HVAC systems.

### **Fire Performance**

XPS boards must be fully tested in accordance with DIN 4102 Part 1 of class B2 and as per ASTM E84 class A, with regard to fire properties, Flame spread, & surface burning characteristics. Also, suitable Fire stops, sleeves, PU spray wherever there are electrical cut outs & opening. The boards must be of self-extinguishing characteristic etc.

## **6.5 Quality Assurance**

The suspended ceiling system is to be manufactured within a recognized quality management system as per ISO 4898 & ASTM C 576 requirements. Each batch should also have the Raw material GPPS test certificates.

## **7.0 Sheet Metal Flashing and Trim**

### **GENERAL**

#### **7.1 Related Documents**

- A. Shop Drawings and general provisions of the Contract, including General and Supplementary Conditions & Specifications, apply to this Section.

#### **7.2 Summary**

- A. This Section includes sheet metal flashing and trim in the following categories:
  - i. Exposed trim, gravel stops, and fasciae.
  - ii. Copings.
  - iii. Metal flashing.
  - iv. Reglets.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
  - i. Sealants

#### **7.3 Performance Requirements**

- A. General: Install sheet metal flashing and trim to withstand, thermally induced movement, and exposure to weather without failing.

#### 7.4 Submittals

- A. General: Submit each item in this Article according to the Conditions of the Contract.
- B. Product Data including manufacturer's material and finish data, installation instructions, and general recommendations for each specified flashing material and fabricated product.
- C. Shop Drawings of each item specified showing layout, profiles, methods of joining, and anchorage details.
- D. Samples of sheet metal flashing. Aluminium flashing, trim, and accessory items, in the specified finish. Where finish involves normal color and texture variations, include Sample sets composed of 2 or more units showing the full range of variations expected.
  - i. 300mm x 300mm- square Samples of specified sheet materials to be exposed as finished surfaces.
  - ii. 300mm- long Samples of factory-fabricated products exposed as finished work. Provide complete with specified factory finish.
- E. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

#### 7.5 Quality Assurance

- A. Installer Qualifications: Engage an experience Installer who has completed sheet metal flashing and trim work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. Mockups: Prior to installing sheet metal flashing and trim, construct mockups indicated to verify selections made under Sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for final unit of Work.
  - i. Locate mockups on-site in the location and of the size indicated or, if not indicated, as directed by Architect/Owner's Consultant.
  - ii. Notify Architect/ Owner's Consultant one week in advance of the dates and times when mockups will be constructed.
  - iii. Demonstrate the proposed range of aesthetic effects and workmanship.
  - iv. Construct mockups for the following type of sheet metal flashing . Aluminium flashing and trim:
    - a. Exposed trim, and fasciae.
    - b. Copings.

- v. Obtain Architect's approval of mockups before start of final unit of Work.

## **7.6 Project Conditions**

- A. Coordinate Work of this Section with interfacing and adjoining Work for proper sequencing of each installation. Ensure best possible weather resistance, durability of Work, and protection of materials and finishes.

## **7.7 Metals**

- A. Alum Sheet: ASTM A 167, Type 316, soft annealed, mill finish, except where harder temper is required for forming or performance; minimum 2mm thick, unless otherwise indicated.

## **7.8 Concealed Through-Wall Sheet Metal Flashing**

Material: Fabricate from the following metal:

- i. Alum alloy 2.5mm thick.
- 
- A. General: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counter flashing pieces and compatible with flashing indicated.
  - B. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers and with channel for sealant at top edge.
  - C. Stucco Type: Provide with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
  - D. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
  - E. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
  - F. Flexible Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counter flashing or where Drawings show reglet without metal counter flashing.

## **7.9 Miscellaneous Materials and Accessories**

- A. Fasteners: Same metal as sheet metal flashing or other noncorrosive metal as recommended by sheet metal manufacturer. Match finish of exposed heads with material being fastened.
- B. Asphalt Mastic: SSPC-Paint 12, solvent-type asphalt mastic, nominally free of sulfur and containing no asbestos fibers, compounded for 15-mil dry film thickness per coat.
- C. Mastic Sealant: Polyisobutylene; nonhardening, nonskinning, nondrying, nonmigrating sealant.



- D. Elastomeric Sealant: Generic type recommended by sheet metal manufacturer and fabricator of components being sealed and complying with requirements for joint sealants as specified in Section 07900 – Joint Sealants.
- E. Adhesives: Type recommended by flashing sheet metal manufacturer for waterproof and weather-resistant seaming and adhesive application of flashing sheet metal.
- F. Polyethylene Underlayment: ASTM D 4397, minimum 6-mil- thick black polyethylene film, resistant to decay when tested according to ASTM E 154.
- G. Metal Accessories: Provide sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of Work, matching or compatible with material being installed; noncorrosive; size and thickness required for performance.

#### FABRICATION, GENERAL

- A. Sheet Metal Fabrication Standard: Fabricate sheet metal flashing and trim to comply with recommendations of SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of the item indicated.
- B. Comply with details shown to fabricate sheet metal flashing and trim that fit substrates and result in waterproof and weather-resistant performance once installed. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
- C. Form exposed sheet metal Work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems.
- D. Seams: Fabricate nonmoving seams in sheet metal with flat-lock seams. Tin edges to be seamed, form seams, and weld.
- E. Seams: Fabricate nonmoving seams in aluminum with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
- F. Expansion Provisions: Space movement joints at maximum of 3m with no joints allowed within 600mm of corner or intersection. Where lapped or bayonet-type expansion provisions in Work cannot be used or would not be sufficiently weatherproof and waterproof, form expansion joints of intermeshing hooked flanges, not less than 25mm deep, filled with mastic sealant (concealed within joints).
- G. Sealed Joints: Form non expansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
- H. Separate metal from non compatible metal or corrosive substrates by coating concealed surfaces at locations of contact with asphalt mastic or other permanent separation as recommended by manufacturer.
- I. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of sheet metal exposed to public view.

- J. Fabricate cleats and attachment devices from same material as sheet metal component being anchored or from compatible, noncorrosive metal recommended by sheet metal manufacturer.
  - i. Size: As recommended by SMACNA manual or sheet metal manufacturer for application but never less than thickness of metal being secured.

#### **7.10 Sheet Metal Fabrications**

- A. General: Fabricate sheet metal items in thickness or weight needed to comply with performance requirements but not less than that listed below for each application and metal.

#### **7.11 Examination**

- A. Examine substrates and conditions under which sheet metal flashing and trim are to be installed and verify that Work may properly commence. Do not proceed with installation until unsatisfactory conditions have been corrected.

#### **7.12 Installation**

- A. General: Unless otherwise indicated, install sheet metal flashing and trim to comply with performance requirements, manufacturer's installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Anchor units of Work securely in place by methods indicated, providing for thermal expansion of metal units; conceal fasteners where possible, and set units true to line and level as indicated. Install Work with laps, joints, and seams that will be permanently watertight and weatherproof.
- B. Install exposed sheet metal Work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
- C. Roof-Edge Flashings: Secure metal flashings at roof edges according to FM Loss Prevention Data Sheet 1-49 for specified wind zone.
- D. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Prein edges of sheets to be soldered to a width of 1-1/2 inches, except where pretinned surface would show in finished Work.
  - i. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux & spatter from exposed surfaces.
- F. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards. Fill joint with sealant and form metal to completely conceal sealant.
  - i. Use joint adhesive for nonmoving joints specified not to be soldered.

- G. Seams: Fabricate nonmoving seams in aluminum with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
- H. Separations: Separate metal from noncompatible metal or corrosive substrates by coating concealed surfaces, at locations of contact, with asphalt mastic or other permanent separation as recommended by manufacturer.
- I. Counterflashings: Coordinate installation of counterflashings with installation of assemblies to be protected by counter flashing. Install counter flashings in reglets or receivers. Secure in a waterproof manner by means of snap-in installation and sealant, lead wedges and sealant, interlocking folded seam, or blind rivets and sealant. Lap counter flashing joints a minimum of 2 inches and bed with sealant.
- J. Roof-Drainage System: Install drainage items fabricated from sheet metal, with straps, adhesives, and anchors recommended by SMACNA's Manual or the item manufacturer, to drain roof in the most efficient manner. Coordinate roof-drain flashing installation with roof-drainage system installation. Coordinate flashing and sheet metal items for steep-sloped roofs with roofing installation.
- K. Equipment Support Flashing: Coordinate equipment support flashing installation with roofing and equipment installation. Weld or seal flashing to equipment support member.

### **CLEANING AND PROTECTION**

- A. Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.
- B. Provide final protection and maintain conditions that ensure sheet metal flashing and trim Work during construction is without damage or deterioration other than natural weathering at the time of Substantial Completion.

## **8 Roof Insulation**

Providing and laying roof insulation with 80 mm thick impervious sprayed, closed cell free Rigid Polyurethane foam over deck insulation conforming to IS - 12432 Pt. III (density of foam being 40-45 kg/ cum), over a coat of polyurethane primer applied @ 6-8 sqm per litre, laying 400 G polythene sheet over PUF spray and providing a wearing course of 40 mm thick cement screed 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 20 mm nominal size) in chequered rough finish, in panels of 2.5 m x 2.5 m and embedding with 24 G wire netting and sealing the joints with polymerized mastic, all complete as per direction of Engineer-in-Charge.

### **8.1 Reference Code : IS: 12432**

#### **General**

Rigid urethane foam is a generic; name given to polyurethane (PUR) or polyisocyanurate (PIR) rigid foam. These are high efficiency thermal insulation material suitable for use on surfaces operating within the temperature range of -180 to 110°C for PUR and -180 to 140°C for PIR. When applied by

spray application processes, the service temperature range is restricted to -30 to +120°C for both the materials.

- a) In all cases of overdeck insulation where there is a parapet wall or an upstand around the roof, effectiveness of junction between roof and vertical portion would be ensured by continuing the treatment to a vertical extension of 0.5 m, Min around the roof perimeter. Such extra area are to be measured.
- b) For treatments on vertical areas of overdeck insulation. a multiplication factor of 1.2 shall be applied to the actual area to account for rebound losses! over thickness.
- c) To account for ex-cess rebound losses in underdeck PURIPIR Spray insitu application. measured area shall be subject to a multiplication factor of 1.4.
- d) Spray treatment is applied as a continuous treatment and hence no deductions shall be made in measurements for cutouts having area of one square metre or less.

## 8.2 Application :

- i. Manufacturer's application instructions should be followed at all times. Only qualified applicators with prior experience of spraying the specified foam system should be deployed. Prior to application of the spray foam, the contractor shall apply a test area on the surface to be insulated. This area shall be checked for:
  - a) Local surface roughness
  - b) General foam surface appearance; c) Specified foam thickness
  - d) Foam quality, such as striations, voids, uniform cells
  - e) Foam adhesion
- ii. The panel with the accepted/approved foam shall be treated as the standard for the subsequent implementation of the foaming work.
- iii. The foam shall be applied to roof substrate at a surface temperatures in the range of 15°C to 50°C in 12 mm thick (minimum) passes to reach the desired over all thickness with -3 to +10 nun tolerance. The substrate temperatures stated above may vary depending upon the foam system selected. In areas where obstacles do not permit normal spray techniques and the application tolerances specified above can not be met, the contractor may apply the specified minimum thickness of foam required by a suitable method that he shall select. However, the completed application of foam shall be rendered monolithic with adjacent areas where normal spray application is applied. All foam over roofs of buildings or tanks shall be applied in such a manner as to provide easy drainage of water and prevent ponding.
- iv. Extreme caution shall be taken to prevent spraying in the presence of water/moisture (rain, fog, condensation) as well as when wind velocities are greater than 25 km/h. Shielded scaffolds may be used to allow spraying in high wind velocities with client's approval.
- v. The equipment shall be operated with the temperature settings within the range specified by the foam manufacturer.

- vi. Compressed air sources shall have moisture traps. Before spray application begins, all hoses and guns shall be solvent-flushed and inspected to ensure that no moisture is present.
- vii. All flames, sparks, welding and smoking shall be prohibited in the application area.
- viii. All affected items, in the surrounding area, shall be protected from over spray. Spray guns must be held near perpendicular to the surface being insulated and pressures adjusted so that over spray is minimized.
- ix. The applicator shall keep with him on the scaffolding or on the roof, or in both locations, sufficient buckets, plastic film, etc, to enable him to discharge any test foam without causing unwanted deposition on the application area.
- x. Care is required when spraying on roof surfaces through which chimneys/ducts/pipes penetrate when their temperature exceeds the maximum service temperature limit of foam. An appropriate hot face insulating material 25 to 50 mm in thickness shall be installed prior to foam application in the area. approximately 600 mm x 600 mm on the surface surrounding all such hot chimney inlet or outlet lines, or any area where hot spots are likely.

### **8.3 Coating :**

When foam is exposed to the weather/ultra-violet rays, or used in areas where water will accumulate, or in a corrosive atmosphere, a protective coating is necessary. Since coating performance is highly dependent on the applied film thickness, appropriate minimum film coatings should be ensured.

Coatings shall be polyurethane based for best compatibility with the sprayed foam and shall be applied within 24 h of completion of spraying application. Brush applied high solid build coatings of 0.5 mm to 1 mm, DFT (Typical) preferably single component moisture cure type are best suited to provide protection to the sprayed foam. Most of these coatings can be spray applied using airless guns as well.

Coatings which are suitable include chlorosulphonated polyethylene based solvent bearing products and high solid acrylic latex coatings. When non-urethane based coatings are used, there may be need for a primer. In each case, it must be ensured that:

- a) Coating is elastomeric
- b) Dry film thickness of coating is not less than 0.75 mm.

### **Anti-termite Treatment – Buildings over Ground/Basements.**

Providing and injecting chemical emulsion for pre-constructional anti-termite treatment and creating a chemical barrier under and around the column pits, wall trenches, top surface of plinth filling

junction of wall and floor along the external perimeter of the building, expansion joints, surrounding of pipes, conduits etc. complete.

**Note:** The anti-termite treatment shall be got carried through an approved and registered agency and strictly in accordance with IS:6313 Part -II:1981. (Contractor shall get approved from EIC the specialized firm engaged for this job before start of the work). (Contractor shall furnish 5 years guarantee against defects).

**TECHNICAL SPECIFICATIONS**

**PLUMBING (SEWERAGE, STORM WATER & WATER) WORKS &  
COMPOST PLANT  
SECTION – 4**

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<b>CODES &amp; STANDARDS</b>		
<b>S. No.</b>		<b>Code Name</b>
1	IS:1729	Specification for sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
2	IS:1536	Specification for centrifugally cast (spun) iron pressure pipes for water, gas and sewage
3	IS:1538	(Part-I to XXIII) Specification for cast iron fittings for pressure for water, gas and sewage
4	IS:3714	Code of practices for laying C.I. pipes
5	IS:782	Specification for caulking lead
6	IS:1239(Part-II)	Specification for mild steel tubes, tubular and other wrought steel filling
7	IS:1879	Specification for malleable cast iron pipe fittings
8	IS:4984	High-density polythene pipe for potable water supplies, sewage and Industrial effluents
9	IS:783	Width and depth of trench for R.C.C. pipes
10	IS:4127	Width and depth of trench for S.W. pipes
11	IS:780	Specification for sluice valve for water works purposes
12	IS:651	Specification for salt glazed stoneware pipe and fittings
13	IS:7558	Code of practice for domestic hot water installation
14	IS:1742	Code of practice for building drainage
15	IS:2064	Code of practice for selection, installation and Maintenance of Sanitary appliances
16	IS:2065	Code of practices for water supply in building
17	IS:2183(Part-I)	Code of practice for Plumbing in multistoried buildings.
18	IS:1239	Specifications for mild steel tubes 48ubular and other wrought steel fittings (Fifth Revision)
19	IS:778	Specifications for copper alloy gate, globe and check valves for water works purposes
20	IS:5312 (Part-I)	Specifications for swing check type reflux (Non return) Valve
21	IS:3114	Code of Practice for laying of C.I. pipes (2nd Rev.)
22	IS:456	Code of practice for plain and reinforced concrete (3rd Rev.) (Amendment 2)
23	IS: 12820	Code of practice for dimensional requirements of rubber gaskets for mechanical joints and push on joints for use with cast iron pipes and fittings for carrying water, gas & sewage
24	IS: 1172	Code of basic requirements for water supply, drainage & sanitation (4th Rev.)
25	IS: 1200 Part 16	Code of practice for methods or measurements of Building and Civil Engineering works: Laying of water and sewer lines including appurtenant items (3rd Rev.)

26	IS: 1200 Part 19	Code of practice for methods or measurements of building and Civil Engineering Water supply, works Plumbing and drains (3rd Rev.)
27	IS:3989	Centrifugally cast (spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories (2 <sup>nd</sup> rev.) (Amendment 2)
28	IS: 13095	Butterfly valves for general purposes
29	IS:458	Precast Concrete pipes (with or without reinforcement) (3rd rev.) (Amendment 2)
30	IS: 1726	C.I. Manhole covers & frames (3rd rev.)
31	IS:1916	Steel cylinder pipe with concrete lining and coating (1st rev.)
32	IS: 12592 (Part 1)	Pre-cast concrete manhole covers and frames Covers (Amendment 3)
33	IS: 12592 (Part 2)	Pre-cast concrete manhole covers and frames
34	IS:6392	Steel pipe flanges (Amendment 1)
35	IS:6418	C.I. and malleable C.I. flanges for general engineering Purposes
36	IS:4985	Unplasticized PVC pipes for potable water supplies (2 <sup>nd</sup> Rev) (Amendment 2)
37	IS:7181	Horizontally cast double flanged pipes for water, gas and sewage (1st Rev.) (Amendment 1)
38	IS:210	Grey iron casting (4th Rev.)
39	BS EN 1057	Copper pipes
40	BS EN 1254	Copper Fittings
41	I&4985	UPVC pipes
42	IS: 15778	CPVC pipes
43	IS:8329	Ductile iron

**PLUMBING (SEWERAGE, STORM WATER & WATER) WORKS & COMPOST  
PLANT – TECHNICAL SPECIFICATION**

**1.0 Plumbing & Sanitary**

**1.1 Measures**

1.1.1 100% of total treated water available on-site reused within the project site.

1.1.2 Recharge of rainwater runoff into aquifer shall be carried out through appropriate filtration measures to remove minimum 80% Total Suspended Solids.

1.1.3 Water Fixtures in Toilets: Water demand shall be reduced through selection of low-flow fixtures by minimum 50% over the following GRIHA baseline flow rates:

	<b>Fixtures</b>	<b>Max. Flow rates</b>
1	Water Closets	2/4 LPF
2	Kitchen Faucets	4 LPM
3	Urinals with Sensors	1 LPF
4	Lavatory faucets	4 LPM
5	Shower head	8 LPM

1.1.4 Water Monitoring: Regular monitoring of project's water consumption shall be carried out by installing digital meters at the following point sources:

- Municipal Supply
- Treated water outlet from STP
- Each building level
- Irrigation
- Cooling Tower
- STP/WTP
- Domestic and flushing water connection to buildings.

**1.2 General**

The scope of works for all plumbing works and system comprises Designing, supply, execution, delivery, installation, testing and commissioning, handover, training, maintenance and warranty all as described or reasonably implied in the Contract. The Contractor is obliged to provide fully functioning works and systems in conformance with the requirements of the Contract. In the event certain items are not fully described or indicated in the Contract, but deemed essential by the IRCON

Consultant for the performance of the works and systems, then the provision of such items shall form part of the Contractors scope of works at no additional cost to the Employer.

Shop drawings shall take into account actual measurement and setting out dimensions/levels obtained and determined by the Contractor on site, actual equipment/material used, actual routing of services, co-ordination with all installation, and site conditions/constraints.

### **1.3 Scope of Works for Plumbing and Sanitary Installation**

The scope of work mention here under are broad scope of work, however its contractor responsibility to make proposed development fully functional meeting performance specifications.

- Connections from NDMC water lines.
- Water treatment units [FOR COOLING TOWERS]
- Pumps, Equipment's, Pipes, Valves and accessories
- Pumping mains and connections to underground water tank
- Centifugal Pumps for transfer of water from UG tanks to OH Tanks. Flow from OH Tanks under gravity.
- Soil, Waste and Vent pipes
- Terrace Rain water /Surface drainage system
- Sewerage and Drainage networks
- Connection to the Municipal sewer/Storm Water for Over Flow
- Modular Rain water Harvesting System
- Level indicators for UG tanks/Controllers for auto operations of pumps
- High / Low level alarm signals to the Building Management / Automation System for all water tanks
- Bio Waste Compost Plant
- All associated electrical works as per electrical specifications.
- All interfacing works with the Building Management System for remote control and monitoring.

### **1.4 Equipment and Materials**

Provide products and materials that are new, clean, free of defects, and free of damage and corrosion.

Maintain uniformity of manufacturer for equipment used in similar application and sizes.

Energy consuming equipment shall meet GRIHA requirements & local energy ordinances and by-laws.

### **1.5 Equipment Selection**

The capacities of all plant and equipment described in the drawings are minimum capacities and the Contractor shall take into account of the offered equipment capacities to meet the performance requirement in the Contract and actual installation requirements.

Physical sizes of all plant and equipment shall suit the space allocated, taking into account the requirement for access and proper maintenance.

Any proposal to deviate from the Specification and Drawings is subject to the IRCON / Consultant approval at his sole discretion. Upon approval, any necessary changes to the designing and installation as a result of these deviations shall be the responsibility of the Contractor.

Proposed equipment shall be submitted for approval to the IRCON / Consultant before ordering is placed. All necessary information requested by the IRCON / Consultant for the review of the proposal shall be submitted.

## **1.6 Excavation and Backfill**

Provide trenches details, duly approved by the IRCON / Consultant with all relevant section etc. as per IS codes.

The trench shall be of widths necessary for the proper execution of the work. Grade bottom of the trenches accurately to provide uniform bearing and support the work on undisturbed soil at every point along its entire length.

Excavate trenches for utilities that will provide the following minimum depths of cover from existing grade or from indicated finished grade as required by local authorities.

Trenches should be avoided within 3 meters of foundation or soil surfaces which must be resist horizontal forces.

Do not backfill until all required tests have been performed and installation observed by the IRCON / Consultant. Comply with the requirements of other sections of the specifications. Backfill shall consist of non-expansive soil with limited porosity. Deposit in 15 cm layers and thoroughly and carefully tamp until the work has a cover of not less than 30 cm. Backfill and tamp remainder of trench at 30 cm intervals until complete. Uniformly grade the finished surface.

## **1.7 Supports**

Provide supports, hangers, auxiliary structural members and supplemental hardware required for support of the work.

Provide supporting frames or racks extending from floor slab to ceiling slab for work indicated as being supported from walls where the walls are incapable of supporting the weight.

Provide supporting frames or racks for equipment, which is installed in a free standing position.

Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members, rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workman like arrangement of all equipment mounted on them.

## 1.8 Fastenings

Fasten equipment to building in accordance.

Where weight applied to the attachment points is 45 kg or less, conform to the following as a minimum:

1.	Concrete and solid masonry	Bolts and expansion shields
2.	Solid metal	Machine screws in tapped holes or with welded studs

Where weight applied to the building attachment points exceeds 45 kg, but is 135 kg or less, conform to the following as a minimum:

At concrete slabs provide Hilti or equivalent fasteners.

Wall mounted equipment will be directly secured to wall by means of steel fasteners.

## 1.9 Spare Parts and Tools

The Contractor to submit with his Tender his recommended lists of spares parts for one year operation and maintenance covering all systems and sub-systems of the specification. This list should be priced and the price fixed so that the Employer can, at his discretion, order these spare parts in part or in whole at any time up to the issue of the Performance Certificate without any increase in price.

## 1.10 Samples

Samples showing fabrication techniques, quality and workmanship of component parts, compatibility of accessories shall be submitted for approval, upon request by the IRCON / Consultant.

## 1.11 Warranties

The Contractor shall warrant that the capacity, rating or duty of all equipment used in the installation shall not be less than approved. Equipment/system not meeting this requirement shall be rejected.

## 1.12 Painting

Under Ground: All metal surfaces requiring painting shall be provided with two coats of asphalt aluminum paint, primer coated, and one coat of finished paint.

Exposed surface primer – zinc chromate. Final paint – 2 coats enamel.

No painting shall be done on damp surfaces.

Colour scheme as per IS shall be adopted.

### **1.13 Safety Equipment and Notices**

Solid rubber insulated mats complying with relevant IS codes in front of and extending the full length of the control panel/switchboards.

A copy of the main single line diagram, varnished and mounted on suitable hard backing and framed (in glass panel), showing clearly the full details of the electrical and Plumbing & Sanitary systems as supplied and installed.

Any other Notices as required by all local Authorities.

### **1.14 Progressive Record/As-Built Drawings**

As-built drawings shall be submitted prior to the issue of Taking over Certificate by the IRCON / Consultant.

As-fitted schematic system diagrams, properly framed, shall also be provided and mounted on the wall inside each plant room.

Submission of approved "as-built" or "as manufactured" drawings shall be in the following manner-

One (1) set of special quality plastic film transparency for all drawings;

Two (2) sets of computer soft copy in CD ROM;

Three (3) bound sets of paper prints for all drawings

### **1.15 Testing and Commissioning**

The Contractor shall be responsible for obtaining all necessary licenses as required by all relevant authorities before operation of any equipment/system.

All testing and commissioning to enable proper operation of the works shall be completed to the satisfaction of the IRCON / Consultant before the issuance of Taking Over Certificate.

All final adjustments and final balancing of the equipment/system operation shall be completed before the Date of Taking over Certificate.

The Contractor shall arrange for all submissions to Authorities and pay the cost of statutory inspections and certificates.

### **1.16 Attendance to Occupation Permit Application**

The Contractor shall provide all necessary attendance to inspections by the IRCON / Consultant and authorities for the purpose of Occupation Permit application.

### **1.17 Operation and Maintenance Instructions Manual**

The Operation and Maintenance Instruction manual shall be in A4 size paper and be bound in rigid covers covered and engraved with lettering giving the Employer's name, project name, IRCON / Consultant name.

Final draft manuals must be submitted for the IRCON / Consultant review before Taking Over Certificate is issued. After acceptance by the IRCON / Consultant, the Contractor shall submit Three sets and a soft copy of this manual for record before Taking Over certificate is issued. In general, each manual shall consist, but not be limited to the following section:-

#### **Technical Specification**

Schedules of equipment showing quantities, locations, types, operating duties.

Technical description of all systems and equipment, including circuit diagrams of each printed circuit board and component layout diagram for each printed circuit board installed for this project.

Wiring diagrams.

Manufacturer's drawings.

Equipment list, stating the make, model, serial number, accepted settings (after commissioning).

Catalogues, certificates and performance data sheets for all equipment.

#### **Maintenance**

To Provide: -Inspection manual for all system/equipment; Operation manual for all system/equipment;

Procedure of changing components of equipment requiring regular replacement;

Maintenance instructions, calibration procedures and fault finding instructions for all systems;

Procedures for system fault finding.

#### **Organization of Maintenance Team**

Provide detailed organization of the Maintenance team deployed for the Defect Notification Period with names and CV's, of all key staff. Contact telephone or pager numbers for emergency and/or twenty-four (24) hour call shall also be included.

### **1.18 Defect Notification Period**



Defects Notification Period 12 months. The period commencing on the date of issue of the Taking-Over Certificate. During the Defect Notification Period, the Contractor shall provide a 24-hour 'call-out' service to repair any equipment that has broken down.

Immediately answering the breakdown calls, the Contractor shall attend to such calls within a maximum time limit of 2 hours during night and 1 hour during daytime of receiving such calls.

## **2.0 Sanitary Fixtures**

### **2.1 Hand Drier**

The hand drier shall be no touch operating type with solid state time delay to allow user to keep hand in any position.

The hand drier shall be fully hygienic, rated for continuous repeat use (CRU).

The rating of hand drier shall be such that time required to dry a pair of hands up to wrists is approximately 30 seconds.

The hand drier shall be of wall mounting type suitable for 230 V, single phase, 50 Hz, AC power supply.

### **2.2 Toilets for Handicapped**

Washroom facilities designed to accommodate physically disabled, accessories shall be provided as directed by IRCON / Consultant.

Stainless steel garb brass of required size suitable for exposed mounting and opened non-slip gripping surface shall be provided in all washroom. The flushing cistern/valve shall be provided with dual plate cover.

### **2.3 Mock-up and Trial Assembly**

The installation of the Sanitary fixtures and fittings shall be as per the shop drawings approved by the IRCON / Consultant.

The contractor shall have to assemble at least one set of each type of sanitary fixtures and fittings in order to determine precisely the required supply and disposal connections. Relevant instructions from manufacturers shall be followed as applicable. This trial assembly shall be developed to determine the location of puncture holes, holding devices etc. which will be required for final installation of all sanitary fixtures and fittings. The above assembly shall be subject to final approval by the IRCON / Consultant.

The fixtures in the trial assembly can be re-used for final installation without any additional payments for fixing or dismantling of the fixtures.

## **2.4 Supporting and Fixing Devices**

The contractor shall provide all the necessary supporting and fixing devices to install the sanitary fixtures and fittings securely in position. The fixing devices shall be rigidly anchored into the building structure. The devices shall be rust resistant and shall be so fixed that they do not present an unsightly appearance in the final assembly SS:304 Nut Bolts & screw.

## **2.5 Final Installation**

The contractor shall install all sanitary fixtures and fittings in their final position in accordance with approved trial assemblies. The installation shall be complete 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.

## **3.0 Soil, Waste, Vent & Rain Water Pipes**

### **3.1 Scope**

The scope of this section comprises the supply, installation, testing and commissioning of internal drainage services.

### **3.2 Internal Piping System**

Soil, waste and stack vent pipes in shafts, ducts and in concealed areas i.e. false ceilings etc. shall consist of cast iron pipes & fittings as called for. In general wastes and vents smaller than and upto 50mm dia shall be of uPVC 6 kg/cm<sup>2</sup>.

The soil pipes shall be circular with a minimum diameter of 100mm. Pipes shall be fixed by means of stout GI clamps in two sections, bolted together, built into the walls, wedged and neatly jointed as directed and approved by the IRCON / Consultant. All bends, branches, swan neck and other parts shall conform to the requirement and standards as described for the pipes.

The soil pipes shall be continued upwards without any diminution in its diameter, without any bend or angle to the height shown in the drawings. Joints throughout shall be made with drip seal as described under jointing of cast iron pipes. Soil pipes shall be painted as provided under 'painting'. The soil pipes shall be covered on top with cast iron terminal outlets as directed and approved. All vertical soil pipes shall be firmly fixed to the walls with properly fixed clamps, and shall as far as possible be kept 100mm clear of wall. Waste pipes and fittings shall be of cast iron. Pipes shall be fixed, jointed and painted.

Every waste pipe shall discharge through gully trap/master trap. The contractor will ensure that this requirement is adequately met with. Wherever floor traps are provided, it shall be ensured that at least one wash is connected to such floor traps to avoid drying of water seal in the trap. Ventilating pipes shall be of cast iron, conforming to the requirements laid down earlier. Anti-syphon vent pipes/relief vent pipes where called for on the drawings shall be of cast iron.

Access doors for fittings and clean outs shall be so located that they are easily accessible for repair and maintenance.

All the fittings used for connections between soil, waste and ventilation pipes and branch pipes shall be made by using pipe fittings with inspection doors for cleaning. The doors shall be provided with 3mm thick rubber insertion packing and when closed and bolted shall be air and water tight.

Where soil, waste and ventilating pipes are accommodated in shafts ducts, adequate access to cleaning eyes shall be provided. Fitting will be located at approximate 1m above F.L in shafts for easy maintenance.

Head (starting point) of drains and sewage / waste water sumps (as and where applicable) having a length of greater than 4 m upto its connection to the main drain or manhole shall be provided with a 80 /100 mm vent pipe.

### **3.4 Cast iron pipes and fittings - for all hanging/suspended, vertical and basement floors:**

#### **3.4.1 Cast Iron Pipes IS: 3989 / IS: 1729**

Cast iron pipes and fittings shall be of good and tough quality and dark grey on fracture. The pipes and fittings shall be true to shape, smooth and cylindrical, their inner and outer surface being as nearly as practicable concentric. They shall be sound and nicely cast, shall be free from cracks, taps, pinholes and other manufacturing defects.

The pipes and fittings shall conform to IS:3989 / IS:1729 as called for. Fittings shall be of required degree without access door. All access doors shall be made up with 3mm thick insertion rubber gasket of white lead and tightly bolted to make the fittings air and water tight.

All CIP pipes and fittings shall bear the manufacturer's name and ISI specification to which it conforms.

All pipes and fittings before installation at site shall be tested hydrostatically to a pressure of 0.45 Kg/sq. cm without showing any sign of leakage, sweating or other defects of any kind. The pressure shall be applied internally and shall be maintained for not less than 15 minutes. All these tests shall be carried out in the presence of the representative of the IRCON / Consultant. Alternatively a test certificate from manufacturers be obtained before dispatch of material to site.

#### **Cast Iron Specialties**

Cast iron specialty items such as deep seal floor traps, urinal traps, trap integral pieces with integral inlet/outlet connections, manhole cover with frame, chamber cover etc. shall be fabricated to suit individual location requirements. The contractor shall arrange the fabrication of these items from an approved source.

### **Drip Seal Joints:**

Drip seal (pipe joint sealant) shall be used for joining various diameters of C.I. pipes and specials. This sealant replaces the standard Drip seal caulked joints. The application is by homogenously mixing the two pack system in cold condition.

### **Application Procedure:**

Clean the pipe joints thoroughly to ensure it is free from any traces of oil, dirt or any other foreign body. Mix two parts of Drip Seal thoroughly with an iron flat to get a homogenous compound.

Spun yarn in the pipe joint as a filler and then take the required quantity of the compound and push it in the joint with a caulking tool, MS flat / damp finger uniformly all over to obtain a smooth and uniform joint. Dip the fingers in water every often to ensure the compound does not stick to the hands of the workmen, but this will ensure perfect sealing and the smooth surface for the joint cement. (The compound prepared from the two mixtures is to be used within 30 minutes). Precaution to be taken to wash hands thoroughly with soap before and after use. Preferably use disposable gloves for hand application.

## **3.5 UPVC Pipes**

Waste pipes of 50mm dia and below and where called for shall be PVC IS:4985

## **3.6 UPVC Pipes and Fittings**

The pipes shall be round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth, clean, free from grooving and other defects. The ends shall be cleanly cut and square with the axis of the pipe. The pipes shall be designed by external diameter and shall conform to IS:4985-1981 or IS:13592. The pipes shall be of Class-III; 6 Kg/sqm pressure rating or type B.

### Fittings:

Fittings shall be of the same make as that of pipes, injection moulded and shall conform to IS: 14735.

### Laying and Jointing:

Jointing for UPVC pipes shall be made by means of solvent cement for horizontal lines and 'O' rubber ring for vertical line. The type of joint shall be used as per site conditions / direction of the IRCON / Consultant.

## **External Sewer and Storm Water**

Double coiled wall HDPE Pipe for sewer and storm water will be IS:16098 Part-2.

All pipes and fittings to be HDPE manufactured to DIN 19535, DIN 19537, DIN 8074, DIN 8075 fittings to carry a BBA certificate No. 92/2796.

### **Installation**

All pipes and fittings to be fusion welded by either electro sleeve coupling or butt weld.

Fixed points must be provided at a maximum of 5 metre intervals and / or changes in direction. Intermediate sliding supports must be provided in accordance with the manufacturer recommendations / application technique manual

All operatives to be trained in welding and jointing techniques by the manufacturer.

### **Inspection & testing**

The work shall be inspected and tested during installation at agreed stages. All work which will be concealed shall be tested before it is finally enclosed.

Work to be inspected regularly by the manufacturer who is to verify compliance with manufacturer's installation guidelines

## **3.7 Cast Iron Class (LA) pipes for all areas -basement floors**

All drainage passing under building floor and passing through retaining wall shall be cast iron class (LA) pipes (IS : 1536)

Cast iron class (LA) pipe shall be such that they could be cut, drilled or machined. Pipe centrifugally cast pipe unlined water cooled moulds shall be heat treated in order to achieve the necessary mechanical properties and to relieve casing stress; provided that the specified mechanical properties are satisfied.

### **Material**

Cast iron pipe shall be centrifugally spun cast iron pipe and conforming to IS: 1536-1976

### **Fittings**

Fittings shall be used for cast iron class (LA pipes shall conform to IS: 1538-1976). Whenever possible junction from branch pipe shall be made by wyes.

All cast iron water main pipes and fittings shall be manufactured to IS:1536 of tested quality. The pipes and fittings shall either be spigot and socket type or as called for. The pipes and fittings shall be of uniform material throughout and shall be free from all manufacturing defects.

### **Joints**

Cast iron class (LA) pipe used for soil and waste pipes shall be jointed with drip seal joints sufficient skein of jute rope shall be caulked to leave minimum space of 25 mm for the drip seal, to be poured in.

### **Laying**

Fittings used for CI drainage pipe shall conform to IS:1538-1976. Wherever possible junction from branch pipes shall be made by a Y/tee.

### **Drip Seal Joints :**

Drip seal (pipe joint sealant) shall be used for joining various diameters of C.I. pipes and specials. This sealant replaces the standard Drip seal caulked joints. The application is by Homogenously mixing the two pack system in cold condition.

## **3.8 Installation of Soil, Waste & Vent Pipes (Internal)**

Soil, waste & vent pipes in shafts under the floors / suspended below slab shall consist of cast iron pipes. Waste pipes from bottle trap to floor/urinal traps for wash basin, urinal and sink shall be uPVC pipes and fittings.

All Horizontal pipes running below the slab and along the ceiling, shall be fixed on structural adjustable clamps, sturdy hangers of the design as called for in the drawings. The pipes shall be laid in uniform slope and proper levels. All vertical pipes shall be truly vertical fixed by means of stout clamps in two sections, bolted together, built into the walls, wedged and neatly jointed. The branch pipes shall be connected to the stack at the same angle as that of fittings. All connections between soil, waste and ventilating pipes and branch pipes shall be made by using pipe fittings with inspection doors for cleaning. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts. Where the horizontal run off the pipe is long or where the pipes cross over building expansion joints etc. suitable allowance shall be provided for any movements in the pipes by means of expansion joint etc. such that any such movement does not damage the installation in anyway.

### **Rainwater Pipes and Fittings**

#### **System description**

Rain water Syphonic system designed in accordance to EN 12056-3 including roof outlets, pipes and fittings with HDPE Pipes from gutters.

## **3.9 Traps**

### **3.9.1 Floor Traps**

Floor traps shall be 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).

### **3.9.2 Floor Trap Inlet /Hopper**

Bath room traps and connection shall ensure free and silent flow of discharging water. Contractor shall provide a special type of floor inlet fitting cast PVC pipe with one, two or three inlet sockets welded on side to connect the waste pipe. All joint between waste hopper and CI inlet socket shall be drip seal.

### **3.9.3 Floor Trap Grating**

Floor and urinal traps shall be provided with 100-150 mm square or round stainless steel gratings, with frame and rim of approved design and shape as approved by the IRCON / Consultant.

### **3.9.4 Cleanout Plugs**

#### Floor Clean Out Plug

Clean out plug for soil, waste or rain water pipes laid under floors shall be provided near pipe junctions bends, tees, "Y" and on straight runs at such intervals as required as per site conditions. Cleanout plugs shall terminate flush with the floor level. 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 GI socket. The socket shall be drip seal joined.

#### Cleanout on Drainage Pipes

Cleanout plugs shall be provided on head of each drain and in between at locations indicated as directed by IRCON / Consultant. Cleanout plugs shall be of size matching the full bore of the pipe but no exceeding 150 mm dia CO plugs on drains of greater diameters shall be 150 mm dia. Fixed with a suitable reducing adapter.

Floor cleanout plugs shall be cast brass.

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 galvanized sheets and angles with hinged type doors with fly nuts, gasket etc.

### **3.10 Pipe Protection**

Cast iron soil and waste pipes under floor in sunken slabs and in wall chases shall be encased in cement concrete 1:2:4 mix (1 cement : 2 coarse sand : 4 stone aggregate of 12 mm size) 10 cm bed and around.

### **3.11 Testing**

Testing shall be done in accordance with IS: 1172 and IS: 5329 except as may be modified herein under.

Entire drainage system shall be tested for smoke tightness 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 tests,

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

Before use at site all CI pipes shall be tested by filling up with water for at least 30 minutes.

After filling, pipes shall be struck with a hammer and inspected for blow holes and cracks. All defective pipes shall be rejected and removed from the site within 48 hours.

The entire installation shall be tested by smoke testing machine. The test shall be conducted after the plumbing fixtures are installed and all traps have water seal or by plugging the outlets with bellow plugs. Apply dense smoke keeping the top of stack open and observe for leakages. Rectify or replace defective sections.

After the installation is fully complete, it should be tested by flushing the toilets, running atleast 20% of all taps simultaneously and ensuring that the entire system is self draining, has no leakages, blockages etc. rectify and replace where required.

A test register shall be maintained and all entries shall be signed and dated by the Contractor and the IRCON / Consultant or his representative.

All pipes in wall chase or meant to be encased or burried shall be hydro tested before the chase in plastered or the pipe encased or burried.

## **4.0 Sewerage & Drainage System**

### **4.1 Scope**

The scope comprises the supply, installation, testing and commissioning of external drainage & sewage disposal services.

### **4.2 General Scheme**



The contractor shall install a drainage system to effectively collect, drain and dispose all soil and waste water from various parts of the buildings, appurtenances and equipment. The piping system shall finally terminate and discharge into the STP. The piping work mainly consists of laying of pipes. All piping shall be installed at minimum depth greater than 80 cm below finished ground level. The disposal system shall include construction of gully traps, manholes, intercepting chambers. The piping system shall be vented suitably at the starting point of all branch drains, main drains, the highest/lowest point of drain and at intervals as shown. All ventilating arrangements shall be unobstructive and concealed. The work shall be executed strictly in accordance with IS: 1742. The sewage system shall be subject to smoke test for its soundness as directed. Pipes shall be double wall coiled HDPE class with coupler and elastomeric sealing ring internal surface double wall non-issuance as per IS: 16098 (Part-2).

Sewer lines including earth work for excavation, disposal, back filling and compaction, pipe lines, manholes, drop connections and connections to the STP.

Storm water drainage: earth works for excavation, disposal, backfilling and compaction, pipe lines, manholes, catch basins.

5 minutes RCC storage tanks with pumping arrangement for discharging storm water above HFL of City Drains; in case HFL of city storm water drain is higher than internal IL.

### **General Requirements**

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

Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent authority.

Location of all manholes, etc shall be got confirmed from the 'IRCON / Consultant' before the actual execution of work at site.

**Sewer and Storm Water Pipes upto 1000mm:** Non Smooth External Surface Type-'B' Double Wall Corrugated PE pipes (Smooth Inner Wall) as per ISO 21138/IS: 16098 Part-2-2013.

Manhole for sewerage and storm water Manholes shall be HDPE prefabricated complying EN13598-2:2009 in-built ladder, Spacing of manholes. 30M c/c. CI heavy duty frame and Manhole cover shall be 560mm, double seal, frame to be fixed with cement concrete M-25 size 1200x1200x150mm around the cover.

### **4.3 Alignment & Grade**

The sewer and storm water drainage pipes shall be carefully laid to levels and gradients as per approved shop drawings. Great care shall be taken to prevent sand etc. from entering the pipes. The pipes between two manholes shall be laid truly in straight lines without vertical or horizontal undulations. The body of the pipes shall rest on an even bed PCC 100 thick in the trench for its length.

No deviations from the lines, depths of cuttings or gradients as called for on the drawings shall be permitted without the written approval of the IRCON / Consultant. All pipes shall be laid at least 100cms below the finished ground level or as called for on the drawings.

### **Trench Excavation**

The trenches for the pipes shall be excavated with bottoms formed to level and gradients as shown on the drawings or as directed by the IRCON / Consultant. In soft and filled in ground, the IRCON / Consultant may require the trenches to be excavated to a greater depth than the shown on the drawings and to fill up such additional excavation with concrete (1:4:8) consolidated to bring the excavation to the required levels as shown on the drawings.

All excavations shall be properly protected where necessary by suitable timbering, piling and sheeting as approved by the IRCON / Consultant. All timbering and sheeting when withdrawn shall be done gradually to avoid falls. All cavities be adequately filled and consolidated. No blasting shall be allowed without prior approval in writing from the IRCON / Consultant. It shall be carried out under thorough and competent supervision, with the written permission of the appropriate authorities taking full precautions connected with the blasting operations. All excavated earth shall be kept clear of the trenches.

### **Timbering of Sewer and Trenches**

The Contractor shall at all times support efficiently and effectively the sides of all the trenches and other excavations by suitable timbering, piling and sheeting and they shall be close timbered in loose or sandy starta and below the surface of the sub soil water level.

All timbering, sheeting and piling with their wallings and supports shall be of adequate dimensions and strength and fully braced and strutted so that no risk of collapse or subsidence of the walls of the trench shall take place.

The Contractor shall be held responsible and shall be accountable for the sufficiency of all timbering, bracings, sheeting and piling used and also for, all damage to persons and property resulting from improper quality strength placing, maintaining or removing of the same.

### **Trench Back Filling**

Refilling of the trenches shall not be commenced until the length of pipes therein has been tested and approved. All timbering which may be withdrawn safely shall be removed as filling proceeds. Where the pipes are unprotected by concrete hunching, selected fine material shall be carefully hand-packed around the lower half of the pipes so as to buttress them to the sides of the trench.

The refilling shall then be continued to 150mm over the top of the pipe using selected fine hand packed material, watered and rammed on both sides of the pipes with a wooden hammer. The process of filling and tamping shall proceed evenly in layers not exceeding 150mm thickness, each layer being watered

and consolidated so as to maintain an equal pressure on both sides of the pipe line. In gardens and fields the top solid and turf if any, shall be carefully replaced.

### **Removal of Water from Sewer, Trench etc.**

The contractor shall at all times during the progress of work keep the excavations free from water which shall be disposed by him in a manner as will neither cause injury to the public health nor to the public or private property nor to the work completed or in progress nor to the surface of any road or streets, nor cause any interference with the use of the same by the public.

If any excavation is carried out at any point or points to a greater width of the specified cross section of the sewer with its cover, the full width of the trench shall be filled with concrete by the contractor at his own expense and charges to the requirements of the IRCON / Consultant.

### **Width of Trench**

The IRCON / Consultant shall have power by giving an order in writing to the Contractor to increase the maximum width/depth for excavation and backfilling in trenches for various classes of sewer, manholes and other works in certain length to be specifically laid down by him, where on account of bad ground on other unusual conditions, he considers that such increased width/depths are necessary in view of the site conditions.

### **Drip Seal Joints:**

Drip seal PJS-43 (pipe joint sealant) shall be used for joining various diameters of C.I. pipes and specials. This sealant replaces the standard Drip seal caulked joints. The application is by Homogenously mixing the two pack system in cold condition.

### **Cast Iron Gully Trap**

Gully trap shall be cast iron conforming to IS: 3989/20. These shall be sound and free from visible defects such as fire cracks, or hair cracks. They shall give a sharp clear note when struck with light hammer. There shall be no broken blisters. Each gully trap shall have one CI grating of square size corresponding to the dimensions of inlet of gully trap. It will also have a water tight CI cover with frame inside dimensions 300 x 300mm the cover weighing not less than 4.5 kg and the frame not less than 2.7kg. The grating cover and frame shall be of good casting and shall have truly square machined seating faces.

### **Fixing of Gully Trap**

The excavation for gully traps shall be done true to dimensions and levels as indicated on plans or as directed by the IRCON / Consultant. The gully traps shall be fixed on cement concrete foundation 65cm square and not less than 10cm thick. The mix for the concrete will be 1:4:8. The jointing of gully outlet to the branch drain shall be done similar to the jointing of Pipes described earlier. After fixing

and testing gully and branch drain, a brick work of specified class in cement mortar 1:5 shall be built with a half brick masonry work round the gully trap from the top of the bed concrete upto ground level. The space between the chamber and trap shall be filled in with cement concrete 1:3:6. The upper portion of the chamber i.e. above the top level of the trap shall be plastered inside the cement mortar 1:3 finish with a floating coat of neat cement. The corners and bottom of the chamber shall be rounded off so as to slope towards the grating.

C.I cover with frame 300 x 300 mm (inside) shall then be fixed on the top of the brick masonry with cement concrete 1:2:4 and rendered smooth. The finished top cover shall be so as to prevent the surface water from entering the gully trap.

#### **4.4 HDPE (Pre Fabricated)**

The manhole shall be erected on a base concrete 1:3:6 of 150mm thickness for manholes upto 1500mm depth and 250mm thickness for manholes from 1500 to 2500mm depth and 300mm thickness manholes of depth greater than 2500mm.

##### **Drop Connection**

Drop connection shall be provided between branch sewer and main sewer in the main sewer itself in steep ground when the difference in invert level of two exceeds 60 cms of the required sizes. Drop connections from gully traps to main sewer in rectangular shall be made inside the manholes and shall have HDPE special types door bend on to top and heel rest bend at bottom connected by a HDPE pipe. The pipe shall be supported by holder bat clamps at 180 cms intervals with atleast one clamp for each drop connection.

Drop connections shall be made outside the manhole.

Drop connection made from vertical stacks directly into manholes shall not be considered as drop connections.

#### **4.5 Grease Trap**

##### **Size of Grease Trap**

The contractor shall design the grease trap as per no. of users for each kitchen. Work shall be executed as per approved shop drawings.

##### **Bed Concrete**

Shall be in 1:4:8 cement concrete 150 mm thick.

##### **Brick work**

Brick work shall be with best quality bricks in 1: 5 CEMENT MORTAR.

Baffle walls shall be of R.C.C

### **Finishing**

The walls of chamber shall be finished with white glazed tiles.

## **4.6 Chamber Covers**

Covers shall be of cast iron or MS chequered plate, covered with 1mm aluminium sheet on both sides.

C. I steps shall be provided at two corners of the chamber.

All Cast Iron and MS items shall be painted with two coats of bitumastic paint.

**Removable Stainless steel perforated trays;** and guide bars will be SS-304 Grade

## **4.7 Cast iron Manhole covers and Frame**

The heavy duty Cast Iron Manhole Cover and Frame shall conform to IS: 1726 and the grade. The cover and frames shall be cleanly cast and they shall be free from air and sand holes and from cold shuts. They shall be neatly dressed and carefully trimmed. All castings shall be free from voids whether due to shrinkage, gas inclusion or other causes. Covers shall have a raised checkered design on the top surface to provide an adequate non-slip grip.

The covers and frames shall be coated with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to a temperature of 63° C and shall not brittle as to chip off at a temperature of 0° C.

## **4.8 Testing**

The contractor shall carriage smoke test to the drain and sewer at his own expense.

A test register shall be maintained which shall be signed and dated by contractor and Owner's site representative.

RE-TEST shall be carried after repairs if required.

A test register shall be maintained which shall be signed and dated by contractor and owner's site representative.

## **5.0 Plumbing Valves**

## **5.1 Work Included**

Provide and install valves as approved by 'IRCON / Consultant' in shop drawing.

## **5.2 Scope of Work**

For flanged valves, provide companion flanges of same PSI rating/class of valve being used.

Provide all valves rated not less than 10kg/cm<sup>2</sup> working pressure.

Valves shall be ISI marked.

Valves upto 50mm dia shall be of gunmetal/bronze body with screwed ends and shall be provided with unions on both the sides for removal and repair, unless instructed otherwise.

Valves above 50mm dia shall be butterfly valves with flanged ends and shall be provided with flanges on both the sides for removal and repair.

Provide valves on all main branches of water supply as approved shop drawings. Provide all valves, check valves, PRV, strainers of same size as the pipes in which they are installed.

## **5.3 Gate Valves**

Gate valves shall be as per IS 778. The screwed female ends shall be to BSPT and flanged ends shall be to IS 778.

Gate valves upto 50 mm shall be of hand wheel operated with bronze body, with screwed in bonnet, non rising spindle and solid wedge, with threaded ends.

Gate valves larger than 50 mm shall be of cast iron body with bronze mountings and shall be provided with flanged ends.

## **5.4 Globe Valves**

Globe valves of size 40mm or less shall be as per IS 778 and of size 50mm or more shall be as per IS 780. The screwed female ends shall be to ASME B 16.11 and flanged ends shall be to ASME B 16.5. It shall have screwed in bonnet, rising spindle and gland packing.

All globe valves 50 mm and smaller shall be of bronze body with screwed in bonnet, rising spindle and with threaded ends.

All globe valves larger than 50 mm shall be of cast iron body with bronze mountings and shall be provided with flanged ends.

## **5.5 Ball Valves**

Ball Valves shall be of IS 9890, Gun metal with screwed female ends to IS 554, flanged ends to ASME B 16.5.

Provide full bore, quarter turn, lever operated ball valves with S/S ball and SS(AISI 410) spindle with Teflon seating and gland packing. All ball valves shall have locking handles to allow servicing and removal of equipment.

Provide lever handle with plastic sleeve on all ball valves unless otherwise noted. Provide extension stem for all ball valves to be installed on insulated piping.

## **5.6 Check Valves**

Check valves of size 40mm or less shall be as per IS 778 and of size 50mm or more shall be as per IS 780. The screwed female ends shall be to ASME B 16.11 and flanged ends shall be to ASME B 16.5.

All check valves 50mm and smaller shall be of bronze body and disc, threaded ends.

All check valves 65mm and larger shall be of slim line, swing type cast iron body with epoxy coated ductile iron/ stainless steel trim and shall be of flanged end.

All check valves shall be spring loaded.

## **5.7 Butterfly Valves – CI Double Flanged**

Butterfly valves shall be conforming to I.S 13095.

Butterfly valves shall be high performance valves manufactured of Cast iron/ Ductile Iron body, epoxy coated ductile iron / 316 stainless disc and stainless steel stem with EN-8/ SS-410 shaft.

Joints for double flanged butterfly valves shall be made with suitable tail/socket pieces on the pipeline and flanges joints made with appropriate number of bolts, nuts and washers with 3 mm thick insertion rubber gasket.

## **5.8 Sluice Valves**

Sluice valves shall be Cast Iron double flanged, with rising spindle. Each sluice valve shall be provided with wheel for valves in exposed positions and Cap Top for underground valves. Contractor shall provide suitable operating keys for Sluice Valves with Cap Tops.

Sluice valves shall be conforming to I.S: 780 of PN rating approved.

Sluice valves shall be high performance valves manufactured of Cast iron/ Ductile Iron body, epoxy coated ductile iron / 316 stainless disc and stainless steel stem with SS-410 shaft.

## **5.9 Pressure Reducing Valves (Bellow type)**

Pressure reducing valves shall be of Gun metal/bronze body with screwed female ends to BSP.

Pressure reducing valves shall have high quality Nitrile rubber "O" ring and setting pressure of 1-2Kg/cm<sup>2</sup> in the downstream side.

#### **5.10 Air Release Valves**

Air release valves shall be single acting type air valves with cast iron body and bronze/gunmetal internal parts and plastic float.

#### **5.11 Strainers**

Strainers shall be bucket type strainers with gunmetal/bronze body upto 50mm dia and CI body above 50mm dia. It shall have screwed female ends to BSPT, flanged ends to BS: 10, Table D and shall have perforated S/S(AISI-304) sheet with large screen area.

#### **Testing**

All pipes, fittings and valves shall be tested by hydrostatic pressure of min. 1.5 times the working pressure .

Pressure shall be maintained for a period of at least two hours without appreciable drop in the pressure after fixing at site. (+10%). A test register shall be maintained and all entries shall be signed and dated by IRCON / Consultant.

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.

After completion 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.

### **6.0 Hydropneumatic System**

#### **6.1 Scope**

The scope of work shall include the following:

Fixed speed pumping units for each motor, domestic water, flushing water supply & horticulture distribution and for cooling towers.

Suitably sized food grade quality, non-toxic diaphragm type pressure vessels complete with necessary interconnections and controls.

Control panel for pump control complete with variable speed drives, circuit breakers, MCB's, pressure transmitters etc. complete with all interconnections to pumps and electrical supply panels.



Pump control units complete with pre-programmed micro-processor chip.

Pump monitoring units to monitor operation of pumps.

Each Hydro Pneumatic Pumping unit shall be supplied as a complete set, pressure vessels suction and discharge common manifolds, non-return valves, isolating valves, pressure transmitters on the discharge side and level electrode at the suction tank. Each unit shall be provided with electronic microprocessors for unit control and all necessary electrical work.

Electrical equipment and installation work including the PLC in Control panel.

Provision of dry contacts to BMS indicating the status of the pumps and pressure vessel in form of hardware interfacing panels inside each pump room and control panels of all pumps.

Provision of all level switches, flow switches and other sensing devices for status indication.

All interfacing work with other trades.

Testing & commissioning and balancing of the Hydro pneumatic & Pumping system;  
Provisions of operating instructions and maintenance manuals;

## **6.2 Pumps for Drainage System**

### **Pumps**

Pumps shall be vertical or horizontal, centrifugal, multistage directly coupled to motor. Provision of pump with pump head & base of cast iron and other parts in SS 304 shall be made for pumps required in Hydropneumatic System. Impeller shall be hydraulically balanced and keyed to shaft. Pump shall be mounted on a concrete foundation, projecting at least 15 CM above finished floor level. The pumps base shall be set on a vibration elimination pad. The pump shall be selected for the lowest operating noise level and shall be complete with flexible connections, valves and pressure gauges.

The Contractor shall supply and install pumps of the type and performance as approved.

Pumps shall be so selected that the design duty point is within 5% of the maximum efficiency point.

Starting of pumps: (i) Low / High water level alarm shall be provided. (ii) Pumps working in tandem.

Pump curves for all pumps offered shall be submitted. All curve indicating excessive shut-off head will not be approved.

## **6.3 Motor Control Panel**

The motor control panel shall be equipped with all the necessary electrical components including a microprocessor control unit and a frequency drive. The control panel and the microprocessor shall cover the followings functions:

Flexibility and simplicity in allowing the necessary re-adjustment of the pumping system pre-set delivery pressure to operate the pumps within the specified maximum and minimum delivery ranges.

Built-in frictional loss compensation factor which will automatically increase the delivery pressure setting, in collaboration with the increase in flow demand. This shall be able to minimize the system pressure differences and provide a more constant pressure along the supply line and also to save the energy consumption of the motor when running at low speed.

Automatic changeover of the pumps to be controlled by the microprocessor.

Built-in clock functions with weekly programming and with switch on system to operate at least 10 different pre-set pressure points.

When the system has not been operated for more than 24 hours, it shall automatically start the pumps for a few seconds/day to ensure the pumps readiness at all times. The standby pumps shall be activated upon failure of duty pump(s). In event of control failure, the pumps shall be able to be start/stopped manually at the local panel by means of pressure switches.

To cut-off the pumping system when excess pressure is registered in the discharge common manifold.

The system shall have the capability of receiving input signal concerning reduced water level in suction tanks and shall have control mechanisms to prevent the pumps from running dry.

In case of pump failure due to motor overload, the standby pump is switched on automatically. Alarm signal is displayed on the LCD Display unit and alarm lights are activated.

Functions to limit the no. of start/stop of pumps per hour.

- LCD Display
- Pumps selections for pumps
- Pump status button to display duty pump speed and system capacity
- To display operating parameters for different pumping units.
- Setting button to input preset pressure, system start/stop time etc.
- $\pm 1$  button to key in numeric data such as pressure set point, etc.
- Enter button for confirmation of input into the system

- Alarm button to show location of fault - self diagnostic function display
- Hour Run measurement for each supplied pump set
- Buttons for scrolling to select the actual display reading for system configuration, i.e. up and down scroll concept.
- Manual Mode

#### **6.4 Pump Pressure Vessel –Diaphragm Type**

The pressure vessel shall be of capacity to accommodate fluctuation in water demand by the system with minimum start/ stop cycles of the pumps. The vessel shall be constructed of steel plate built to ASME Standards for Unfired Pressure Vessel. A rubber diaphragm shall be provided in the vessel for separating the water and pre-charge nitrogen. The pre-charge pressure shall be adjustable and charging port with non-return device shall be provided. The adjustable cut-in and cut-off pressure unit for the pumps shall be built-in at the vessel to suit the system.

#### **6.5 Floatless Type Level Switch For:**

High level alarm (over-flow);

Low level alarm;

Low level cut-out for raw water pumps;

Electrodes shall be of polished stainless steel 20 mm OD. Electrode holders shall be weatherproof in all respect.

Each set of electrodes shall be installed inside PVC pipe acting as a wave barrier.

The level switch set shall operate with a stepped down voltage at 24V maximum. Stepped down transformers shall be provided for each set of control probes and shall be installed inside centralised control cubicles inside pump room.

Mechanical steel stuffing boxes shall be used.

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

- Red "overflow level" indicator with buzzer for the associated water tanks;
- Amber "extra high water level" indicator for the associated water tank;
- Amber "high water level" indicator;
- Amber "low water level" indicator;
- Red "pump trip" indicator for each pump;

- Green "pump on" indicator for each pump;
- "Pump electrical supply healthy" indicator for each pump;
- Amber "remote/local" status indicator.

## **6.6 Submersible**

These shall be fully submersible with a fully submersible motor. The pumps shall be provided with an automatic level controller and all interconnecting power and control cabling which shall cause the pumps to operate when the water level in the sump rises to a preset level and stop when the preset low level is reached.

Pumps for drainage shall be single stage, single entry. Impeller clearance (i) sump pumps 10mm, (ii) Sewer pumps min. 38mm.

Pump shall be C.I. casing and C.I. dynamically balanced impeller connected to a common shaft of the motor. The vane for sewage pump will be open type, while for drainage pump, etc. it will be of semi open type.

Stuffing box shall be provided with mechanical seals.

Each pump shall be provided with a suitably rated induction motor suitable for 415 volts, 3 phase, 50 Hz A.C. power supply.

Each pump shall be provided with in built liquid level controller for operating the pump between predetermined levels.

The pumping set shall be for stationary application and shall be provided with pump connector unit. The delivery pipe shall be joined to the pump through a rubber diaphragm, and bend and guide pipe for easy installation.

Pump shall be provided with all accessories and devices.

Level control shall be such that one pump starts on required level, 2nd pump cuts in at high level and alarms is given at extra high level. All level controllers shall be provided with remote level indications.

## **7.0 Pipe Identification**

Identify with symbol identification and colour-code all piping. Provide directional arrows on circulating systems separate from and adjacent to each identification. Identification in conformance with the relevant IS standards.

Colour Coding: The following colour coding shall be used:

<b>Service</b>	<b>A.S.A. Colour background</b>	<b>Colour of Letter</b>	<b>Designation</b>
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Domestic Cold Water	Green	White	DCWS
Domestic Hot Water Supply	Green	White	DHWS
Make-up Water	Green	White	
Sanitary Sewer	Green	White	
Sanitary Sewer Vent	Green	White	
Rainwater	Green	White	
Sprinkler	Red	White	Sprinkler
Standpipe	Red	White	Standpipe

## **8.0 Water Treatment System & Accessories [For Cooling Towers]**

### **8.1 Scope**

Water treatment for cooling towers. The Contractor shall be responsible for carrying out water analysis for the raw water from tube well/Local agency so as to achieve the zero commercial hardness.

The Water Treatment System shall consist of feed pumps; back wash provisions with all accessories complete with all controls, softener and monitoring system, electrical panels, cabling, etc.

All the pipe work between the water tanks, soft water tanks and all the interconnecting pipe work amongst the Treatment pumps and other equipment shall be heavy duty GI.

Electrical equipment and installation work including the necessary wiring etc. in Control panel. Painting and labelling of pipe work and equipment;

Provision of dry contacts to BMS indicating the status of the pumps and pressure vessel in form of hardware interfacing panels inside each control panels of all pumps.

Provision of all level switches, flow switches and other sensing devices for status indication.

Testing and commissioning and balancing of the complete Water Softening system;

Provision of twelve (12) months maintenance and breakdown services including chemicals required.

## **8.2 Reverse Osmosis Plant and Water Coolers (Drinking Water)**

### **Scope**

To design and install the RO plant as per water quality at site and deliver treated water from the RO plant to water cooler. Sufficient contingency in the design shall be kept on account of variation in quality of raw water.

## **9.0 Design Parameter**

The reverse osmosis plant shall be designed for a minimum working of 12 hours per day.

## **10.0 Sewage Treatment Plant (Electro Mechanical Works)**

MBBR technology with water filtration and softening water plant for two numbers of STP of capacity 200 KL/Day for Station building and 250 KL/Day for office building.

### **10.1 Basis of Design –**

The capacity/ rating of pumps and equipment etc. shall hold good for the capacity of STP mentioned above and shall be good for meeting the treated parameters requirement as follows:

Permissible limit as prescribed in IS:2490 (Part-I)-1974 and environment (Protection) Rules 1986 with prevailing amendment.

Water (Prevention and Control of Pollution) Act, 1977 & 1978.

Environment (Protection) Act, 1986.

Environment (Protection) Rules, 1986 and to comply with output norms as directed by MOEF.

Hazardous Wastes (Management & Handling) Rules, 1989.

Manufacturer, Storage and Import of Hazardous Chemicals Rules, 1989.

Manufacturer, use import and storage and hazardous Micro-Organizers, Genetically IRCON / Consultant organizations or Cell Rules, 1989.

Manual on sewage & sewage treatment – CPHEEO

100% recycle of waste water and removal of sludge in cake form

Ultra filtration and water softening part for cooling towers as per requirement.

### **10.2 General**

The sewage treatment plant (STP) system outlined specifies the system design, manufacture, supply and installation Testing & Commissioning of MBBR (Movable Bed Bio Reactor) system acceptable to Water and Sanitation Authority Requirement, Local Pollution Control Board Norms, the local Environmental and Pollution Control Authorities and subject to the approval of the IRCON / Consultant.

The Contractor shall submit shop drawings, complete catalogue, design calculation complete with full technical data and shop drawings for the entire system, test certificates, etc. for acceptance prior to commencement of installation.

Contractor shall be responsible for all permissions from pollution department and any other Govt. Agency for all statutory approval to set up and operate the plant.

The Contractor shall submit analytical test reports of effluent water samples after the commissioning or after the system is put into operation:

First 3 months - 15 days

The report shall contain analysis of all data related to those requirements laid down by the local Authorities.

### **10.3 Design Criteria**

It shall be the Contractor's responsibility to ensure the quality of the treated effluent to comply with the local Authorities requirement and the following characteristics, whichever is stringent.

		<b>Units in Miligram per litre or otherwise stated</b>
1	Item of Analysis Colour	7 Lovibond units
2	pH value	7.1- 7.3
3	BOD(5dayat20°C)	<10
4	COD	<50
5	Total Suspended Solids	<20
6	Grease and Oil	<2
	Item of Analysis	Units in Miligram per litre
7	NH <sub>4</sub> -N	5
8	N - total	10
9	Turbidity (NTU/JTU)	< 1
10	Phosphate (P <sub>04</sub> )	1
11	E-coli	Nil
12	TDS	Max – 300 and commercial zero for soft water to be used for cooling towers.

The effluent from the Sewage Treatment Plant shall be suitably treated and the treated water recovered shall be used for Flushing, Gardening & landscape and HVAC after softening to commercial zero.

### **10.4 Process**

The treatment process shall comprise MBBR with tertiary treatment and softening:

### **10.5 Performance Criteria**

The treatment plant shall be designed to treat the following basic characteristic expected in the raw sewage.

Influent Waste Water Characteristics		
A	Estimated daily flow	200 Cum/day (For Admin+Dining+Staff Accomodation Block) 250 Cum/day (For Hostel blocks+all other blocks)
B	Peak factor	3.0
C	Expected peak flow	3 times of normal flow
D	Duration of flow to STP	24 hours
E	Annual mean Max.	Max. 43 Degree C
F	pH	7.15 – 8.2
G	Colour	Mild
H	Oil & Grease	10 – 50 mg/lit
I	Total suspended solids (mg/l)	250 to 350
J	BOD (mg/l)	200 to 250
K	COD (mg/l)	300 to 400

### 10.6 Inlet Screen Chamber

Raw sewage shall flow into the inlet screen chamber by gravity. Large solids particles shall be intercepted by an Coarse & fine step screen. A manual screen shall be installed in parallel with the screw screen as a standby screen when the step screen is under maintenance.

### 10.7 Equalization Tank

The equalization tank is designed to provide storage at peak flow. Min. 3 Nos. submersible pumps shall be provided with level switch control and automatic cut-in of the standby unit.

An aeration system shall be provided for mixing and aerating the sewage.

### 10.8 Air Blowers

Air blowers shall be provided in duplicate (i.e. one duty and one standby). Blowers shall be centrifugal with pressure vessle type complete with motor, base-plate, inlet filter, intake silencer and off-load starting system outlet silencer, anti-vibration damper, flexible coupling, filter restriction indicator, non-return valve, pressure relief valve, direct drive coupling. The casing rotor shall be of cast iron construction. Bearings and gears shall be grease lubricated. Motor speed shall be not less than 1500 rpm.

The size and performance of the air blower shall be so selected that it can provide a minimum air flow rate 0.4 I /sec / diffuser to 1/sec/d if user maximum, and to maintain a minimum of 2.0 mg/litres dissolved oxygen in the aeration tanks in operation.

### 10.9 Air Diffusers for Equalization, Sludge holding tank



Air diffusers shall be made to provide a uniform distribution of fine bubble air release performance in the system. The air diffuser shall be either made of elastomeric rubber membrane or composed of crystalline fused aluminium oxide with a suitable ceramic bonding material.

Diffuser shall be of self-cleaning, non-clog disc or dome-shaped type. Oxygen transfer efficiency shall not be less than 20% at 3.5m submergence in clear water. Alternatives may be offered for consideration.

Diffuser hold down assemblies shall consist of a retainer bolt, a matching washer and gasket. Sealing gasket shall be composed of solid neoprene rubber and shall be conform to ASTM D-2000 and shall be suitable for withstanding the effects of wastewater high temperature up to 120°C.

#### **10.10 Ultra Violet Treatment/Chlorination**

Waste water shall be passed through UV unit for disinfection. As standby measure chlorine solution shall be metered in to the effluent by an electric dosing pump paced according to the sewage inflow. The effluent shall be retained in the baffle walled chlorine tank for a minimum of 30 minutes for effective disinfection prior to discharge.

##### **Sewage feed, sludge transfer Pumps**

Minimum one standby pump for each function.

Non-submersible type centrifugal pump with suction grid and automatic discharge connection. Pump casing and impeller shall be of cast iron material. Shaft shall be of CS material.

##### **Sludge Transfer and Disposal Pumps (SCREW TYPE)**

Two numbers of sludge feed pumps to filter press (one duty and one standby)

##### **Chlorination System (Standby System)**

A chlorine contact tank (HDPE) with a capacity of not less than 30 min average flow detention shall be attached to the settling tank.

Chlorine feed system shall be furnished as a complete package assembly for installation in the plant room. Assembly shall include base plate, electronic positive displacement type chemical feed pump, fiberglass solution tank, suction and discharge tubing and fittings.

Each chlorine solution dosing pump shall perform to achieve a residue not more than 0.5 mg// in the treated effluent. Solution feed pump shall have a maximum capacity of 1 /hr chemical pump will operate on 50 Hz supply. Fiberglass solution tank shall be of no less than 100 litre capacity and include suction line fitted with strainer.

Control shall be by means of compound loop (i.e. flow proportional and residual measuring).

The feed pump shall be of variable speed positive displacement, solenoid-riven diaphragm metering type. The construction material shall be suitable for corrosive nature and as follows:

#### **UV Unit / System**

UV system for disinfection: Shall Utilize High purity quartz sleeves and high output UV lamps. UV Reactor MOC will be SS316L. System shall be designed to provide a UV dose of 600 J/m<sup>2</sup> at UVT of 65% and TSS less than 10 mg/L. System should deliver a 4 log reduction of coliforms and provide TC count to less than 200 CFU/100ml. The electrical control system should utilize high frequency electronic ballasts and provide efficiency of more than 90%. The reactor vessel shall utilize internal baffles to ensure turbulent and plug flow.

The UV intensity monitoring system shall be designed in accordance with the German DUGW W294 standard/US standard. The sensor shall be of dry type and removable without system shutdown.

**Valves – Flanged, SS for stainless outlet pipes for PVC Pipes**  
**GI – Cast Steel/Gun Metal**

### **10.11 Maintenance Facilities**

Permanent work platform and catwalk shall be designed by the Contractor and provided by the Contractor for access to elevated equipment. The catwalk and platform for access shall allow a minimum width of 1000mm.

Catwalk to maintenance platform shall be provided with railings and guards designed for safe movement of personnel in a restricted space including provision for gaining access and to accommodate maintenance personnel.

Hand railing and guards shall be designed by the Contractor and provided by the Contractor for all concrete tanks to allow safe movement of personnel.

Waterproof power sockets required for servicing shall be provided by the Contractor. The number and locations shall be proposed by the Contractor and approved by the IRCON / Consultant.

The design of all permanent work platform, hand rails, etc. shall be submitted to the IRCON / Consultant for approval. The loading and fixing method of lifting facilitate shall also be submitted to the IRCON / Consultant for approval and checking within 4 weeks on award of Contract or receipt of letter of intent.

### **10.12 Testing at hand over**

The performance of the system shall be demonstrated by taking hourly samples of the raw sewage and final effluent over a twelve-hour period. The sample shall be taken at periods approximately the flow rates specified by the plant. The sample shall be combined and a 5-day BOD shall be run, the results of which must verify the capacity of the treatment plant prior to acceptance.

## **11.0 Electrical Installation: As per electrical specifications**

### **11.1 General**

Work shall be carried out in accordance with the accompanying specifications and shall comply with the latest relevant Indian Standards and Electricity Rules and Regulations.

The configuration of the MCC shall be designed to suit the requirements of the process. The necessary Single Line diagrams/ Schematic drawings shall be furnished for approval by IRCON / Consultant/ Owner.

All motor control centers shall be CPRI approved and shall be suitable for operation on 3 phase/single phase 415/230 volts, 50 cycles power supply system.

### **11.2 Constructional Features**

Control panel: founder coated inclusions: 2 mm CRCA sheet, floor mounted.

Bus Bar – Sheathed aluminium energy meter – Incoming

Control power cables upto 10sqmm – copper

Power cable above – 10 mm – aluminium

Indicating lamps – LED

Incoming MCCB: 35 KA breaking capacity

Motor Protection – MCCB, 25 KA Railing

MCB's - 10 KA railing

Starters – DOL upto 7.5 HP

Soft starter alum 7.5 HP

### **11.3 Labels**

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the control panel shall be pasted on inside of the panel door and covered with transparent plastic sheet.

### **11.4 Indicating Lamp and Metering**

All meters and indicating lamps shall be in accordance with IS:1248 and IS-1258. The meters shall be flush mounted type. The indicating lamp shall be of low wattage. Each MCC and control 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. All phase indicating lamp shall be backed up with MCB.

### **11.5 Push Button Stations**

Push button stations shall be provided for manual starting and stopping of motors / equipment 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.

### **11.6 Drawings**

Shop drawings for control panels and for wiring of equipment showing the route of conduit & cable shall be submitted by the contractor for approval of IRCON / Consultant/IRCON / 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.

### **11.7 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 gotten approved by Electrical Inspector and a certificate from Electrical Inspector shall be submitted. All tests shall be carried out in the presence of IRCON / Consultant. Testing of the panels shall be as per relevant BIS Codes:

### **11.8 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 baked in an oven. The finishing treatment shall be by application of powder coating of approved shade.

### **11.9 Rubber Mat**

Rubber mat shall be provided in front to cover the full length of all panels. Where back space is provided for working from the rear of the panel, rubber mat shall also be provided to cover the full length of panel on the rear also.

### **12.0 Testing**

The entire works shall be fully tested in stages as the work proceeds and on completion of work as applicable.

The Contractor shall provide during normal working hours, all necessary labours, instruments, equipment, materials, fuel, power and maker's representatives, to carry out such tests as may be necessary to satisfy the IRCON / Consultant that the installation meets the requirement and intent of the Specification as well as such tests required by Local Authorities.

All tests shall be made in the presence of the IRCON / Consultant or any inspecting authority. At least seven working days' notice in writing shall be given to the inspecting parties before performing any test.

Three copies of all test results shall be submitted to the IRCON / Consultant in A4 size sheet paper within two weeks after completion of the tests.

Tests described hereinafter and including all tests prescribed by the Authority having jurisdiction shall be carried out. Any tests proved unsatisfactory shall be repeated to the satisfaction of the inspecting parties.

The Contractor shall provide skilled technicians/IRCON / Consultant to commission the plant and associated controls to the satisfaction of the IRCON / Consultant. The technicians/ IRCON / Consultant will be required to demonstrate the correct procedures in starting and stopping the plant, running the various items of equipment under automatic and manual control and the correct maintenance of the plant.

Water flow rates of all equipment shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.

## **12.1 Control Panels**

Contractor to submit test reports:-

- Inspection of switchboard including wiring, electrical and mechanical connections;
- Mechanical tests;
- Primary and secondary injection tests to commission and calibrate all measuring, protection and control circuits and associated components;
- Continuity and dielectric tests;
- Power frequency and pressure test;
- Functional check of all control wiring.

'Type-Test' and approval certificate for pressure test and compliance with the regulations laid down by the local Water Authority/IRCON / Consultant.

## **Hydrostatic Tests**

All parts of the water circuit shall be filled with water before hydrostatic pressure testing, and pump running tests for verification of pressure and flow rate, are conducted.

The hand jacking pump shall be applied to increase the system pressure to 2 times the working pressure and 1.5 times the working pressure plus 3.5 bar whichever is the lower but in any case not less than 7 bar. The pressure shall be maintained for a period not less than 24 hours.

Where any section of pipe work or equipment is found to be unable to withstand the maximum pipe work test pressure, it shall be isolated during the pipe work test then that section of pipe work or equipment shall be made good and re-tested at the appropriate test pressure.

The working pressure for various systems shall be as per shop drawings.

Drains shall be tested with dense smoke.

#### Cleaning, Flushing and Pre-Treatment

Prior to start-up and hydraulic testing of pressure pipes, the Contractor shall clean the entire installation including all fitments and pipe work and the like after installation. All pumping systems shall be flushed and drained at least once through to get rid of contaminating materials.

All strainers shall be inspected and cleaned out.

Pre-treatment chemical shall be introduced and circulated for at least 8 hours. Warning signs shall be provided at all outlets during pre-treatment. The pre-treatment chemical shall:

- a) Remove oil, grease and foreign residue from the pipe work and fittings;
  - b) Pre-condition the metal surfaces to resist reaction with water or air;
  - c) Establish an initial protective film;
  - d) After pre-treatment, the system shall be drained and refilled with fresh water and left until the system is put into operation.
  - e) Details and procedures of the pre-treatment shall be submitted to the IRCON / Consultant for approval.
- Pump Operating Test : To verify the capacity of pumps

## **12.2 Statutory Authorities' Tests and Inspections**

As and when notified in writing or instructed by the IRCON / Consultant, the Contractor shall submit shop drawing and attend all tests and inspections carried out by Local Pollution Control Board Authorities, Water Authority and other Statutory Authorities, and shall forthwith execute free of charge any rectification work ordered by the IRCON / Consultant as a result of such tests and inspections where these indicate non-compliance with Statutory Regulations.

The Contractor shall assist for the submission of all necessary forms and shop drawings to the Statutory Authorities which shall conform in layout to the latest IRCON / Consultant plans submitted to and kept by these Authorities.

The submission shall comply with the requirements set forth in the current Codes of Practice and circular letters of the Statutory Authorities. The shop drawings to be submitted shall be forwarded to the IRCON / Consultant for checking before submission.

The Contractor shall allow for at least two submissions of complete sets of shop drawings to the Authorities, one to be made within six months after the award of the Contract but not less than six weeks before the inspection. The IRCON / Consultant may at his discretion instruct the Contractor for additional submissions to the Local Authorities whenever necessary.

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

### **12.3 Commissioning**

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

That all valves, switches, controls, etc. are regulated and capable of proper operation and in the case of isolation valves that they are capable of tight shut off.

That all apparatus is silent in accordance with the requirements of this Specification.

That all instruments are correctly calibrated and read accurately.

That all services are tested in accordance with the details in the relevant clauses of this Specification.

Operate pumps, pressure reducing sets, etc. to ensure that all control systems are functioning correctly and are properly set, sequenced or interlocked.

### **12.4 Final Acceptance Tests**

Following commissioning and inspection of the entire installation, and prior to issue of the Completion Certificate, the Contractor shall carry out final acceptance tests in accordance with a programme to be agreed with the IRCON / Consultant.

Should the results of the acceptance tests show that plant, systems and/or equipment fail to perform to the efficiencies or other performance figures as given in this Specification, the Contractor shall adjust, modify and if necessary replace the equipment without further payment in order that the required performance is obtained.

Where acceptance tests are required by the relevant Authorities having jurisdiction, these tests shall be carried out by the Contractor prior to the issue of Completion Certificate to the acceptance of the Authorities.

#### **12.5 Handing Over of Documents**

All testing and commissioning shall be done by the Contractor to the entire satisfaction of the IRCON / Consultant and all testing and commissioning documents shall be handed over to the IRCON / Consultant.

The Contractor shall also hand over all maintenance and operation manuals, all certificates and other documentation as per the terms of the contract to the 'IRCON / Consultant'.

#### **12.6 Performance of equipment**

Operate all the pumps and record pressures, flows and amps in the following table.



<b>Sr. No.</b>	<b>Equipment</b>	<b>Pressure kg/cm<sup>2</sup></b>	<b>Flow L/s</b>	<b>Amps</b>	<b>Pump Make</b>	<b>Pump Remarks Model</b>
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### **13.0 Plumbing Performance Specifications**

S.NO	PARAMETERS		REQUIREMENTS		
[1]	General	(i)	100% of total treated water available on-site to be reused within the project site		
		(ii)	Recharge of surplus rainwater runoff into aquifer to be carried out through appropriate filtration and treatment measures to remove minimum 80% Total Suspended Solids		
		(iii)	Water Fixtures in Toilets: Water demand to be reduced through selection of low-flow fixtures by minimum 50% over the following GRIHA baseline flow rates:		
			S.N.	Fixtures	Max. Flow rates
			1	Water Closets	2-4 LPF
			2	Kitchen Faucets	4 LPM
			3	Urinals	1 LPF
			4	Lavatory faucets	4 LPM
			5	Shower head	8 LPM
[2]	Sanitary Fixtures	(i)	Wall/Floor mounted W.C. flush pipe/bend to be connected to the W.C. by means of suitable rubber adapter		
		(ii)	Wall hung W.C. to be supported by C.I. wall mounted bracket with concealed cistern		
		(iii)	Each wash basin to be provided with 32mm dia C.P. waste 32mm dia C.P Brass Bottle Trap with C.P. connection pipe to wall with flange		
		(iv)	Urinals to be provided with Auto Sensor 15 mm dia C.P. spreader, 32 mm dia C.P. domical waste and C.P. brass bottle trap with C.P pipe to wall with flange and to be fixed to wall by one C.I. bracket and two C.I. wall clips battery operated sensor		
		(v)	Each sink to be provided with 40 mm dia C.P. waste with chain and plug		
		(vi)	Urinal partitions to be of frosted 12mm toughened glass		

[3]	<b>Soil, Waste, Vent</b>	(i)	Wastes and vents shall be of CI 3989.
		(ii)	All traps on branch soil and waste pipes also to be ventilated at a point not less than 75mm or more than 300mm from their highest part and on the side nearest to the soil pipe or waste pipes
		(iii)	Head (starting point) of drains and sewage / waste water sumps (as and where applicable) having a length of greater than 4 m upto it connection to the main drain or manhole to be provided with a 80 /100 mm vent pipe
[4]	Cast Iron Pipes IS:3989/IS:1729- for embedded areas only.	(i)	The pipes and fittings to conform to IS:3989
		(ii)	For fittings, access door 1m above floor level to be made up with 3mm thick insertion rubber washer and dripseal joint.
		(iii)	All pipes and fittings before installation at site to be tested hydrostatically to a pressure of smoke testing without showing any sign of leakage, sweating or other defects of any kind. The pressure to be applied internally and to be maintained for not less than 15 minutes
[5]	Galvanised Iron Pipes	(i)	GI pipes of 50mm dia and below and where called for shall be galvanised iron pipes screwed and socketed conforming to the requirements of IS:1239 of medium grade
[6]	UPVC Pipes and Fittings	(i)	UPVC pipes to be designed by external diameter and to conform to IS:4985-1981 or IS:13592. The pipes to be of 6 Kg/sqm pressure rating or type B.
		(ii)	Fittings to be of the same make as that of pipes, injection moulded and to conform to IS:14735
		(iii)	Recommended support spacing for unplasticised PVC pipes is 1400 mm for pipes 50 mm dia and above
[7]	HDPE Pipes and Fittings	(i)	All pipes and fittings to be HDPE manufactured to DIN 19535, DIN 19537, DIN 8074, DIN 8075 fittings to carry a BBA certificate No. 92/2796

		(ii)	Fixed points to be provided at a maximum of 3 metre intervals and / or changes in direction
[8]	Cast Iron Class (LA) pipes	(i)	All drainage passing under building floor and passing through retaining wall to be cast iron class (LA) pipes (IS : 1536)
		(ii)	Fittings to be used for cast iron class (LA) pipes shall conform to IS:1538-1976)
[9]	Rainwater Pipes	(i)	UPVC pipes shall be used of 10 kg/ cm <sup>2</sup> conforming to I.S:4985
[10]	Painting	(i)	Non-Flat Paints and Coatings: VOC not more than 150 g/L. Anti-Corrosive Coatings VOC not more than 250 g/L
[11]	Testing	(i)	Testing to be done in accordance with IS:1172 and IS:5329
[12]	Internal Water Supply System	(i)	Pipes in chase/ false ceiling of toilets/ wet areas to consist of CPVC PIPES.
[13]	Testing	(i)	System to be hydrostatically pressure tested at 150 psi (10 Bar) for one hour
[14]	G.I. Pipes & Fittings	(i)	Pipes to be galvanised mild steel welded (ERW) or (HFW) screwed and socketed conforming to the requirements of IS:1239. The Galvanising to conform to IS:4736, the zinc coating to be uniform, adherent reasonably smooth and free from such imperfections
[15]	Fitting	(i)	Fixing to be done by means of standard pattern holder bat clamps keeping the pipes about 1.5 cm clear of the wall where to be laid on surface
[16]	Testing	(i)	Pressure testing to be done for 12 hours and then put into operation on regular basis
[17]	Piping Insulation Support (Valid for GI)	(i)	The insulation for chilled water piping, pump, expansion tank etc., shall be carried out from 25mm thick closed cell elastomeric nitrile rubber, class "O" secured with approved adhesive.
		(ii)	The chilled water piping shall be finished with UV shield using 2 layers of FRP fabric and Epoxy as per manufactures recommendation.

[18]	Water Meters	(i)	Meters to conform to Indian Standard IS:779 and IS:2373 or as applicable.
[19]	Testing	(i)	All water supply system to be tested to hydrostatic pressure test of at least one and a half (1.5) times the maximum pressure (but not less than 10Kg/Sq.cm) for a period of not less than 8 hours
[20]	Valves	(i)	Gate, globe and check valves to conform to Indian Standard IS:776 and non-return valves and swing check type reflux to IS:5312. Sluice valves to conform to Indian standard IS:780 and IS:2906
[21]	Pressure Reducing Valve Set	(i)	Bellow Type
[22]	Pressure Relief Valves	(i)	Pressure relief valve in a pressure reducing station to have a flow capacity equal to that of the pressure reducing valve
[23]	Pressure Gauge	(i)	It shall be stainless steel Bourden tube type pressure gauge with a scale range from 0 to 16 Kg / cm square and to be constructed as per IS:3524. Each pressure gauge to have a siphon tube connection
[24]	Lawn Hydrants	(i)	All the external garden hydrant system piping shall be uPVC 10 kg/cm <sup>2</sup> conforming to I.S.4985.
[25]	Hot Water Piping Insulation	(i)	Insulation material for Pipe insulation to be Closed Cell Elastomeric Nitrile Rubber or closed cell cross linked polyethylene foam. Thermal conductivity of elastomeric nitrile rubber not to exceed 0.038 W/moK or 0.0313 Kcal / MhroC or 0.212 BTU / (Hr-ft <sup>2</sup> -oF/inch) at an average temperature of 40°C. The product to have temperature range of ^0°C to 105°C. Density of material not to be less than 0.06 gm/cm <sup>3</sup>
		(ii)	Pre-fabricated thermal insulation consists of flexible, closed-cell flexible polyolefin foam that is bonded to the casing pipe, having density of 30 - 40 kg/ m <sup>3</sup> , capable of operating for the temperature range of- 80 to + 95°C, the thermal conductivity: of the pre-fabricated (pre-insulated) system should be 0.301 W/mK at 50°C. The casing pipe to be of HDPE and to be water tight while being bonded with insulation
[26]	Sewerage & Drainage System	(i)	Work to be executed strictly in accordance with IS: 1742. All piping to be installed at depth greater than 80 cm below finished ground level

[27]	Trenches	(i)	Pipes between two manholes to be laid truly in straight lines without vertical or horizontal undulations
		(ii)	Trenches for the pipes to be excavated with bottoms formed to level and gradients
		(iii)	Excavated earth to be kept clear of the trenches to a distance equal to 75 cms
[28]	HDPE Pipes (Double Coiled)	(i)	Pipes for sewerage and storm water to be HDPE DWC class SN8 pipes with coupler, internal surface double wall non- pressure as per IS-16098 Part-2/2013.
[29]	S.W. Gully Trap	(i)	Gully trap to be cast iron conforming to IS:651. The gully traps to be fixed on cement concrete foundation 65cm square and not less than 10cm thick.
[30]	Manhole Covers	(i)	Manholes covers shall be of cast iron.
[31]	Testing	(i)	Smoke testing to be carried out for testing of sewerage and storm water pipes.
[32]	Plumbing Valves	(i)	All valves rated not less than 10kg/cm <sup>2</sup> working pressure for plumbing systems unless indicated otherwise
		(ii)	All the valves up to 50mm dia to be of gunmetal/bronze body with screwed ends and to be provided with unions on both the sides for removal and repair
		(iii)	All the valves above 50mm dia to be of CI body with flanged ends and to be provided with flanges on both the sides for removal and repair
		(iv)	Gate valves to be as per IS 778.The screwed female ends to be to BSPT and flanged ends to be to IS 778
			All gate valves up to 50 mm to be of hand wheel operated with bronze body, with screwed in bonnet, non rising spindle and solid wedge, with threaded ends as specified and as required by the piping system
			Gate valves larger than 50 mm to be of cast iron body with bronze mountings and to be provided with flanged ends as required by the piping system

			Globe valves of size 40mm or less to be as per IS 778 and of size 50mm or more to be as per IS 780. The screwed female ends to be to ASME B 16.11 and flanged ends to be to ASME B16.5
			All globe valves 50 mm and smaller to be of bronze body with screwed in bonnet, rising spindle and with threaded ends and as required by the piping system
			All globe valves larger than 50 mm to be of cast iron body with bronze mountings and to be provided with flanged ends as required by the piping system
			Ball Valves to be of IS 9890, Gun metal with screwed female ends to IS 554, flanged ends to ASME B 16.5
			Check valves of size 40mm or less to be as per IS 778 and of size 50mm or more to be as per IS 780. The screwed female ends to be to ASME B 16.11 and flanged ends to be to ASME B16.5
			Check valves 50mm and smaller to be of bronze body and disc, threaded ends or as required by the piping system
			Check valves 65mm and larger to be of cast iron body with epoxy coated ductile iron/ stainless steel trim and to be of flanged end as required by the piping system
			All valves 80mm dia and above to be Butterfly valve
			Butterfly valves to be of best quality conforming to I.S 13095
			Butterfly Valves 200 mm or larger to have gear operator with crank handle or hand wheel
			Butterfly Valves smaller than 150 mm to have nine position levers
			Where Butterfly valves are located 2 m above floor level in equipment rooms, chain wheel operators and chains to be provided
			Sluice valves to conform to I.S: 780
			Butterfly valves to be installed for isolating the main branches above 80mm dia

		(xxi)	Pressure reducing valves to have high quality Nitrile rubber "O" ring and setting pressure of 1-3 Kg/cm2 in the downstream side unless stated otherwise						
		(xxii)	Air release valves to be single acting type air valves with cast iron body and bronze/gunmetal internal parts and plastic float						
		(xxiii)	Scour valves to be with cast iron body with flanged connections						
		(xxiv)	Strainers to be Y type strainers with gunmetal/bronze body up to 50mm dia and CI body above 50mm dia and have screwed female ends to BSPT, flanged ends to BS:10						
[33]	Pumps	(i)	Each Hydro Pneumatic Pumping unit to be supplied as a complete set with pressure vessels suction and discharge common manifolds, non-return valves, isolating valves, pressure transmitters on the discharge side and level electrode at the suction tank.						
[34]	Pumps	(i)	Pumps to be so selected that the design duty point is within 5% of the maximum efficiency point						
[35]	Vertical Multi-Stage Pumps	(i)	Pump motors above 7.5 kW to be equipped with a spacer coupling which allows changing of shaft seals without removing the motor. The pump motors to be of Class "F" insulation and IP55 rating and to be provided with built-in thermistors						
[36]	Pump Pressure Vessel	(i)	Diaphragm type pressure vessels to be provided & incorporated into the system so that during normal operation the pump not need to be start within 30 seconds of it switching off in order to prevent the pump hunting						
[37]	Submersible Pumps	(i)	Each pump to be provided with a suitably rated induction motor suitable for 415 volts, 3 phase, 50 Hz A.C. power supply						
		(ill)	Motors to be designed for continuous running duty type at 415 volts, 3 phase, 50 Hz power supply and capable of sustaining a minimum of 20 starts/stops per hour						
[38]	Sewage Treatment Plant	(i)	Design Criteria:						
			<table><tr><td>S.No.</td><td>Item of Analysis</td><td>Units in Milligram per litre or otherwise stated</td></tr><tr><td>1</td><td>Colour</td><td>7 Lovibond units</td></tr></table>	S.No.	Item of Analysis	Units in Milligram per litre or otherwise stated	1	Colour	7 Lovibond units
			S.No.	Item of Analysis	Units in Milligram per litre or otherwise stated				
1	Colour	7 Lovibond units							



			2	pH value	7.1 – 7.3
			3	BOD(5dayat20°C)	< 10
			4	COD	< 50
			5	Total Suspended Solids	< 20
			6	Grease and Oil	< 2
			7	NH <sub>4</sub> – N	5
			8	N - total	Nil
			9	Turbidity (NTU/JTU)	10
			10	E – Coli	Nil
			11	TDS	Max 300/Commercial zero for soft water to be used for cooling towers
		(ii)	Air blowers to be provided in duplicate (i.e. one duty and one Standby). Motor speed not to be less than 500 rpm. The size and performance of the air blower to be so selected that it can provide a minimum air flow rate 0.4 I /sec / diffuser to 11/sec/diffuser maximum, and to maintain a minimum of 2.0mg/liters dissolved oxygen in the aeration tanks in operation		
		(iii)	Tertiary treatment plant to comprise of the softener with brine to achieve hardness less than 5 ppm		
		(iv)	System to be designed to provide a UV dose of 600 J/m <sup>2</sup> at UVT of 65% and TSS less than 10 mg/L. System to deliver a 4 log reduction of coliforms and provide TC count to less than 200 CFU/100ml		
		(v)	Piping to be properly supported on or suspended from, on stands, clamps, hangers as specified and as required		

**14.0 Bio-Waste Compost Plant (NOT APPLICABLE)**

- SCOPE:**

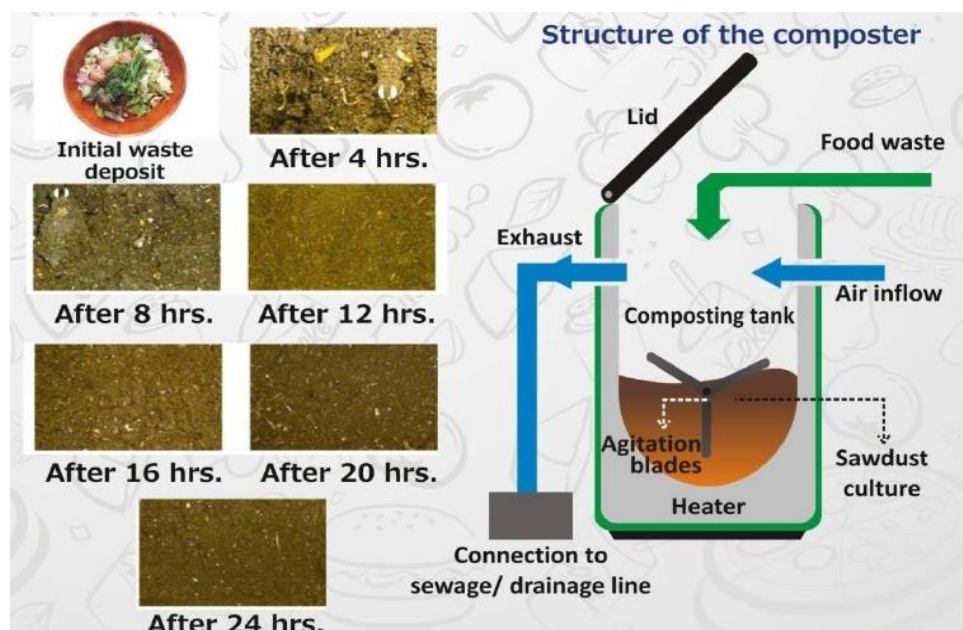
- The contractor shall install a Fully Automatic bio-waste composting machine separately

- b) The minimum capacity of the bio-waste composter to be installed for the Station/Signal Building is 100 Kg and for Office building is 500 Kg.

- **SALIENT FEATURES**

- a) The machine shall require no labour/ no manual intervention for operation and no maintenance.
- b) The machines shall be operational 365 days.
- c) Machine shall be capable of volume reduction by 80 – 90%. Hence, 100 kg of wet waste is converted into 10 – 15kg of compost, reducing the space requirements for compost storage also.
- d) The machine shall be completely noiseless.
- e) The operating temperature of the machine shall be 50-55 degrees.
- f) The bacterial culture is to be provided along with the machine during commissioning and need not be put in again in its lifetime. Hence no recurring costs of bacteria, dry leaves or labour.
- g) Even if the machine is down, it would not emit any foul odour as long as fresh food waste is not added, since the waste that was put in the day before is already 90% composted.
- h) All necessary warranties and AMCs for the machine to be provided.

**WORKING: A BRIEF ON THE TECHNOLOGY OF COMPOSTING**





**Technical Specifications of microbes supported 24 hours 100 Kg/Day Composting Machine with inbuilt shredder**

S. No.	Descriptions	Specifications
1	INPUT CAPACITY/DAY	<b>100 Kg Per Day</b>
2	INPUT	Mixed Bio-Degradable Waste Wet & Dry
3	OUTPUT	Dry Organic Compost, with test results and parameters matching to compost standards mentioned in MSW Rules 2000, Govt. of India, amended SWM 2016
4	REDUCTION BY VOLUME	80 to 90% Depending on Material
5	COMPOSTING METHOD	High Temp. Microbes Supported Natural digestion/ Composting
6	DIMENSIONS	Compact Size as per manufacturer.
9	POWER SUPPLY	415V , 3 PHASE ,50Hz
10	GEAR BOX	Compact planetary gearbox
11	HEATING ELEMENT	Heating Element/Coil field heaters
12	INSULATION	Should be Insulated With Rock-wool/Glass wool/ Fiber Blanket AS PER IS8183
13	BLOWER	Blower with powder coated shroud & SS impeller
14	POWER RATING	5.5 KW
15	PROCESSING TIME	24 HOURS
16	SHREDDER	Twin shaft inbuilt
17	MIXING ARRANGEMENT	Should be Made of SS 304 High Quality Material
18	COMPOSTING TANK	SS 304
19	OUTER COVERS	SS 202
20	HANDLES & LOCKS	Standard Handles & Locks
21	CONTROL PANEL	PLC Based as per make list
22	CONTROL SYSTEM	PLC + HMI Touch Screen Display as per make list
23	INDIATORS	Forward & Reverse Cycle, Heater With ON & OFF Sign., Overload & Auto Unloading Switch
24	SWITCHS	Emergency stop & Manual Operation
25	LOADING & OPERATION	Mechanical loading & Fully Automatic operations
26	CURING	Not Allowed
27	LEACHATE	Not Allowed
28	HARMFUL GASES	Not Allowed
29	REMOVALS/ UNLOADING	Once in a week (mechanically auto unloading by machine)
30	SAFETY FEATURE	Emergency switch, overload indication function and Safety Switch Safety feature: Internal mixing blades automatically stop when input door is opened

**Technical Specifications of microbes supported 24 hours 500 Kg/Day Composting Machine with inbuilt shredder**

S. No.	Descriptions	Specifications
1	INPUT CAPACITY/DAY	<b>500 Kg Per Day</b>
2	INPUT	Mixed Bio-Degradable Waste Wet & Dry

3	OUTPUT	Dry Organic Compost, with test results and parameters matching to compost standards mentioned in MSW Rules 2000, Govt. of India, amended SWM 2016
4	REDUCTION BY VOLUME	80 to 90% Depending on Material
5	COMPOSTING METHOD	High Temp. Microbes Supported Natural digestion/ Composting
6	DIMENSIONS	Compact as per manufacturer.
9	POWER SUPPLY	414V , 3 PHASE ,50Hz
10	GEAR BOX	Compact planetary gearbox
11	HEATING ELEMENT	Heating Element/Coil field heaters
12	INSULATION	Should be Insulated With Rock-wool/Glass wool/ Fiber Blanket AS PER IS8183
13	BLOWER	Blower with powder coated shroud & SS impeller
14	POWER RATING	14.5 KW
15	PROCESSING TIME	24 HOURS
16	SHREDDER	Twin shaft inbuilt
17	MIXING ARRANGEMENT	Should be Made of SS 304 High Quality Material
18	COMPOSTING TANK	SS 304
19	OUTER COVERS	SS 202
20	HANDLES & LOCKS	Standard Handles & Locks
21	CONTROL PANEL	PLC Based as per make list
22	CONTROL SYSTEM	PLC + HMI Touch Screen Display as per make list
23	INDIATORS	Forward & Reverse Cycle, Heater With ON & OFF Sign., Overload & Auto Unloading Switch
24	SWITCHES	Emergency stop & Manual Operation
25	LOADING & OPERATION	Mechanical loading & Fully Automatic operations
26	CURING	Not Allowed
27	LEACHATE	Not Allowed
28	HARMFUL GASES	Not Allowed
29	REMOVALS/ UNLOADING	Once in a week (mechanically auto unloading by machine)
30	SAFETY FEATURE	Emergency switch, overload indication function and Safety Switch Safety feature: Internal mixing blades automatically stop when input door is opened

## **TECHNICAL SPECIFICATIONS**

### **FIRE FIGHTING WORKS**

#### **SECTION – 5**

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## **1.0 GENERAL PROVISIONS**

### **1.1 Description**

The scope of works for all Fire Fighting system comprises detailed engineering, supply, delivery, installation, testing, commissioning, handover, training, maintenance and warranty all as described or reasonably implied in the Contract. Contractor is obliged to provide fully functioning works and systems in conformance with the requirements of the Contract. In the event certain items are not fully described or indicated in the Contract, but deemed essential (in all reasonableness) for the performance of the works and systems then the provision of such items shall form part of the scope of works at no additional cost to the Employer.

The Contractor shall be responsible to co-ordinate the equipment and services with all other discipline and shall produce properly coordinated shop drawings to demonstrate the installation & comply with the performance requirement with shop drawing, calculations, samples and details.

Shop drawings shall take into account actual measurement and setting out dimensions/levels obtained and determined by the Contractor on site, actual equipment/material used, actual routing of services, coordination with all installation, and site conditions/constraints.

### **1.2 Scope of Detailed Engineering Works**

The Contractor shall prepare and submit, as applicable all plans and documents to all relevant Authorities, assist in securing all the necessary statutory approvals.

The detailed design of all works shall be carried out in good engineering practices in compliance with the provision and regulations set out in the National Building Code 2016, and other Indian Codes (its latest amendments) and also in compliance with the terms and conditions.

The Contractor shall engage a team of professional engineers for detailed design, submission to authorities and supervision of all works in accordance with the approved design, development & contract terms.

The Contractor shall be responsible for testing, commissioning & handing over of the completed works with defect liability.

### **1.3 Detailed Design responsibility and Liability**

Contractor shall be fully responsible for the detailed design, including all temporary fire fighting works required during execution of project.

Contractor shall furnish sufficient details of the detailed design of the works including plans, specifications, calculations, method of construction and any other relevant information as required by IRCON / Consultant.



Acceptance of the Contractor's tender proposal and subsequent design, including any revisions, by the IRCON / Consultant shall in no way relieve the Contractor of his overall responsibility for the adequacy of his detailed design to meet functional requirement and complying the authority's requirement. All costs for any remedial work, be it temporary or permanent, that are ordered by the IRCON as a consequence of the failure for the works, to satisfy the above-said requirements at any time shall be borne by the Contractor.

#### **1.4 Technical Specification**

Contractor shall be responsible for the preparation of the complete set of Technical Specifications for the execution of works. The Contractor shall refer to the NBC Part-IV and ISI Specifications, which shall be the minimum requirement and he shall comply with IRCON / Consultant Specifications.

Contractor shall ensure that the quality and workmanship of the works under the Contract shall not fall below the tender specifications. Contractor shall be allowed to propose standards higher than; but not below IRCON / Consultant's requirements.

#### **1.5 Submission of Documents**

Contractor shall submit requisite sets as specified, the following documents during execution of work.

A summarized description of the proposed firefighting system and method of construction to be adopted for his contract.

Key plans with scale of 1:100 for all floors and roof showing the fire fighting system of the proposed development and dimensions for all key fire fighting elements.

Plans showing summary of all proposed firefighting components

#### **1.6 Submission of Drawings**

Contractor shall submit to the IRCON / Consultant, all drawings and calculations, submitted to the Authorities, including as-built drawings.

#### **1.7 Scope of Works**

The Fire Fighting installation shall generally include, but not limited to following:

Fire Pumps

Wet Riser & Hydrant system

Sprinkler system

Water curtain for ramps and compartmentations in basement parking.

Pipe, valves and accessories

Fire Extinguishers

Yard Hydrants

Fire Brigade Connections

Motor Control Panel

Pressure switch, Pressure Gauge and Instrumentation Accessories

Hangers and Supports

Anticorrosive Painting

Associated electrical works

Associated interfacing works with other trades including electrical, plumbing and sanitary, gas supply and fire alarm/detection, lifts, escalators, etc.

Liaison with the local fire authority and obtain all necessary approvals after completion.

Integration and Interface with BMS systems.

Inert gas fire fighting system of Electrical panel / D.G. Sets / Server Room Etc.

All the necessary accessories will be provided to meet functional requirements of the fire Fighting system:

## **1.8 Quality Assurance**

The IRCON / Consultant reserves the right to inspect and reject any part of the works not complying. The Contractor shall replace such rejected works without additional cost implication and delay to the Contract.

Approval or acceptance by the IRCON / Consultant shall not relieve the Contractor of his responsibilities under the Contract for the quality of materials and the standard of workmanship in the works.

No work shall be covered up or put out of view without the agreement of the IRCON / Consultant. The Contractor shall provide/allow the IRCON / Consultant full opportunity for the examination and measurement of any work which is about to be covered or put out of view. Upon request by the IRCON / Consultant, the Contractor shall expose their works and allow/provide access to the IRCON / Consultant to inspect any part of the works during the course of installation/erection.

All materials and equipment shall be used as per approved list of manufacturer. Any item not specified in approved list should comply to IS code for which technical details/ catalogue should be submitted for approval before procurement.

Sprinklers shall be UL-listed and FM approved inevitably, as specified in schematic drawings.

Other equipments and accessories shall be ISI approved plans.

## 1.9 Relevant Indian Standards

The following minimum Indian standards must be followed by the Contractor while installing the system in the building. All material and work to be in accordance with applicable portions of the latest revisions and editions of the following standards unless otherwise indicated.

I.S 1239 (Part I) – 1990 C class Mild Steel Tubes, tubular & other wrought steel fittings (Amendments – 3)

I.S 3589-1991	Seamless or electrically welded steel pipes
I.S 5290-1993	Landing Valves (Amendment No.1)
I.S. 5132-1962	Hose reel tubing for fire fighting
I.S. 884-1985	First Aid Hose Reel for Fire Fighting
I.S. 636-1988	Non-percolating flexible fire fighting delivery hose
I.S. 903-1993	Fire hose delivery couplings, branch pipe, nozzle & Nozzle spanner
I.S. 908-1975	Fire hydrant, stand post type
I.S. 904 -1983	2 way & 3/4 way suction collecting heads for fire fighting purposes
IS: 15105	Design and installation of fixed automatic sprinkler fire extinguishing system
IS: 2190	Code of practice for selection, installation and maintenance of Portable first aid fire extinguisher
I.S.:15683	Portable Fire Extinguishers Performance and construction
I.S.780	Sluice Valves
I.S.5312	Non Return Valve
I.S.778	Brass Gate Valve

I.S.13095              Butterfly Valves

I.S.2379-1990        Colour Code for identification of pipe lines

I.S. 12992 (Part-I)   Safety relief valves, spring loaded Part-I Design (Part-II)-1990 Spring loaded

## **2.0    PRODUCTS AND EQUIPMENTS**

### **2.1    Yard Hydrant**

External yard hydrants shall be conforming to Type 'A' of I.S. 5290-1977.

The outlet shall be angled towards ground with instantaneous spring lock type SS female coupling of 63 mm dia. for connecting to hose pipe.

Hydrant outlets shall be situated 1 m above ground level.

Hydrants shall be easily accessible, storage of any kind on or around the hydrant being prohibited.

Hydrant heads shall be as per NBC 2016 positioned at distances not less than 2 m from the face of the building.

Two numbers of 63 mm dia. 15 m long rubberized fabric lined (RRL) hose pipe with SS male and female instantaneous type couplings machine wound with SS wire (hose to I.S. 636 Type 2 and couplings to I.S. 903 with MS certification), SS branch pipe with nozzle to I.S. 903 shall be provided near external hydrant in a suitable enclosed cabinet.

### **2.2    Internal Hydrant (Landing Valve)**

Landing valve shall be of the type approved by the relevant fire authority applicable as per Indian standard or equivalent. The landing valve shall comply with the requirements of IS 5290. Landing valve shall be fitted to a Tee connection on the wet riser at the landing.

Outlet shall be fitted with a removable SS plug secured by a chain with hand wheel.

Landing valves at lower floors shall incorporate SS Orifice plates to limit the maximum pressure as required by NBC-2016/Fire Authority.

At each landing and as required at other locations one single headed SS landing valves (connected to the Fire Riser) with 63 mm dia outlet and 80 mm inlet (I.S.5290). Each landing valve shall be with one shut off butterfly valve.

The valve shall have flanged inlet and instantaneous type outlets and shall be fixed at a height of 1000 mm from the finished floor.

Contractor shall provide for each internal fire hydrant station two numbers of 63 mm dia. 15 m long reinforced rubberized fabric hose pipes with SS male and female instantaneous type coupling machine wound with SS wire (hose to I.S. 636 Type 2 and couplings to I.S. 903 with I.S. Certification), fire hose reel with 20 mm hose 36-meter-long, SS branch pipe with nozzle I.S. 903 and SS Fire man's axe as per NBC 2016. one 6 kg ABC and one 4.5 kg CO2 fire extinguisher.

### **2.3 First Aid Hose Reel Equipment**

First aid hose reel shall comprise reel, hose guide fixing bracket, hose tubing globe valve, stop cock and shut off nozzle. This shall conform to IS: 884 -1969. The hose tubing shall conform to IS: 1532 - 1969.

Hose tubing shall be 20mm dia and 36.5m long. The nozzle and globe valve shall be of 20mm size.

The reel shall be of rigid construction using heavy duty CRCA steel. It shall rotate freely on leak proof bearings and be fitted with pivoted nylon rollers to allow easy run-out of the hose.

Hose reel shall be connected directly to the wet riser and installed in the Fire Hose Cabinet.

The shutoff nozzle shall be 5mm bore. It shall be adjustable for jet or spray pattern with complete shut-off.

Fire Hose Cabinets for all internal as well as external fire hydrants shall be provided. Hose cabinets shall be fabricated from 2mm CRCA Sheet of fully welded construction hinged double front door partially glazed with L&K locking arrangement, stove enameled finish in Fire red colour with 100 mm high letters "FIRE HOSE" painted on it prominently.

Branch line from Wet riser to Hose Reel shall incorporate SS Orifice plate to limit the maximum pressure as required by NBC/Fire Authority.

### **2.4 Hose Pipe, Branch Pipes and Nozzles**

#### **2.4.1 Hose Pipe**

Hose pipes shall be rubberized fabric lined and 63mm in diameter. They shall conform to type 2 (Reinforced rubber lined) of IS: 636 - 1979. The hose shall be sufficiently flexible and capable of being rolled.

Each run of hose pipe shall be complete with necessary SS coupling at the ends to match with the landing valve or with another run of hose pipe or with branch pipe. The coupling shall be of instantaneous spring lock type.

#### **2.4.2 Standard Branch Pipes**

Branch pipe shall be of SS 63mm dia and be complete with male instantaneous spring lock type coupling for connection to the hose pipe. The branch pipe shall be externally threaded to receive the nozzle.

Branch pipes shall be conforming to IS: 903 -1985

#### **2.4.3 Nozzle**

The nozzle shall be SS 16mm in (Internal) diameter. The screw threads at the inlet connection shall match with the threading on the branch pipe. The inlet end shall have a hexagonal head to facilitate screwing of the nozzle on to the branch pipe, with nozzle spanner.

Nozzles shall be conforming to IS: 903 -1985

#### **2.4.4 Fire Hose Cabinet**

Fire Hose Cabinet will accommodate the landing valve, hose pipe, hose reel fire man axe, portable extinguisher etc. This shall have lockable, centre opening, glazed doors as per Indian standards or equivalent.

Fire Hose Cabinet may be provided of steel frame structure.

The hose cabinet shall be painted red and stove enameled.

#### **2.4.5 Fire Brigade Connections**

Stainless Steel collecting head with four 63 mm instantaneous type inlets with built in check valves and 150 mm diameter outlet connected to the fire tank, wet riser or sprinkler riser shall be provided for each building. Collecting head shall be installed on a stand post and provided with horizontal C.I. reflux valve. Etched Stainless Steel label plates with 100 mm high letters shall be provided at each fire brigade connection. The plates should be firmly fixed to the Fire Brigade connection and support system. Fire Brigade inlet connections must be provided in accessible locations generally in front side of the premises and must be free of traffic and parking and other obstructions.

### **2.5 MS Pipes & Fittings**

#### **2.5.1 Pipes**

All fire pipes within and outside the building in underground / exposed locations shall be as follows:

MS pipes 150 mm dia. and below confirming to IS: 1239 part-1, heavy grade, C class.

MS pipes 200 mm dia. and above confirming to IS: 3589, minimum 6.35 mm thick, grade 330.

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.

M.S. pipes when buried underground shall be painted with two coats of approved primer and wrapped with one/two layer of 4 mm thick PYPKOTE sheet or equivalent as per manufacturer's specifications

All underground pipes are to be laid not less than 1m below ground level.

### **2.5.2 Fittings**

(a) All GI and MS fittings shall be as per IS 1239 part-2 – For Infrastructure.

Pipe fittings viz, tees, bends, couplings, flanges, reducers etc. and all such connecting device that are needed to complete the piping work in its totality.

Screwed GI fittings shall be forged suitable for screwed joints, (upto 50mm dia).

(b) For Internal Pipes above 50 mm:-

Fabricated fittings shall not be permitted under normal circumstances.

All fittings shall be able to withstand a pressure of 150% of the maximum working pressure.

## **2.6 Jointing**

### **2.6.1 Welded Joints**

Use forged steel with V groove fittings for welded joints.

## **2.7 Flanges**

Flanges shall be provided on both ends of any fabricated fittings e.g. bends tees etc. of 50 mm dia or larger diameter wherever necessary.

Flanges shall be provided 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.

Flanges shall be as per ASME/ANSI B16.5 with appropriate number of G.I. nuts and bolts, 3 mm insertion neoprene gasket complete.

Unions are to be provided on pipes lines 50 mm and below, near valves and assemblies and as required as per site conditions. All Unions when used shall be with socket welded ends. Usage of unions shall be avoided wherever the pressure exceeds 7 kg/cm<sup>2</sup> and break up flanges are recommended at these locations.

All couplings and fittings shall be provided by a single source supplier.

## **2.8 Valves**

Valves shall be of same manufacturer for all systems, including valves furnished with equipment.

For flanged valves, companion flanges are to be provided of same PSI rating/class of valve being used.

All valves are to be provided with rating not less than 16kg/cm<sup>2</sup> working pressure for fire systems or as indicated otherwise.

Valves to be provided as required for complete isolation of equipment, branches from the main lines, arranged so as to give complete and regulation control of piping systems throughout the building. Valves to be provided with neat appearance and grouping, so that all parts are easily accessible for maintenance.

All the valves up to 50mm dia. shall be of gunmetal/bronze body with screwed ends and shall be provided with unions on both the sides for removal and repair, unless instructed otherwise.

All the valves above 50mm dia shall be of CI body with flanged ends and shall be provided with flanges on both the sides for removal and repair, unless instructed otherwise.

Wherever possible, install valves accessible from floor level. Provide operating handles for all valves and cocks. Provide adequate clearance for easy operation.

## **2.9 Ball Valves**

Ball valves shall be in accordance to IS: 9890, gun metal with screwed female ends to IS: 554.

Provide full bore, quarter turn, lever operated ball valves with S/S ball and SS(AISI 410) spindle with Teflon seating and gland packing. All ball valves shall have locking handles to allow servicing and removal of equipment.

Provide lever handle with plastic sleeve on all ball valves unless otherwise noted. Provide extension stem for all ball valves to be installed on insulated piping.

## **2.10 Gate Valves**

All gate valves up to 50 mm shall be of hand wheel operated with bronze body, with screwed in bonnet, non rising spindle and solid wedge, with threaded ends as specified and as required by the piping system in which they are installed.



All gate valves larger than 50 mm shall be outside screw and Yoke (OS&Y) of cast iron body with bronze mountings or as approved and shall be provided with flanged ends as required by the piping system in which they are to be installed.

### **2.11 Globe Valves**

All globe valves 50 mm and smaller shall be of bronze body with screwed in bonnet, rising spindle and with threaded ends and as required by the piping system in which they are installed.

All globe valves larger than 50 mm shall be of cast iron body with bronze mountings and shall be provided with flanged ends as required by the piping system in which they are to be installed.

### **2.12 Check Valve**

All check valves 50mm and smaller shall be of bronze body and disc, threaded ends or as required by the piping system in which they are installed.

All check valves 65mm and larger shall be of cast iron body with stainless steel trim and shall be of flanged end as required by the piping system in which they are installed.

All check valves shall be swing check type.

### **2.13 Butterfly Valve**

Butterfly valves 80mm 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.

Butterfly valves shall be of best quality conforming to IS: 13095 of PN16 class.

Provide wafer type C.I. double flanged butterfly valves of required sizes and of rating.

Butterfly valves shall be high performance valves manufactured of ductile iron body SS-304 stainless disc and stainless steel stem with EN-8/ SS-410 shaft.

Joints for double flanged butterfly valves shall be made with suitable tail/socket pieces on the pipeline and flanges joints made with appropriate number of bolts, nuts and washers with 3 mm thick insertion rubber gasket.

Provide the following butterfly valve accessories:

Valves 150 mm and smaller shall have nine position levers.

Position indicator on all butterfly valves.

## **2.14 Sluice Valve**

Sluice Valves (80 mm dia. and above) shall be C.I. double flanged sluice valves with rising stem. Each sluice valve shall be provided with wheel in exposed positions and cap top for underground valves. Contractor shall provide suitable operating keys for sluice valves with cap tops.

Sluice valves shall be of approved makes conforming to IS: 780/PN16 class.

Sluice valves shall be high performance valves manufactured of ductile iron body, SS-304 stainless disc and stainless steel stem with SS-410 shaft

Joints for double flanged sluice valves shall be made with suitable tail/socket pieces on the pipeline and flanges joints made with appropriate number of bolts, nuts and washers with 3 mm thick insertion rubber gasket.

## **2.15 Pressure Reducing Valves**

Use bellow type pressure reducing devices or orifice plates judiciously to limit the pressure in the high pressure areas as per the requirements and keep the pressure within the permissible and operable limits.

## **2.16 Air Valve**

25 mm dia. screwed inlet C.I. single acting air valve shall be provided on all high points.

## **2.17 Installation Testing Valve**

Alarm valve shall be provided in the sprinkler system, to indicate the flow of water in the sprinkler system.

Flow switch with modem for annunciation on fire alarm panel shall be installed on the sprinkler system on each floor.

Contractor shall submit detailed shop drawings showing the exact location, details of installation of the valve and alarm complete in all respects.

Installation valve shall comprise of a cast/ductile iron sluice valve with gunmetal trim, pressure gauge, double seated clapper check valves as alarm valve with pressure gauge, test valve and orifice assembly and drain pipe with pressure gauge, bye pass on check valve to regulate differential pressure and false alarm, turbine water gong including all accessories necessary and required and as supplied by original equipment manufacturer and required for full and satisfactory performance of the system.

## **2.18 Orifice Plates**

Orifice Plates fabricated made of 6mm thick stainless steel of required size shall be provided to reduce pressure at strategic locations as per requirements. The Contractor shall submit detailed design calculations for the orifice plates for approval before installation as per location & pressure condition.

### 2.19 Drain Pipe

50 mm dia black steel pipe confirming to IS: 1239 (heavy class) with 50 mm gunmetal full way valve for draining any water in the system in low pockets shall be provided.

Flange and blind flange shall be provided after the valve to ensure accidental opening of drain valve.

### 2.20 Testing Of Valves

Test valve bonnets for tightness. Test and operate the valves from closed-to-open-to-closed position while valve is under test pressure.

Test automatic valves including solenoid, pressure relief valves, safety valves and temperature and pressure relief valves for proper operation at settings indicated.

Ensure that valves are field checked for packing and lubricated.

Test all valves, air relief valves, safety relief valves, safety valves and temperature and pressure relief valves three times.

### 2.21 Strainers

Strainers shall be bucket type with CI/MS body of class 150. The flanged ends shall be confirming to Indian Standard and it shall have perforated S/S (AISI-304) sheet with large screen area.

It shall be of compact shape and size as per approval and should be easy to install and repair.

### 2.22 Hangers and Supports

Hangers and supports shall be provided and installed for all piping as required work. Self-threaded and shall be approved by the IRCON / Consultant.

Hangers and supports shall be installed so as not to interfere with the free expansion and contraction of piping, and all nuts and bolts shall be drawn up tight.

Hangers shall be complete with bolts, rod and two nuts for each bolt. The diameter of hanger rods shall be as follows:

Pipe Size	Diameter of Rod
20 mm - 50 mm	10 mm
65 mm - 85 mm	13 mm

100mm-125mm	16 mm
150 mm / 200 mm	20 mm

Small tubing to gauges, controls, or other equipment installed on any apparatus shall be secured in place with bolted clips.

All vertical piping shall be firmly supported by riser clamps properly installed to relieve weight from fittings and piping at base of risers. Vertical pipes shall have riser clamps not to exceed 4.5 m spacing.

Horizontal piping shall be supported at intervals not greater than 3 m spacing and at all changes of direction.

Pipes shall be hung by means of expandable anchor fastener of approved make (Hilti or equivalent) and design. 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 five times of the weight of water filled pipe.

### **2.23 Pressure Gauge**

Pressure gauge shall be 96 mm dia gunmetal Bourden type with stainless steel isolation cock, tapping and connecting pipe and nipple. The gauge shall be installed at appropriate level and height for easy readability. Pressure gauges shall read 0-15 Kg/sqcm.

### **2.24 Hydrant/Valve Chambers**

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) 12 mm thick cement plaster inside and outside finished with a floating coat of neat cement inside with cast iron surface box as approved or as specified in Schedule of Quantities and in drawings including excavation, backfilling complete.

Valve chambers shall be of following size:-

I. 120 x 120 cms x 100 cms

II. 90 x 90 cms x 100 cms

### **2.25 Flow Switches [Sprinkler System]**

Provide REED type flow switches for

Water flow alarm switches shall be UL listed and FM approved with pneumatic retard mechanism.

Alarm switches shall be installed and coordinated with fire alarm system.

Flow switch shall be provided on sectional mains and branch lines of sprinkler systems where necessary and required and directed by the IRCON / Consultant.

Flow switch should be suitable to actuate within 90 seconds of opening of a single sprinkler and shall be suitable for connection to a central Annunciation Panel. Wiring up to MODEM / SMOKE DETECTOR will be included.

## **2.26 Sprinklers [Quartz Bulb Type]**

All sprinkler heads shall be UL listed and FM approved. Sprinklers shall be rated for ordinary temperatures (68 deg. C) except as required near kitchen heaters or locations where elevated temperatures may normally be expected or as otherwise indicated in the drawings or required by the local fire regulations. The temperature rating of a sprinkler should not be less than 30 deg. centigrade greater than the highest anticipated temperature of the location of the installation.

Sprinklers shall not be painted. They shall not be altered in any respect nor have any type of ornamentation or coating.

Pendant sprinklers shall be used @9m2 of built up area, with a center to center spacing not to exceed approximately 3.0 meters. Sidewall sprinklers shall be used as per detailing.

Upright sprinklers shall be provided for any areas greater than 800mm in height, if any. They shall also be provided in the Office areas, with a tapping point for installation of the pendant sprinkler system by the end users as per their internal layouts.

Contractor to submit performance curves of sprinklers selected for approval.

### **Open Nozzles / Water Curtain**

To be installed as per manufacturers.

## **2.27 Fire Extinguishers**

6kg multi-purpose ABC dry chemical type as per IS: 15683:2006 of approved make/type in red glossy polyester coated cylinder with pressure gauge and nozzle shall be used throughout.

4.5kg Carbon Dioxide as per IS: 15683:2006 of approved make/type in red glossy polyester coated cylinder with discharge horn and wall bracket shall be used in specified areas.

5kg inert Fire Extinguishers: Provide fire extinguishers in accordance with local fire authority, where indicated on the drawings, and in each mechanical, electrical equipment and elevator machine room.

Automatic inert Gas extinguisher for electrical installation with discharge mechanism on temperature rise

## **2.28 Hydrant, Sprinkler , Jockey & Water Curtain Pump**

Fire pumps, Sprinkler pumps & Jockey pumps, associated controllers, and transfer switches shall be provided by a single source supplier.

Pump shall be capable of delivering 150% of rated capacity at not less than 65% of rated head. Pump shall be fire authority approved and the unit shall be design proven in fire protection services.

Pump sets shall be single stage/multistage horizontal centrifugal single outlet with cast iron body and bronze dynamically balanced impellers. Connecting shaft shall be stainless steel with bronze sleeves and grease lubricated bearings.

Pumps shall be connected to the drive by means of spacer type love joy couplings, which shall be individually balanced dynamically with bearings.

The pump coupling joining the prime movers with the pump shall be provided with a sheet metal coupling guard.

All pumps shall be provided with mechanical seals.

The pump and motor shall be floor mounted on a cast iron floor pedestal frame.

## **2.29 Electric Motor**

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 currents.

Motors for fire protections pumps shall be at least equivalent to the horse power required to drive the pump at 150 % of its rated discharge and be designed for continuous full load duty and shall be design proven in similar services.

Motors shall be wound for class H insulation and winding shall be vacuum impregnated with heat and moistures resistant varnish glass fibre insulated.

Motors shall be suitable for 415+ 10% phase, 50 cycles, AC supply and shall be designed for 38 deg C temperature. Motors shall conform to the relevant I.S. Standards.

Motors shall be capable of handling the required starting torque of the pumps.

The pump shall be direct driven and the speed of the motor shall be compatible with the speed of the pump.

## **2.30 Diesel Engine**

Diesel engine shall be of suitable multi cylinders single/twin outlets with individual head assemblies as per approved fire regulations. The engine shall be water-cooled and shall include heat exchanger

and connecting piping, strainer; isolating & pressure reducing valves, by pass line complete in all respects.

Engine shall be direct ignition type matching the pump speed for direct drive and with electronic governor.

The speed of the engine shall match the pump speed for direct drive.

The engine shall be capable of being started without the use of works, 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.

The engine shall efficiently operate at 40 deg, ambient temperature at 50 meters above mean sea levels.

Noise level of the engine shall not exceed 90 DBA (free field sound pressure) at 3 meters mean distance.

The engine shall be self starting type up to 4 deg C and shall be provided with one 24 volts heavy duty DC battery, started, 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.

A battery re-charge of 10 to 15 amperes capacity with trickle and booster charging facility and regulator shall be provided.

The engine shall be provided with an oil bath or dry type air cleaner as per manufacturer's design.

Engine shall be suitable for running on high-speed diesel oil.

The system shall be provided with a control panel with push button starting arrangement also wired to the engine on a differential pressure gauge.

The entire system shall be mounted on a common structural base plate with anti vibration mountings and flexible connections on the suction and delivery piping.

One self supported one-day oil tank fabricated from 4mm thick MS sheet electrically welded with a capacity of 8 hours working load but not less than 200 lit shall be provided. Preferably in base frame of pumping set. Level indicating gauge glass on the day oil tank and low fuel level indications on the control panel shall also be provided.

One insulated exhaust pipe with suitable muffler (residential type) to discharge the engine gases to outside open air.

All other accessories, fittings & fixtures necessary and required for a complete operating engine set shall be provided.

Contractor shall provide requirements, if any, for any ventilation of the pump room.

The materials of construction for the major components are as are as follows:

Casting	: Cast iron
Impeller	: Bronze
Shaft	: EN-8
Wear Rings	: Bronze
Gland Packing	: Graphite Asbestos
Type of Bearing	: Ball bearing/ Roll Bearing
Type of coupling	: Flexible coupling



### 2.31 Instrumentations

The diesel engine shall be provided with the following instrumentation:

- Temperature indicator in cooling water inlet and outlet
- Temperature indicator in lubrications oil outlet from the oil cooler
- Pressure gauge for lubricating oil system
- Speed indicator
- Lubricating oil sump level indicator
- Fuel oil in tank level indicator
- Voltmeter and ammeter in battery charging circuit
- Cooling water high temperature alarm
- Oil pressure low alarm

A local instrument panel shall be provided with the engine for mounting all the above instruments and annunciations.

Pumps and engine shall be mounted on a common base fabricated from M.S structure and placed in suitable concrete foundations 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.

### 2.32 Operating Conditions

The fire pumps shall operate on drop of pressure in the mains. 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.

Jockey pump shall start and stop through pressure switch automatically.

Jockey pump shall stop when main pump starts.

Main pumps shall start automatically on fall of pressure but stopping automatically/manual.

Diesel pump – Start Automatic – Stop Manually.

Automatic transfer switch(es) shall be factory mounted and inter wired with the fire pump controller. The controller and transfer switch shall be capable of interrupting a short circuit current at least equal to the available short circuit current in the controller supply circuit.

Ratings shall suite the electricity demand and meet the requirement of local Fire Authority.

Contacts shall be silver plated, arching type with arc barriers and arc chutes.

Accessories will be as under:

- Test switch in cover.
- Green pilot light to indicate "Normal" position.
- Amber pilot light to indicate "Emergency" position.
- Push-to-test emergency indicating pilot light with long life lamps and fuses.
- Adjustable time delay on retransfer to normal:
- 0-25 minutes plus 5 minutes unloaded running time for the generator. The time delay shall be by passed automatically upon failure of the emergency source.
- Number of closed auxiliary contacts shall be 1 on normal, 1 on emergency.

Isolating means shall be a manually operable, moulded case switch, horsepower rated and suitable for the interrupting of the motor locked rotor current

Provide an isolating switch ahead of the emergency input terminals of the automatic transfer switch.

Provide auxiliary contacts for remote audible and visual signals indicating that the switch is in the open position.

Withstand rating shall not be less than the transfer switch rating.

Pump casing to spill over to the floor drain.

Fire pump flow measuring system/devices approved by local fire authority.

### **2.33 Motor Control Centre / Cabling**

As per electrical specifications.

Panel 2mm CRCA sheet, floor mounted.

Starters for fire pumps to be soft starter.

Panel to be fully automatic and linked to fire alarm control panel and BMS.

### 3.0 IDENTIFICATION

#### 3.1 Valve and Equipment Charts

Provide typewritten schedules giving numbers, service and locations, and notations of normal position and future position of all tagged valves. List piping systems with symbol and color coding on pipe identification chart. List valve model numbers and symbol for service corresponding to piping symbol on valve identification chart. Provide small "key plan" identifying valves as related to column lines. Enclose each schedule, list and key plan in separate transparent plastic binder.

Frame one copy of schedule under glass; in equipment room.

Provide typewritten list of equipment, indicating location, service, area served, with equipment reference number corresponding to as-built drawings suitably framed, with glass front, mounted in each equipment room.

Provide engraved plastic laminate identification plate showing function of switches and manually operable controls, including switches furnished under another Division. Provide point numbers on all control system components corresponding to programmed and second drawing point numbers.

#### 3.2 Equipment Identification

Properly identify each piece of equipment and controls pertaining thereto by nameplates mounted on equipment and controls using round head brass machine screws or pop rivets.

Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

Place warning signs on machines driven by electric motors which are controlled by automatic starters.

#### 3.3 Valve Identification

Valve Identification tags shall have the following abbreviations plus valve number.

Service	Abbreviation
Sprinkler	S
Hydrant	H
Water Curtain	W

### 4.0 EXECUTION

#### 4.1 Building Management System and Interfaces

Contractor shall co-ordinate the mechanical system and equipment to interface with the Building Management System in accordance with the data point schedules.

## **4.2 Spare Parts and Tools**

Contractor to submit with his Tender his recommended lists of spares parts for one year operation and maintenance covering all systems and sub- systems of the specification. This list should be priced so that the Employer can, at his discretion, order these spare parts in part or in whole at any time up to the issue of the Performance Certificate without any increase in price.

The Contractor shall also include in the Contract to procure and hand-over the required quantity of spare parts.

## **4.3 Warranties**

Contractor shall warrant that the capacity, rating or duty of all product used in the installation shall be less than 2 years operating under the specified conditions. Any product/system not meeting this requirement shall be rejected and replaced by contractor at his cost.

## **4.4 Safety Equipment and Notices**

Contractor shall supply and install the following safety equipment and notices for each switchboard/control panel in the respective switch rooms and plant rooms:-

Solid rubber insulated mats complying with Indian Standard in front of and extending the full length of the control panel/switchboards.

Copies of all statutory safety notices, regulations and instructions for resuscitation and treatment after electrical shock.

Danger signs on the switchboards/control panels to the requirements of the Power Supply Authority.

A copy of the main single line diagram, varnished and mounted on suitable hard backing and framed (in glass panel), showing clearly the full details of the electrical and mechanical systems as supplied and installed.

Notices as required by all local Authorities.

## **4.5 As-Built Drawings Submissions**

As-built drawings shall be developed and produced during the course of the installation and, when requested by the IRCON / Consultant.

As-built drawings shall be submitted prior to the issue of Taking over Certificate by the IRCON / Consultant.

As-fitted schematic system diagrams, properly framed, shall also be provided and mounted on the wall inside each plant room.

Submission of approved "as-built" or "as manufactured" drawings shall be as specified.

## **5.0 TESTING**

### **5.1 General**

The entire works shall be fully tested in stages as the work proceeds and on completion of work as applicable.

To provide during normal working hours, all necessary labour, instruments, equipment, materials, fuel, power and maker's representatives, to carry out such tests as may be necessary to satisfy the IRCON / Consultant that the installation meets the requirement and intent of the specification as well as such tests required by local Fire Authority as per guide lines.

All piping in the system shall be tested to a hydrostatic pressure of 2 times the working pressure and 1.5 times the working pressure plus 3.5 kg/cm<sup>2</sup> whichever is more. The pressure shall be maintained for a period not less than 24 hours.

Rectify all leakages, make adjustments and retest as required and directed.

All tests shall be made in the presence of the IRCON / Consultant or his representative or inspecting authority.

Tests described hereinafter and including all tests prescribed by the Fire Authority having jurisdiction shall be carried out. Any tests proved unsatisfactory shall be repeated to the satisfaction of the inspecting parties.

To provide skilled technicians/contractor's engineer to commission the plant and associated controls to the satisfaction of the IRCON / Consultant. The engineers will be required to demonstrate the correct procedures in starting and stopping the plant, running the various items of equipment under automatic and manual control and the correct maintenance of the plant.

Water flow rates of all equipment shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.

### **5.2 Method of Testing**

Method of testing shall be as follows:

Pressurize the fire hydrant system by running the main fire pump and after attaining the required pressure shutoff the pump.

Open by-pass valve and allow the pressure to drop in the system. Check that the jockey pump cuts-in and cuts out at the pre-set pressures. If necessary adjust the pressure switch for the jockey pump. Close by-pass valve.

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

Switch off the main fire pump and test check the diesel engine driven pump in the same manner as the electrically driven pump.

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 two hours so that its performance can be checked.

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.

### **5.3 Tanks and Level Switches**

The tanks shall be thoroughly cleaned with water and drained before city mains supply will feed in.

Also before city mains supply will feed in, the level switch shall be simulated for the various cut-in and cut-out settings.

- **Pressure Switches**

The testing equipment shall be suitable for nominal working pressure of 20 bar (PN 20) conforming to the IS, e.g. the pipe work shall conform to relevant IS Code for class C heavy class black mild steel tube. The pressure settings corresponding for pump cut-in (lamp and buzzer energized) and pump cut-out (lamp and buzzer de-energized) and reset differentials shall be tested by applying the hand jacking pump or by opening the test valve.

- **Flow Switches:**

The calibration test equipment shall provide a flow of 60 dm<sup>3</sup>/min over the vane of the flow switch in the direction shown, to be confirmed by the direct reading flow meter.

The flow switch contacts shall make with energisation of the lamp and the buzzer, upon a flow not greater than 60 dm<sup>3</sup>/min flowing over the vane in the correct direction.

- **Hydrostatic Tests:**

All parts of the water circuit shall be filled with water before hydrostatic pressure testing, and pump running tests for verification of pressure and flow rate are conducted.

The hand jacking pump shall be applied to increase the system pressure to 2 times the working pressure and 1.5 times the working pressure plus 3.5 kg/cm<sup>2</sup> whichever is more but in any case not less than 7 bar. The pressure shall be maintained for a period not less than 24 hours.

Where any sections of pipe work or equipments unable to withstand the maximum pipe work test pressure, it shall be isolated during the pipe work test then that section of pipe work or equipment shall be re-tested at the appropriate test pressure.

- **Electrical Tests:**

Electrical tests shall comply with the current edition of IEE regulations and requirements enforced by local authorities.

#### **5.4 Statutory Authorities Tests and Inspections**

As and when notified in writing or instructed by the IRCON / Consultant, submit as-built shop drawing and attend all tests and inspections carried out by the Local Fire Authorities, and shall forthwith execute free of charge any rectification work ordered by the IRCON / Consultant as a result of such tests and inspections which determine non-compliance with Statutory Regulation.

Submit of all necessary forms and shop drawings/as-built drawings to the Statutory Authorities which shall conform in layout to the latest architectural plans submitted kept by these Authorities.

The submission shall comply with the requirements set forth in the current Codes of Practice and circular letters of the Statutory Authorities.

#### **5.5 Preliminary Commission Checks**

Ensure that all equipment is thoroughly cleaned, lubricated and checked for serviceability before setting to work. Particular attention is drawn to the removal of building debris from the pipe work systems.

Special attention is drawn to the need for thoroughly flushing out all pipe work systems to ensure that all foreign matter is removed.

All automatic controls and safety devices shall be inspected and checked for service ability before the working fluid or electricity is applied to the system.

#### **5.6 Commission Checks**

Contractor shall set to work, regulate and calibrate all system in the entire installation. Special attention shall be paid to the following items:

That all valves, switches, controls, etc. are regulated and capable of proper operation and in the case of isolation valves that they are capable of tight shut off.

That all apparatus is silent in accordance with the requirements of this Specification.

That all instruments are correctly calibrated and read accurately.

That all services are tested in accordance with the details in the relevant clauses of this Specification.

Operate pumps, pressure reducing sets, etc. to ensure that all control systems are functioning correctly and are properly set, sequenced or interlocked.

## **6.0 COMMISSIONING**

### **6.1 General**

Contractor shall be responsible for obtaining N.O.C. from Local Fire Service.

All testing and commissioning to enable proper operation of the Works shall be completed to the satisfaction of the IRCON / Consultant.

All final adjustments and final balancing of the equipment/system operation shall be completed before the Date of Taking Over Certificate.

The complete testing and commissioning are deemed to be concluded successfully only when the installation operated properly within the specified limits of its rating continuously without failure of any kind.

Contractor shall arrange for all submissions to Authorities and pay the cost of statutory inspections and certificates.

### **6.2 Attendance to Occupation Permit Application**

Contractor shall provide all necessary attendance to inspections by the IRCON / Consultant and authorities for the purpose of Occupation Permit application.

### **6.3 Operation and Maintenance Instructions Manual**

Each set of Operation and Maintenance Instruction manual shall be in A4 size paper and be bound in rigid covers covered and engraved with lettering giving the Employer's name, project name, IRCON / Consultant name.



Contractor shall submit three (3) sets and a soft copy of this manual for record before Taking Over certificate is issued.

### **Technical Specification**

Technical descriptions and functions of all equipment and components.

Schedules of equipment showing quantities, locations, types, operating duties.

Technical description of all systems and equipment, including circuit diagrams of each printed circuit board and component layout diagram for each printed circuit board installed for this project.

Wiring diagrams.

Manufacturer's drawings.

Equipment list, stating the make, model, serial number, accepted settings (after commissioning).

Catalogues, certificates and performance data sheets for all equipment.

One set of manufacturer's guarantee/ warranty for each equipment supplied.

### **Maintenance Procedure**

Inspection manual for all system/equipment;

Operation manual for all system/equipment;

Maintenance instructions;

Procedures for system fault finding.

### **Directory of Suppliers**

Name of suppliers and agents of each type of equipment, materials and accessories. Correspondence address, telephone number, fax number, pager number, and E-mail address shall be included.

## **6.4 Taking over Procedure**

Contractor shall submit the arrangement of the commissioning to the satisfaction of the IRCON / Consultant.

The installation shall be complete following issue of the N.O.C. by Local Fire Service. It is solely the Contractor's responsibility to ensure that all plant/equipment shall have their respective warranty by the respective equipment/plant supplier directly in favour of client.

A joint inspection shall be held among the IRCON / Consultant and Contractor to establish an outstanding works and defects list. All outstanding works/defects shall be completed within one month from the date when the Taking Over Certificate was issued.

If, at the end of the one month's period from the date of issuing the Taking Over Certificate, any defects/outstanding works mentioned in the list still exist, the IRCON / Consultant is empowered to appoint a body to rectify all defects/outstanding works at the risk and cost of contractor.

## **6.5 Defect Notification Period**

Notwithstanding the liability of the Contractor in terms the Defects Notification Period for Fire Suppression System shall be 12 months. The period commencing on the date of issue of the Taking Over Certificate. During the Defect Notification Period, Contractor shall provide a 24-hour 'call-out' service to repair any equipment that has broken down.

Contractor shall attend to such calls within a maximum time limit of 4 hours.

During the Defect Notification Period, Contractor shall at his own cost remedy and make good with all faults or defects in the Works.

If the Contractor fails to remedy such faults or defects within 48-72 hours, the IRCON / Consultant may proceed to do so at the expense of the Contractor and without prejudice to such other rights as the Employer may have under the Contract.

## **6.6 Building Management System and Interfaces**

All necessary interfacing works with IBMS amongst all installation shall be included.

## **7.0 SCHEDULE OF TECHNICAL DATA**

Contractor shall get approval from the IRCON / Consultant on calculations and details regarding the effectiveness and adequacy of the equipment. Any modification or changes as required shall be made by the Contractor at no extra cost.

## **8.0 FIRE SUPPRESSION SYSTEM**

### **8.1 General**

All the equipment of Fire Suppression System namely Cylinders, Nozzles, and accessories for completing the Fire Suppression system except piping and manifold shall be of one make only.

Following authorizations shall be made available from the manufacturer.

- Technical compliance to the specifications by Manufacturer.
- Providing test reports complying the specifications at the time of inspection.

- Authorization that the items quoted by the tenderer are in production and would be serviceable for at-least 5 years from the date of tender. No obsolete products should be quoted.
- Manufacturer must have presence in India. Manufacturer products shall have quality system is in compliance with the international standards.
- Initial fill & subsequent filling of Seamless Cylinders Location.

### **8.1.1 GAS SUPPRESSION SYSTEM FOR TOTAL ROOM FLOODING SYSTEM**

#### **SCOPE OF TENDER**

Fire suppression system is fire detection and quenching system. This is proposed for flooding entire room with Novec 1230. The Cylinder Valve Assembly must be UL/FM approved with Seamless CCOE approved cylinder and an undertaking from manufacturer must be submitted with the tender to comply the same.

#### **SYSTEM DETAILS**

- a. The amount of FK-5-1-12 (Dodecafluoro-2-Methylpentan-3 One –  $\text{CF}_2\text{CF}_2\text{C}(\text{I})\text{CF}(\text{CF}_3)_2$ ). to be for provided shall be the amount required to obtain a uniform (minimum) design concentration Class 4.7% required to extinguish the fire at minimum anticipated temperature with the risk and as required by NFPA 2001, 2012 Edition with a hold time for 10 minutes. The system design shall not exceeds 10% for normally occupied areas, adjusted for maximum area temperature anticipated with provision for room evacuation before agent release. The system provided shall be Main and 100% reserve.
- b. Necessary warning signs shall be displayed in and near such risk (entry and exit) envisaged for clean agent Gas suppression.
- c. The Pipe used should be MS, ASTM Schedule 40.
- d. The Cylinder to be pressurized at 34.5 Bar and Cylinder Valve Assembly must be UL/FM Listed.
- e. Each cylinder shall have pressure gauge and low pressure switch to provide visual and electrical supervision of the cylinder pressure. The low pressure switch shall be wired to the control panel to provide audible and visual trouble alarm in the event of drop of pressure at 20 Bars and below. The pressure gauge shall be color coded to provide an easy, visual indication of cylinder pressure.
- f. Furnish a welded steel bracket with each cylinder assembly for holding the cylinders in a saddle with a front bracket plate that secures the cylinders depending on installation requirements.

- g. The cylinder shall have pressure relief provisions that automatically operate before the internal nominal pressure exceeds 60 Bars.

### **Extinguishing Agent:**

FK-5-12 (Dodecafluoro-2-Methylpentan-3 One –  $\text{CF}_2\text{CF}_2\text{C}(\text{I})\text{CF}(\text{CF}_3)_2$ ). The Agent shall not contain any Hydrofluorocarbons (HFC).

The manufacture of Agent FK – 5 – 12 should give a 20 year of warrantee against any regulatory bans from Environment agency. The Agent must be UL/FM approved.

Comply with requirements of the authorities having jurisdiction.

Filling facility should be UL Listed / PESO approved.

### **Design Criteria**

- |     |                            |   |
|-----|----------------------------|---|
| 1.  | Standard Code              | : NFPA-2001 (Latest Addition)                       |
| 2.  | Temperature of Risk        | : 20°C to 27°C                                      |
| 3.  | Design Concentration       | : 4.7%  |
| 4.  | Flooding Factor            | : As per Manufacturer                               |
| 5.  | Discharge Time             | : 10 Seconds  |
| 6.  | Design Pressure            | : Upstream of pressure reducer 34.5 Bars            |
| 7.  | Design Pressure            | : Downstream of pressure reducer as per calculation |
| 8.  | Cylinder Capacity          | : 34 Ltr., 80 Ltr., 120 Ltr., 150 Ltr.              |
| 9.  | Nozzle Type                | : 360° / 180°C                                      |
| 10. | Altitude correction factor | : As per Manufacturer                               |
| 11. | Hold Period                | : 10 Minutes  |

### **SUBMITTALS:**

The Contractor must submit mechanical Working Drawing showing Pipe, Pipe Size, Bends, Reducer, Splits, Tee Connection, Valves, Fittings, Supports etc which should be supported with Hydraulic Flow Calculation. The Hydraulic Flow Calculation Software must be UL/UDS/FM approved.

### **Sequence of Operation**

- a) Activation of the First Smoke Detector (the crossed-zoned laser detector)
  - i) Illuminate the respective circuit lamp on the control unit.
  - ii) Energize a pre-alarm audible alarm bell.
  - iii) Treatment remote alarm to the building Fire Alarm Panel.
  - iv) Activation of the Second Smoke Detector (the cross-zoned laser detector).
  - v) Illuminate the respective circuit lamp on the control unit.
  - vi) Energize an evacuation audible alarm horn device.

- vii) Shut down the stand-alone air conditioning units serving the protecting area.
  - viii) Closes the supply and exhaust / return dampers serving the protected area.
  - ix) Activates a time delay mechanism which delays release of the clean agent for up to 20 seconds from the time the 2<sup>nd</sup> loop is activated. The Fire Suppression clean agent is released at the end of the time delay interval unless a “dead man” type abort switch is operated between the 1<sup>st</sup> and 2<sup>nd</sup> detection loops. A timed out system discharges upon abort disengagement unless the system is cleared and reset.
- b) Discharge of the Fire Suppression Clean Agent.
- i) Operates strobe light outside the protected area.
  - ii) The system may be activated by manual discharge switches located in the protected area. Operation of a manual discharge switch causes immediate discharge of the fire suppression agent and causes alarm and shut-down devices to operate the same as if the system had operated automatically operation of a manual discharge switch overrides all time delay and abort system devices in the system.

**PERFORMANCE SPECIFICATIONS****FIRE FIGHTING PERFORMANCE SPECIFICATIONS****Note: All Stainless Steel 304 Grade**

<b>S. NO</b>	<b>PARAMETERS</b>	<b>REQUIREMENTS</b>	
<b>[1]</b>	<b>External Hydrant</b>	(i)	Outlet to be angled towards ground with instantaneous spring lock type female coupling of 63 mm dia. For connecting to hose pipe
		(ii)	Hydrant outlets situated 1 m. above ground level
		(iii)	Hydrant heads positioned at distances not less than 2 m from the face of the building
		(iv)	Two numbers 63 mm dia. 15 m long rubberized fabric lined (RRL) hose pipe with male and female instantaneous type couplings machine wound with Stainless Steel wire (hose to I.S. 636 Type 2 and couplings to I.S. 903 with MS certification) provided near external hydrant
<b>[2]</b>	<b>Internal Hydrant (Landing Valve)</b>	(i)	At each landing, single headed Stainless Steel landing valves (connected to the Fire Riser) with 63 mm dia outlet and 80 mm inlet (I.S.5290), with individual shut off valves and cast iron wheel shall be provided
		(ii)	Valve to have flanged inlet and instantaneous type outlets and to be fixed at a height of 1000 mm from the finished floor
		(iii)	Each internal fire hydrant station to have two numbers of 63 mm dia. 15 m long reinforced rubberized fabric hose pipes with stainless steel male and female instantaneous type coupling machine wound with stainless steel wire (hose to I.S. 636 Type 2 and couplings to I.S. 903 with I.S. Certification) fire hose reel with 20 mm hose 36 meter long, stainless steel branch pipe with nozzle I.S. 903 and Fire man's axe
<b>[3]</b>	<b>First Aid Hose Reel</b>	(i)	Hose tubing to be 20mm dia and 36 m long or as specified.
		(iii)	Hose cabinets shall be fabricated from M.S sheet
<b>[4]</b>	<b>Hose Pipe, Branch Pipes and Nozzles</b>	(i)	Hose pipes to be rubber lined woven jacketed and 63mm in diameter
		(ii)	

S. NO	PARAMETERS	REQUIREMENTS	
			Branch pipe to be of Gunmetal material 63mm dia and complete with male instantaneous spring lock type coupling for connection to the hose pipe
		(iii)	Nozzle Gunmetal, 20mm in (Internal) diameter
		(iv)	Stainless Steel collecting head with three or four 63 mm instantaneous type inlets with built in check valves and 150 mm diameter outlet connected to the fire tank, wet riser or sprinkler
[5]	MS Pipes & Fittings	(i)	ERW pipes 150 mm dia. and below confirming to IS: 1239 part-1, heavy grade, C class
		(ii)	ERW pipes 200 mm dia. and above confirming to IS: 3589 minimum 6.35mm thick, grade 330
[6]	G.I. Pipes & Fittings	(i)	G.I pipes up to 50mm diameter to be galvanized steel tubes grade, conforming to I.S. 1239 heavy grade C class
[7]	Jointing	(i)	Joint for steel pipes and fittings to be metal to metal joints using Teflon tapes on threads for pipes up to 50mm diameter
		(ii)	Welded connection with wrought iron filling for pipe above 50 mm.
[8]	Pipe Protection	(i)	M.S. pipes when buried underground to be painted with two coats of approved primer and wrapped with one layer of 4 mm thick PYPKOTE sheet
[9]	Flanges	(i)	Unions to be avoided wherever the pressure exceeds 7 kg/cm <sup>2</sup>
[10]	Valves	(i)	Valves are to be provided with rating not less than 16kg/cm <sup>2</sup> working pressure for fire systems or as indicated otherwise
		(ii)	Valves up to 50mm dia. to be of gunmetal/bronze body with screwed ends and to be provided with unions on both the sides
		(iii)	Valves above 50mm dia to be of CI body with flanged ends and to be provided with flanges on both the sides for removal and repair

S. NO	PARAMETERS	REQUIREMENTS	
[11]	Ball Valves	(i)	Ball valves to be in accordance to IS: 9890, gun metal with screwed female ends to IS: 554, flanged ends to ASME B 16.5
[12]	Gate Valves	(i)	Gate valves of size 40mm or less to be as per IS: 780 and of size 50mm or more to be as per API 600
		(ii)	All gate valves up to 50 mm to be of hand wheel operated with bronze body, with screwed in bonnet, non rising spindle and solid wedge, with threaded ends as specified and as required by the piping system in which they are installed
		(iii)	All gate valves larger than 50 mm to be of cast iron body with bronze mountings and to be provided with flanged ends as required by the piping system in which they are to be installed
[13]	Globe Valves	(i)	All globe valves 50 mm and smaller to be of bronze body with screwed in bonnet, rising spindle and with threaded ends and as required by the piping system in which they are installed
		(ii)	All globe valves larger than 50 mm to be of cast iron body with bronze mountings and to be provided with flanged ends as required by the piping system in which they are to be installed
[14]	Check Valve	(i)	All check valves 50mm and smaller to be of bronze body and disc, threaded ends or as required by the piping system in which they are installed
		(ii)	All check valves 65mm and larger to be of cast iron body with epoxy coated ductile iron/ stainless steel trim and to be of flanged end as required by the piping system in which they are installed
[15]	Butterfly Valve	(i)	Butterfly valves conforming to IS: 13095 of PN1.6 class
		(iii)	Joints for double flanged butterfly valves to be made with suitable tail/socket pieces on the pipeline and flanges joints made with appropriate number of bolts, nuts and washers with 3 mm thick insertion rubber gasket
[16]	Sluice Valve	(i)	Sluice Valves above 50 mm (inside screw and non-raising screw type) shall be of Cast Iron body and Gunmetal seat with double flanged ends and valve wheel



S. NO	PARAMETERS	REQUIREMENTS	
		(ii)	Sluice valves shall be of approved makes conforming to IS: 780 / BS 5163 of PN16 class
		(iii)	Sluice valves upto 50mm (outside screw raising spindle type) shall be of Gunmetal Full way Valve with wheel tested to 20 Kg./cm <sup>2</sup> class-II as per I.S: 778 with female screwed ends.
[17]	<b>Air Valve</b>	(i)	25 mm dia. screwed inlet C.I. single acting air valve to be necessarily provided on all high points in the system
[18]	<b>Orifice Plates</b>	(i)	Orifice Plates fabricated made of 6mm thick stainless steel of required size
[19]	<b>Drain Pipe</b>	(i)	50 mm dia black steel pipe confirming to IS:1239 (heavy class) with 50 mm gunmetal full way valve for draining any water in the system in low pockets
[20]	<b>Strainers</b>	(i)	Strainers shall be of the approved type with SS body with SS304 Strainer Basket designed to the test pressure of 10 Kg/ cm <sup>2</sup> . Strainers shall be fabricated with minimum 1.2mm thick stainless steel sheet with 3 mm dia. perforation holes
[21]	<b>Hangers and Supports</b>	(i)	Vertical pipes to have riser clamps not to exceed 4.5 m spacing
		(ii)	Horizontal piping to be supported at intervals not greater than 3m spacing and at all changes of direction
		(iii)	The size/ diameter of the anchor fastener and the clamp to be suitable to carry five times of the weight of water filled pipe plus 100 kg pressure
[22]	<b>Pressure Gauge</b>	(i)	Each pumping set shall be provided with a 150mm dia or of suitable size gunmetal "Bourden" type pressure gauge with gunmetal isolation cock and connecting piping
		(ii)	Pressure gauges to read 0-10 Kg/sqcm
[23]	<b>Hydrant/Valve Chambers</b>	(i)	Valve chambers to be of following size:- I. 120 x 120 cms x 100 cms II. 90 x 90 cms x 100 cms
[24]	<b>Flow Switch</b>	(i)	

S. NO	PARAMETERS	REQUIREMENTS	
			Flow switch to be suitable to actuate within 90 seconds of opening of a single sprinkler and to be suitable for connection to a central Annunciation Panel
[25]	<b>Sprinklers as per performance curves</b>	(i)	Sprinklers to be rated for ordinary temperatures (68 deg. C)
[26]	<b>Fire Extinguishers</b>	(i)	The Extinguisher shall be filled with ABC Grade 40, Mono Ammonium Phosphate (MAP base)
		(ii)	The Capacity of the extinguisher when filled with Dry Chemical Powder (First filling) as per IS 4308, part II 8/ IS 2171, shall be 5 kg +/-2 % or 10 kg +/-3 %.
		(iii)	Nitrogen to be charged at a pressure of 15 kg / cm <sup>2</sup>
[27]	<b>Jockey Pump</b>	(i)	Pump to be capable of delivering 150% of rated capacity at not less than 65% of rated head
[28]	<b>Electric Motor</b>	(i)	For fire pumps the motors to be rated not to draw starting current more than 3 times normal running Currents
		(ii)	Motors to be suitable for 415+ 10% phase, 50 cycles, AC supply and to be designed for 42°C temperature
[29]	<b>Diesel Engine</b>	(i)	Engine to efficiently operate at 40 deg, ambient temperature at 50 meters above mean sea levels
		(ii)	Noise level of the engine should not exceed 105 DBA (free field sound pressure) at 3 meters means distance
		(iii)	Engine to be self starting type up to 4 deg C and to be provided with 24 volts heavy duty DC battery
		(iv)	The battery to have a capacity not less than 180ampere hours/ as recommended by manufacturer.
[30]	<b>Testing</b>	(i)	All piping shall be tested to hydrostatic test pressure of minimum 14 kg/cm <sup>2</sup> or 1.5 times the design pressure whichever is higher for a period of not less than 24 hours
		(ii)	For testing pipe work, when installed and subjected to the test loadings the pipe to be supported in excess of 8mm.
		(iii)	While testing pressure switches, testing equipment to be suitable for nominal working pressure of 16 bar (PN 16) conforming to the IS.

S. NO	PARAMETERS	REQUIREMENTS	
		(iv)	While testing flow switches, calibration test equipment to provide a flow of 60 dm <sup>3</sup> /min over the vane of the flow switch in the direction shown, to be confirmed by the direct reading flow meter
		(v)	In hydrostatic test, hand jacking pump to be applied to increase the system pressure to 2 times the working pressure and 1.5 times the working pressure plus 3.5 kg/cm <sup>2</sup> whichever is more but in any case not less than 7 bar for a period not less than 24 hours
		(vi)	In electrical test, 500V DC instrument to be used to check the insulation resistance. The reading shall not be less than 1 mega-ohm in all instances.

**NOTE:**

The Contractor has to carry out the detailed engineering design of services in coordination with Architectural, Structural and other services requirement as per the duly approved layouts to be obtained by the Contractor.

The services drawing are indicative and show the detailed design parameters to be adopted: makes of sanitary fixtures and fittings to be used; by the contractor in addition to parameters specified in DBR and Technical Specification.

## **TECHNICAL SPECIFICATIONS**

### **HVAC WORKS**

#### **(Section – 6)**

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**CENTRIFUGAL CHILLER WITH VFD****1.0 General:**

- 1.1 Factory assembled, liquid chiller shall consist of compressor, motor, starter, lubrication system, cooler, condenser, initial oil and refrigerant operating charges, microprocessor control system, and documentation required prior to start-up.
- 1.2 Free standing/Unit Mounted VFD starter shall include interconnecting cabling.
- 1.3 Chiller shall have full charge of R134a / R514a refrigerants.
- 1.4 Automatic tube cleaning system for condenser.
- 1.5 **Performance will be certified in accordance with AHRI Standard.**

**2.0 Compressor:**

- 2.1 One no. semi-hermetic/open centrifugal, single/multi stage compressor suited for high performance.
- 2.2 Internal compressor parts must be accessible for servicing without removing the compressor base from the chiller. Connections to the compressor casing shall use O-rings instead of gaskets to reduce the occurrence of refrigerant leakage. Connections to the compressor shall be flanged or bolted for easy disassembly.
- 2.3 All pressure transducers shall have quick disconnects to allow replacement of the sensor without replacement of the entire sensor wire. Pressure transducers shall be capable of field calibration to ensure accurate readings and to avoid unnecessary transducer replacement. Pressure transducers and temperature sensors shall be serviceable without the need for refrigerant charge removal or isolation.
- 2.4 Transmission shall be single ratio, single helical, parallel shaft speed increaser. Gears shall conform to AGMA Standards, Quality II.
- 2.5 Journal bearings shall be of the steel backed Babbitt lined type. Aluminum journal bearings are not acceptable. The thrust bearing shall be tilting pad or rolling element type.
- 2.6 Centrifugal compressors shall use variable inlet guide vanes to provide capacity modulation while also providing pre-whirl of the refrigerant vapor entering the impeller for more efficient compression at all loads.
- 2.7 Centrifugal compressors shall be provided with a factory-installed lubrication system to deliver oil under pressure to bearings and transmission. Included in the system shall be:
  - 2.7.1 Hermetic driven rotary vane oil pumps with factory-installed motor contactor with overload protection.
  - 2.7.2 Refrigerant-cooled oil cooler. Water-cooled oil coolers are not acceptable.
  - 2.7.3 Oil pressure regulator.
  - 2.7.4 Oil filter with isolation valves to allow filter change without removal of refrigerant charge.

- 2.7.5 Oil sump heater controlled from unit microprocessor.
- 2.7.6 Oil reservoir temperature sensor with main control center digital readout.
- 2.7.7 When factory-mounted or free standing compressor motor starter is provided, all wiring to oil pump, oil heater, and controls shall be prewired.
- 2.7.8 Compressor shall be fully field serviceable. Compressors which must be removed and returned to the factory for service shall be unacceptable.

### **3.0 Motor:**

- 3.1 Compressor motor shall be totally enclosed with minimum IP 55 protection/Equivalent & above. Motor shall be suitable for 415 +/- 10% volts, 3 phase, 50 cycles AC supply. Totally Enclosed Water cooled to Air-cooled (TEWAC)/Totally Enclosed Fan Cooled (TEFC) for Open type chillers or Totally Enclosed refrigerant cooled (TERC) for hermetic/semi hermetic chiller, squirrel cage, induction type.
- 3.2 If an open drive motor is provided, a compressor shaft seal leakage containment system shall be provided:
- 3.3 An oil reservoir shall collect oil and refrigerant that leaks past the seal.
- 3.4 A float device shall be provided to open when the reservoir is full, directing the refrigerant/oil mixture back into the compressor housing.
- 3.5 A refrigerant sensor shall be located next to the open drive seal to detect leaks.
- 3.6 Motors shall be suitable for operation in a refrigerant atmosphere and shall be cooled by atomized refrigerant in contact with the motor windings.
- 3.7 One motor winding temperature sensor (and one spare) shall be provided.
- 3.8 Motor stator shall be arranged for service or removal with only minor compressor disassembly and without removing main refrigerant piping connections.
- 3.9 Full load operation of the motor shall not exceed nameplate rating.
- 3.10 The additional piping, valves, air-handling equipment, insulation, wiring, switchgear changes, ductwork, and coordination with other trades shall be the responsibility of the mechanical contractor. Shop drawings reflecting any changes to the design shall be included in the submittal and incorporated into the final as-built drawings for the project.

### **4.0 Cooler and Condenser:**



- 4.1 Cooler shall be of shell and tube type construction, each in separate shells. Material of Construction shall conform to GB Codes / ASME codes as per below table

Shell	:	GB6654-20R
Nozzle on Shell	:	GB8163-20
HX Tube	:	Finned Copper
Tube sheet	:	GB6654-16MnR
Water box	:	HR Steel
First flange on nozzle of shell	:	JB4726-16Mn Forging

Units shall be fabricated with high-performance tubing, minimum ¼ inch steel shell and tube sheets with fabricated steel water boxes.

- 4.1.1 Unit manufacturer shall furnish nozzle-in-head style water boxes on the cooler and/or condenser rated at 150 psig.
- 4.1.2 Water box shall have standard Flange / Victaulic grooves.
- 4.2 Condenser shall be of shell and tube type construction, each in separate shells. Units shall be fabricated with high-performance tubing, minimum ¼ inch steel shell and tube sheets with fabricated steel water boxes.
- 4.3 Tubes shall be individually replaceable from either end of the heat exchanger without affecting the strength and durability of the tube sheet and without causing leakage in adjacent tubes.
- 4.4 Tubing shall be copper, high-efficiency type, with integral internal and external enhancement unless otherwise noted. Tubes shall be nominal 3/4-in. OD with nominal wall thickness of 0.028 in. measured at the root of the fin at the enhanced areas and nominal wall thickness of 0.049 in. where the tubes are in contact with the end tube sheets unless otherwise noted. Tubes shall be rolled into tube sheets and shall be individually replaceable. Tube sheet holes shall be double grooved for joint structural integrity.
- 4.5 Water boxes shall have vents, drains, and covers to permit tube cleaning within the space shown on the drawings. A thermistor type temperature sensor with quick connects shall be factory installed in each water nozzle.
- 4.6 Cooler shall be designed to prevent liquid refrigerant from entering the compressor. Devices that introduce pressure losses (such as mist eliminators) shall not be acceptable because they are subject to structural failures that can result in extensive compressor damage.
- 4.7 The condenser shell shall include a FLASC (Flash Sub cooler) which cools the condensed liquid refrigerant to a reduced temperature, thereby increasing the refrigeration cycle efficiency.
- 4.8 A reseating type pressure relief valve shall be installed on each heat exchanger. If a non-reseating type is used, a backup reseating type shall be installed in series.

## 5.0 **Refrigerant Flow Control:**

To improve part load efficiency, liquid refrigerant shall be metered from the condenser to the cooler using a float-type metering valve to maintain the proper liquid level of refrigerant in the heat exchangers under both full and part load operating conditions. By maintaining a liquid seal at the flow valve, bypassed hot gas from the condenser to the cooler is eliminated. The float valve chamber shall have a bolted access cover to allow field inspection and the float valve shall be field serviceable.

## **6.0 Controls, Safeties, and Diagnostics:**

### **6.1 Controls:**

- 6.1.1 The chiller shall be provided with a factory installed and wired microprocessor control center. The control center shall include a 16-line by 40-character liquid crystal display, 4 function keys, stop button, and alarm light. The microprocessor can be configured for either English or SI units.
- 6.1.2 All chiller and starter monitoring shall be displayed at the chiller control panel.
- 6.1.3 The controls shall make use of non-volatile memory.
- 6.1.4 The chiller control system shall have the ability to interface and communicate directly to the building control system.
- 6.1.5 The default standard display screen shall simultaneously indicate the following minimum information:  
Date and time of day
  - 24-character primary system status message
  - 24-character secondary status message
  - Chiller operating hours
  - Entering chilled water temperature
  - Leaving chilled water temperature
  - Evaporator refrigerant temperature
  - Entering condenser water temperature
  - Leaving condenser water temperature
  - Condenser refrigerant temperature
  - oil supply pressure
  - oil sump temperature
  - percent motor Rated Load Amps (RLA)

6.1.6 In addition to the default screen, status screens shall be accessible to view the status of every point monitored by the control center including:

- Evaporator pressure
- Condenser pressure
- Bearing oil supply temperature
- Compressor discharge temperature
- Motor winding temperature
- Number of compressor starts
- control point settings
- Discrete output status of various devices
- Compressor motor starter status
- Optional spare input channels
- Current and voltage for each phase
- Frequency

6.1.7 Schedule Function:

The chiller controls shall be configurable for manual or automatic start-up and shutdown. In automatic operation mode, the controls shall be capable of automatically starting and stopping the chiller according to a stored user programmable occupancy schedule. The controls shall include built-in provisions for accepting:

- A minimum of two 365-day occupancy schedules.
- Minimum of 8 separate occupied/unoccupied periods per day.
- Daylight savings start/end.
- 18 user-defined holidays.
- Means of configuring occupancy timed override.
- Chiller start-up and shutdown via remote contact closure.

6.1.8 Service Function:

The controls shall provide a password protected service function which allows authorized individuals to view an alarm history file which shall contain the last 25 alarm/alert messages with time and date stamp. These messages shall be displayed in text form, not codes.

#### 6.1.9 Network Window Function:

Each chiller control panel shall be capable of viewing multiple point values and status from other like controls connected on a common network, including controller maintenance data. The operator shall be able to alter the remote controller's set points or time schedule and to force point values or statuses for those points that are operator forcible. The control panel shall also have access to the alarm history file of all like controllers connected on the network.

#### 6.1.10 Pump Control:

Upon request to start the compressor, the control system shall start the chilled water pump, condenser water pumps and verify that flows have been established.

#### 6.1.11 Ramp Loading:

A user-configurable ramp loading rate, effective during the chilled water temperature pulldown period, shall control the rate of guide vane opening to prevent a rapid increase in compressor power consumption. The controls shall allow configuration of the ramp loading rate in either degrees/minute of chilled water temperature pulldown or percent motor amps/minute. During the ramp loading period, a message shall be displayed informing the operator that the chiller is operating in ramp loading mode.

#### 6.1.12 Chilled Water Reset:

The control center shall allow reset of the chilled water temperature set point based on any one of the following criteria:

- Chilled water reset based on an external 4 to 20 mA signal.
- Chilled water reset based on a remote temperature sensor (such as outdoor air).
- Chilled water reset based on water temperature rise across the evaporator.

#### 6.1.13 Demand Limit:

The control center shall limit amp draw of the compressor to the rated load amps or to a lower value based on one of the following criteria:

- Demand limit based on a user input ranging from 40% to 100% of compressor rated load amps.
- Demand limit based on external 4 to 20 mA signal.

#### 6.1.14 Controlled Compressor Shutdown:

The controls shall be capable of being configured to soft stop the compressor. When the stop button is pressed or remote contacts open with this feature active, the guide vanes shall close to a configured amperage level and the machine shall then shut down. The display shall indicate “shutdown in progress.”

## 6.2 Safeties:

6.2.1 Unit shall automatically shut down when any of the following conditions occur: (Each of these protective limits shall require manual reset and cause an alarm message to be displayed on the control panel screen, informing the operator of the shutdown cause.)

- motor overcurrent
- over voltage\*
- under voltage\*
- single cycle dropout\*
- bearing oil high temperature
- low evaporator refrigerant temperature
- high condenser pressure
- high motor temperature
- high compressor discharge temperature
- low oil pressure
- prolonged surge
- loss of cooler water flow
- loss of condenser water flow
- starter fault

\*Shall not require manual reset or cause an alarm if auto-restart after power failure is enabled.

6.2.2 The control system shall detect conditions that approach protective limits and take self-corrective action prior to an alarm occurring. The system shall automatically reduce chiller capacity when any of the following parameters are outside their normal operating range:

- high condenser pressure

- high motor temperature
- low evaporator refrigerant temperature
- high motor amps.

6.2.3 During the capacity override period, a pre-alarm (alert) message shall be displayed informing the operator which condition is causing the capacity override. Once the condition is again within acceptable limits, the override condition shall be terminated and the chiller shall revert to normal chilled water control. If during either condition the protective limit is reached, the chiller shall shut down and a message shall be displayed informing the operator which condition caused the shutdown and alarm.

6.2.4 Internal built-in safeties shall protect the chiller from loss of water flow. Differential pressure switches shall not be allowed to be the only form of freeze protection.

### 6.3 Diagnostics and Service:

A self diagnostic controls test shall be an integral part of the control system to allow quick identification of malfunctioning components. Once the controls test has been initiated, all pressure and temperature sensors shall be checked to ensure they are within normal operating range. A pump test shall automatically energize the chilled water pump, condenser water pump, and oil pump. The control system shall confirm that water flow and oil pressure have been established and require operator confirmation before proceeding to the next test. A guide vane actuator test shall open and close the guide vanes to check for proper operation. The operator manually acknowledges proper guide vane operation prior to proceeding to the next test. In addition to the automated controls test, the controls shall provide a manual test which permits selection and testing of individual control components and inputs. A thermistor test and transducer test shall display on the ICVC (International Chiller Visual Controller) screen the actual reading of each transducer and each thermistor installed on the chiller. All out-of-range sensors shall be identified.

### 6.4 Multiple Chiller Control:

The chiller controls shall be supplied as standard with a two chiller lead/lag and a third chiller standby system. The control system shall automatically start and stop a lag or second chiller on a two chiller system. If one of the two chillers on line goes into a fault mode, the third standby chiller shall be automatically started. The two chiller lead/lag system shall allow manual rotation of the lead chiller, include load balancing if configured, and a staggered restart of the chillers after a power failure.

## 7.0 **Electrical Requirements:**

Contractor shall supply and install main electrical power line, disconnect switches, circuit breakers, and electrical protection devices per local code requirements and as indicated necessary by the chiller manufacturer.

Contractor shall wire the chilled water pump, condenser water pump, and tower fan control circuit to the chiller control circuit.

Contractor shall supply and install electrical wiring and devices required to interface the chiller controls with the building control system if applicable.

Electrical power shall be supplied to the unit at the voltage, phase, and frequency listed in the equipment schedule.

## **8.0 Variable Frequency Drive (VFD):**

- 8.1 The VFD starter shall be Freestanding/Unit Mounted and have all interconnecting wiring and piping between the VFD and the chiller. Electrical connection for compressor motor power shall be limited to main power leads to the VFD and wiring liquid pumps and tower fans to the chiller control circuit.

VFD shall be tested to UL standard-508 & shall also meet C-UL & CE marked, built to ISO-9001 standard.

Drive shall be PWM type utilizing IGBT's with a power factor of 0.95 or better at all loads and speeds.

The VFD shall incorporate the following features:

### **8.2 VFD Design:**

Microprocessor based, pulse width modulated (PWM) design. Input power devices are diodes.

Converter section with full-wave fixed diode bridge/SCR converts incoming fixed voltage/frequency to fixed DC voltage.

AC Line Reactor to smooth converted DC voltage

Transistorized inverter and control regulator converts the fixed DC voltage to a sinusoidal wave, Pulse Width Modulated (PWM) wave form.

Integrated controls coordinate motor speed and guide vane position to optimize chiller performance over a wide variety of operating conditions.

Surge prevention and surge protection algorithms take action to prevent surge and move chiller operation away from surge.

The following features shall be provided: a door interlocked circuit breaker, capable of being padlocked; UL listed ground fault protection; over voltage and under voltage protection; 3 phase sensing motor over current protection; single phase protection; insensitive to phase rotation; over temperature protection; digital readout at the Chiller unit control panel of:

Output frequency

Output voltage

3 phase output current

Input kilowatts (KW) and Kilowatt-hours (KWH)

Self-diagnostic service parameters

### **8.3 Enclosure:**

Pre-painted, minimum IP-54/55 protection cabinet shall include hinged, lockable doors and removable lifting lugs.

8.4 VFD Electrical Service (single point power):

The VFD shall have input circuit breaker

The VFD shall have standard branch oil pump circuit breaker to provide power for chiller oil pump.

The VFD shall have standard 3 KVA control power transformer with circuit breaker to provide power for oil heater, VFD controls and chiller controls.

The branch oil pump circuit breaker and control power transformer shall be factory-wired.

Input power shall be 415  $\pm 10\%$  V, 3 Phase, 50 Hz,  $\pm 2\%$  Hz. AC Supply.

- 8.5 A harmonic filter that limits electrical power supply distortion for the variable speed drive to comply with the guidelines of IEEE Std. 519-1992 shall be provided. Total Harmonics distortion within 5%. The filter shall be unit mounted within the same NEMA-1 enclosure and shall be UL listed (Optional). The following digital readouts shall be provided at the Chiller unit control panel as part of the filter package:

Input KVA

Total power factor

3 phase input voltage

3 phase input current

3 phase input voltage total harmonic distortion (THD)

3 phase input current total demand distortion (TDD)

Self diagnostic service parameters.

Separate meters for this information shall not be acceptable.

9.0 Vibration Isolation:

Chiller manufacturer shall furnish neoprene isolator/VI pads for mounting equipment on a level concrete surface.

10.0 Quality Assurance

- 10.1 Chiller performance shall be rated in accordance with AHRI Standard 550/590, latest edition.
- 10.2 Equipment and installation shall be in compliance with ANSI/ASHRAE 15 (latest edition).
- 10.3 Cooler and condenser refrigerant side shall comply with GB Codes / ASME Codes.



- 10.4 Chiller shall be designed and constructed to meet GB Codes / ASME Codes and have labels appropriately affixed.
- 10.5 Centrifugal compressor impellers shall be dynamically balanced and over-speed tested by the manufacturer at a minimum of 120% design operating speed. Each compressor assembly shall undergo a mechanical run-in test to verify vibration levels, oil pressures, and temperatures are within acceptable limits. Each compressor assembly shall be proof tested at a minimum 204 psig (1406 kPa) and leak tested at 185 psig (1276 kPa) with a tracer gas mixture.
- 10.6 Entire chiller assembly shall be proof tested at 204 psig (1406 kPa) and leak tested at 185 psig (1276 kPa) with a tracer gas mixture on the refrigerant side. The water side of each heat exchanger shall be hydrostatically tested at 1.3 times rated working pressure.
- 10.7 Prior to shipment, the chiller automated controls test shall be executed to check for proper wiring and ensure correct controls operation.
- 10.8 Chillers shall be with unit-mounted or free-standing compressor motor starter with interconnecting wires and tested to verify proper operation.
- 11.0 Necessary AHRI approved Computer selection with Model / catalogues to be submitted with quote for evaluation.

#### 12.0 WITNESS TEST

Prior to shipment, chilling machines shall be subjected to inspection and witness of performance tests by Consultant and Owner's representative to verify various performance parameters as confirmed by vendor earlier at the time of award of contract. Performance test shall be carried out as per procedure laid down by AHRI / EUROVENT and as per specified parameter, at 100%, 75%, 50% & 25% loading. Temp. of leaving chilled water shall be kept constant during part load testing.

Fouling factor simulation for condenser and evaporator shall be done as per AHRI-550/590 latest addition. Incremental temperature difference (to be calculated based on Normative appendix-C of AHRI-550/590 latest addition) on account of designed fouling factors shall be added in condenser water entering temperature and shall be subtracted for leaving chilled water temperature. Chiller shall produce design refrigeration capacity and guaranteed power consumption at these corrected set of entering condenser water and leaving chilled water temperature. Outside tube surface area (for condenser and flooded evaporators) and inside tube surface area (for DX-Evaporator), being inputs for ARI mathematical model for fouling, shall be submitted along with the offer.

All expenses inclusive of business class airfare, boarding lodging etc. relating to the witness test will be borne by the vendor / contractor.

#### 13.0 Design Parameters:

Performance rating of the water chilling machine shall be based on the following design parameters.

Temperature of chilled water entering chiller	:	(54° F) 12.2° C
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Temperature of chilled water leaving chiller	:	(44° F) 6.7° C
Fouling factor for chiller	:	0.0005 sqft/hr °F/Btu
Max. permissible pressure drop in chiller	:	10 m of water head
Temperature of condenser water entering condenser	:	(88° F) 31.1° C
Temperature of condenser water leaving condenser	:	(98° F) 36.7° C
Fouling factor for condenser	:	0.001 sqft/hr °F/Btu
Max. permissible pressure drop in condenser	:	10 m of water head
Refrigerant	:	R134a / R514a
COP / IPLV at AHRI conditions	:	6.5 / 8.9

***Minimum requirement of either COP or IPLV of respective efficiency level shall be met.***

Chiller COP shall be fine-tuned in accordance with energy simulation results provided by contractor.

**WATER-COOLED SCREW CHILLING MACHINE WITH STAR-DELTA STARTER****1.0 SCOPE**

The scope of this consists of but is not necessarily limited to the following:

- a. Manufacture and supply of screw liquid chillers with associated motors, soft starter and accessories.
- b. Automatic tube cleaning system for condenser.
- c. All associated items herein to be supplied delivered and installed.
- d. In case of multiple compressors, distribution panel having one incoming and multiple outgoings (equal to number of compressors) along with cabling from panel to compressor motors.
- e. Assembly of chiller components including connection of coolers, condensers, motors, compressors, purge system for low pressure machine etc. into complete refrigeration machines.
- f. Provide manufacturer's factory representative's services, including coordination, and start-up and testing supervision.
- g. Testing (factory and field), start-up supervision, training and providing necessary documentation and tools for operation.
- h. Carry out performance test run at site.

**2.0 QUALITY ASSURANCE PROGRAM**

- a. Chillers shall be rated in accordance with parameters indicated. Pressure vessels shall be designed, constructed, tested, stamped and complete with devices in accordance with ANSI/ASHRAE 15-1989 Safety Code and ASME Code.
- b. Chillers shall be the product of a manufacturer normally supplying this type of equipment.
- c. The chiller shall be designed/manufactured and tested in accordance with the applicable portions of the latest revisions of the following Standards and Codes.

ARI 550 / 590 - Performance rating of water chilling packages using the vapor  
- 2003 compression cycle.

ARI 575 - Air Conditioning and Refrigeration Institute. Standard Method of  
Measuring Machinery Sound Within Equipment Rooms (Base of all  
data presented or field testing of equipment with relation to sound  
requirements).

ASME CODE - American Society of Mechanical Engineers Code for Unfired  
Pressure Vessels - Section VIII (Design, construction, testing and  
certification of pressure vessels).

- |            |   |   |
|------------|---|---|
| ANSI-B9.1  | - | American National Standards Institute. Safety Code for Mechanical Refrigeration (overall general safety requirements, relief device sizing, etc.) |
| ANSI-B31.5 | - | American National Standards Institute. Code for Refrigerant Piping.   |
| ISO R281   | - | Rolling Bearings – Dynamic Load Ratings and Rating for Life.  |

### 3.0 CAPACITY

Actual refrigeration capacity of chilling machine shall be as shown on Drawings and indicated in DBR.

### 4.0 COMPRESSOR

Compressor shall have open / semi-hermetic direct / gear drive with integrate lubrication system utilizing compressor pressure differential / oil pump. Refrigerant shall be R134a / R514a. Compressor casing shall be constructed from a high strength iron casting, having reinforced double wall construction to provide a rigid structure and minimize the transmission of noise. Multiple pressure lubricated rolling element bearing shall be used to absorb axial thrust as well as radial load. Minimum 80 mesh reinforced SS strainer shall be provided at the suction of compressor for protection. Rotors shall be precision made from ductile iron.

Oil separator shall be provided at discharge side of compressor. Oil separator can be an integral part of compressor or alternatively, it could be separate pressure vessel. Oil separator shall contain impingement plate, removable SS oil strainer and electrical oil heater. Drained oil from oil separator shall be piped back to the compressor.

Step-less capacity control to exactly match system load shall be provided. A microprocessor-based controller shall modulate slide valve in response to chilled water outlet temp. controller shall be programmed for PID&T logic. Compressor shall be able to unloaded upto 10% of load with stable running.

### 5.0 MICRO COMPUTER CONTROL CENTRE

Each unit shall be furnished with microcomputer control center in a locked enclosure, factory mounted, wired and tested. The control center shall include a 40-character alphanumeric display showing all system parameters in English language with numeric data in English (FPS) units.

Digital programming of essential setpoints through a colour coded, tactile-feel keypad shall include: entering and leaving chilled water temperature and condensing water temperature; percent loading; pull down demand limiting; seven-day time clock for starting and stopping chiller (complete with local holiday schedule); and remote reset temperature range.

All safety and cycling shutdowns shall be annunciated through the alphanumeric display and consist of day, time, cause of shutdown, and type of restart required. Safety shutdowns shall include: high oil pressure; high compressor discharge temperature; low evaporator pressure; motor controller fault; and sensor malfunction. cycling shutdowns shall include: low water temperature; low oil temperature; chiller / condenser water flow interruption; power fault; internal time clock; and entire cycle.

System operating information shall include: return / leaving chilled water temperatures; return/leaving condenser water temperatures; evaporator / condenser refrigerant pressure; differential oil pressure; percent motor current; evaporator/condenser saturation temperatures; operating hours (Hours Run) and number of compressor starts.

Security access shall be provided to prevent unauthorized change of setpoints to allow local or remote control of the chiller, and to allow manual operation of the pre rotation vanes and oil pump.

The chiller shall be provided with an RS-232 port to output all system operating data, shutdown/cycling messages and a record of the last four cycling or safety shutdowns to a remote printer or Building Automation System (BAS). The control center shall be programmable to provide data logs to the BAS/printer at a set time interval.

Control center shall be able to interface with the Building Automation System (BAS) to provide remote chiller start/stop reset of chilled water temperature reset of current limit; and status messages indicating chiller is ready to start, chiller is operating, chiller is shut down on a safety requiring reset, and chiller is shut down on a recycling safety.

## 6.0 INTERFACE WITH BUILDING AUTOMATION SYSTEM

All necessary hardwares / softwares to integrate the chiller panel to BAS system shall be provided free of cost by chiller manufacturer / supplier. Control panel should be with open protocol like Modbus RTU/ Bacnet/ Lon work for integrating with BAS.

For the integration of Microprocessor Panel of the chilling machine with the Building Automation System, an Interface Control Document shall be developed by BAS Unit. It shall be responsibility of HVAC Team to provide following to BAS Team for preparing the interface.

- a. Hardware Protocol of Chiller Microprocessor panel.
- b. Software Protocol of Chiller Microprocessor panel.
- c. Communication structure relating to collection of message / event information.
- d. Description of the formatted packets / blocks of data which construct controller commands / responses.
- e. Written permission to contractor to develop the interface without any financial implication.

## 7.0 ELECTRIC MOTOR

Motor shall be energy efficient and suitable for  $415 \pm 10\%$  volts, 3 phase, 50 cycles AC supply. Hermetic/semi hermetic motors shall be suction gas cooled, two pole, squirrel cage induction types. In case of open compressor type motors shall be screen protected drip proof squirrel cage induction type. Motor shall be designed and guaranteed for continuous operation. Insulation of motors shall be F class. Temperature rise of motor under rated service conditions shall not exceed 80 Deg C (by resistance method of measurement) over an ambient of 40 Deg C. the motor shall be provided with a combination of ball and roller bearing.

Starting current at rated voltage and frequency shall not exceed 2 times of full load current at rated voltage and frequency.

Terminal box of sturdy construction shall provide enough space for terminating, connecting and earthing of PVC - insulated aluminium conductor cable. All terminal boxes shall be located at the same side of the motor and have terminal and cable glands suitable for the specified cables.

The efficiency and power factor shall be not less than the following values, at rated voltage and frequency and at the specified loads.

Load	Efficiency	Power Factor
Full Load	96%	0.86
3/4	96%	0.8
1/2	96%	0.8

Starting current at rated voltage and frequency shall not exceed 2 times the full load current at the rated voltage and frequency. The total efficiency shall include losses of the auxiliaries such as independent excitation, motor-driven fans, lube-oil pumps etc. Over voltage surge protection shall be provided to protect motor.

#### 8.0 STARTER

Shall be close transition star delta starter or soft starter to ensure starting current at rated voltage & frequency does not exceed 2 times full load current.

All components of starter shall be housed in dust proof enclosure and suitable for  $415 \pm 10\%$  volts 50 cycles 3 phase AC power supply.

#### 9.0 EVAPORATOR AND CONDENSER

- a. Shells and Water Boxes: The evaporator and condenser shells will be of rolled carbon steel plate with fusion welded seams. Removable compact water boxes of cast iron or welded steel with stub-out water connections shall be provided to permit access for tube cleaning and replacement. Water boxes shall be designed for **150 psig** working pressure and **hydraulically tested at 225 psig**. The tubes shall be finned from outside having spiral ridges from inside, roller expanded into the tube sheets providing a leakproof seal. The tube material will be copper, intermediate steel tube supports should be provided at intervals not exceeding 1200 mm.
- b. Evaporator (Chiller): Chiller shall be provided with eliminator to prevent liquid carry over to the compressor. The chiller shall be provided with liquid level sight glass and a relief device (of the bursting type) to prevent excess pressure in the heat exchanger. The chiller shall be horizontal, shell and tube type, provided with the following connections and accessories, as separately identified in the schedule of quantities:
  - i. Refrigerant inlet and outlet pressure gages.

- ii. Water inlet and outlet connections.
- iii. Drain and vent connections with stop valves.
- iv. Pressure gauges on water inlet and outlet connections.
- v. Descaling valves.

Chiller shall be insulated with 25 mm thick nitrile rubber. The insulation shall be set with compound recommended by the insulation manufacturer and shall be applied sealing the joints. The insulation shall be applied in such a manner that water boxes and covers shall be removable without damaging it.

- c. Water cooled Condenser: The condenser shall be of same construction as for chiller above (without insulation). It shall be complete with the accessories as separately defined in the schedule of quantities. Shell side volume of the condenser shall be high enough to contain complete refrigerant charge in case of pump-down. In case of chiller with de-superheater, main condenser shall be sized for 100% heat rejection duty.

Air cooled condenser shall be constructed of copper tubes and die formed aluminium fins giving self-spacing collars. Fins shall be mechanically bonded to the tubes. Coil shall be with anti-corrosive coating, suitable to operate in saline, coastal humid environment. Condenser fans shall be direct driven, heavy duty axial type. Blades shall be of aluminium. Fan motor shall be 6 pole with internal overload protection and shall be permanently lubricated. Belt driven fans are not acceptable.

## 10.0 INSTALLATION

The chilling machine shall be installed over a cement concrete platform and shall be adequately isolated as per manufacturers recommendations against transmission of vibrations to the building structure.

## 11.0 PAINTING

Screw water chilling machine shall be finished with durable enamel paint. Shop coats of paint that have become marred during shipment or erection, shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop-painted surfaces.

## 12.0 PERFORMANCE RATING

The unit shall be selected for the lowest operating noise level Capacity ratings, and power consumption with operating points clearly indicated, shall be submitted and verified at the time of testing and commissioning of the installation. Capacity shall be ascertained by measurements of chilled water flow rate and temperature of chilled water in and out of the chilling unit.

Power consumption shall be computed from measurements of incoming voltage & input current to the chilling machine.

Sound Pressure level for Air cooled chillers shall not exceed 75dBA at 1m distance from chiller.

## 13.0 WITNESS TEST

Prior to shipment, chilling machines shall be subjected to inspection and witness of performance tests

by Consultant and Owner's representative to verify various performance parameters as confirmed by vendor earlier at the time of award of contract. Performance test shall be carried out as per procedure laid down by AHRI / EUROVENT and as per specified parameter, at 100%, 75%, 50% & 25% loading. Temp. of leaving chilled water shall be kept constant during part load testing.

Fouling factor simulation for condenser and evaporator shall be done as per AHRI-550/590 latest addition. Incremental temperature difference (to be calculated based on Normative appendix-C of AHRI-550/590 latest addition) on account of designed fouling factors shall be added in condenser water entering temperature and shall be subtracted for leaving chilled water temperature. Chiller shall produce design refrigeration capacity and guaranteed power consumption at these corrected set of entering condenser water and leaving chilled water temperature. Outside tube surface area (for condenser and flooded evaporators) and inside tube surface area (for DX-Evaporator), being inputs for ARI mathematical model for fouling, shall be submitted along with the offer.

All expenses inclusive of business class airfare, boarding lodging etc. relating to the witness test will be borne by the vendor / contractor.



## **ELECTRIC HOT WATER GENERATOR**

### **1.0 SCOPE**

This section sets out the general requirements in respect of shell type hot water generator as per ASME Standards.

### **2.0 SHELL TYPE HOT WATER GENERATOR**

The shell of the generator shall be vertical / horizontal, shell type, designed, constructed and tested for the specified water flow rates and temperatures. The hot water generator shall be suitable for Indoor / Outdoor application (exposed to sky)

### **3.0 MATERIAL DESIGN AND CONTRUCTION**

The shell of the generator shall be made 10mm M.S steel sheet and dish of 12mm M.S steel sheet with electric fusion welded seams. In accordance with ASME section 4 / unfired pressure Vessel code IS 2825.

### **4.0 HEATERS**

Electric heaters shall be provided in banks of equal capacity distributed over three power phase, heaters shall be mounted within seamless copper / Incoloy sheathed electrically resistant U-tubes floor mounted with EPDM Rubber and S.S steel with magnesium anode for Longevity and easy maintenance of heaters. The heaters shall be easily removable externally, without opening terminal plate or disturbing other components. Heaters shall be suitable for 415 + 10% volts, 50 cycles, three phase AC supply and shall be in direct contact with water contained in shell.

### **5.0 CONNECTIONS AND ACCESSORIES**

Unless specified otherwise in the schedule of quantities the hot water generator shall be provided with following accessories.

- a. Inter locking of electric panel cover with incoming switch / limit switch.
- b. Flow switch, automatic alarm for low water level and reset type high temperature switch with respective indication lights.
- c. Drain point with GM valve.
- d. Descaling point with GM valve.
- e. Automatic air vent and automatic high temperature pressure relief valve.
- f. Step control thermostat for individual heaters bank / Master safety thermostat.
- g. Flanges for water pipe connections.

### **6.0 PRESSURE TESTING**

The shell shall be tested in the factory upto two times the working pressure as specified by head of water column in tender or 21 kg/sq. cm. gauge whichever is higher.

### **7.0 INSULATION**

The shell shall be insulated with 50mm thick resin bonded fiberglass wool insulation and covered with 26 SWG aluminium cladding.

#### 8.0 ELECTRIC CONTROL CABINET

The electric control cabinet shall be made as detailed in electrical panels and mounted directly on main frame. All controls and terminals shall be factory wired and tested. The control cabinet shall consist of following major controls of rated capacities unless specified otherwise in tender.

- a. Incoming S.F.U / M.C.C.B
- b. ON / OFF Rotary switch for individual banks with light.
- c. SCR with MCB for individual heaters.
- d. Indicating lights for ON status for individual banks.
- e. Fault indicating lights.
- f. Alarm with manual reset.
- g. Cabling and control wiring.
- h. Three phase ammeter and voltmeter with selector switches.
- i. Control cabinet shall be BMS compatible.

The panel shall be open able only after switching off the incoming power supply.

#### 9.0 PAINTING

The external surface of the shell shall be cleaned, derusted and applied with three with three coats of primer.

The hot water generator shall be factory finished with durable Backed enamel paint on outside. Shop coats of paints that have become marred during shipment / erection shall be cleaned off with mineral spirits, then coated with enamel paint to match the finish over the adjoining shop painted surface.

### VRV/VRF AC SYSTEM

#### 1.0 General

- 1.1 The scope of this section comprises of the detailed engineering / design, supply erection, testing and commissioning of inverter technology-based D.C Twin Rotary / Scroll Type VRV/VRF type system of air conditioning conforming to these specifications and in accordance with the requirements of Drawing and DBR.
- 1.2 The prices quoted shall include all the equipment ancillary material as specified and all such items whatsoever and which may be required to fulfill the intent and purpose as laid down in the specification and the approved drawings.
- 1.3 The contractor shall calculate equipment capacity based upon design parameters specified for the system design & verify all the quantities and sizes of refrigerant pipe, fitting, cables, control cable, pipes, insulation, indoor units, and outdoor units etc. before installation to avoid any shortfall or surplus.
- 1.4 The tenderer shall also include all necessary minor civil work & MS frame work required for installation of outdoor and indoor units in VRF based air condition system.
- 1.5 The cost quoted by tenderer shall also include the refrigerant R-410A & its charging for proper & specified functioning of air conditioning system.
- 1.6 The scope in the tender schedule also covers detailed designing of complete air-conditioning system based on inverter technology-based D.C Twin Rotary / Scroll VRV/VRF air conditioner with air cooled outdoor unit system capable of cooling and heating (reverse cycle) as per individual or season requirement suitable for operation on 415 V, 3 Phase, 50 Hz AC electric supply.
- 1.7 Each indoor unit should have capability to cool or heat as per seasonal weather changes as per DBR.
- 1.8 This shall also include complete capacity calculation for indoor and outdoor units complete with CAD drawing, designing & layout of following.
  - Outdoor units.
  - Indoor units.
  - Refrigerant piping
  - Condensate water piping & disposal.
  - Power & Control Cables between Outdoor units & Indoor units.

## **2.0 OUTDOOR UNIT**

- a) The outdoor unit shall be factory assembled, weather proof casing (Material of construction of casing shall be vendor's standard design), constructed from heavy gauge GI sheets steel panels and coated with baked enamel finish. The outdoor unit shall be completely factory wired, tested with all necessary controls & filled with first charge of refrigerant before delivering at site.
- b) The inverter technology based/ D.C Twin Rotary / Scroll/ VRV / VRF equipment should be capable so that refrigerant piping between indoor units and outdoor unit shall be Extendable upto 150m with maximum height difference between outdoor & indoor unit of 50m & level difference between two indoor units shall be maximum upto 10m.

- c) **Minimum acceptable value of Seasonal Energy Efficiency Ratio (SEER)/EER/IEER shall be conforming to Table No. 6.8.1A of ASHRAE standard 90.1-2007.**
- d) The outdoor unit shall be factory tested and filled with first charge of refrigerant R-410A before delivering at site.
- e) It should also be provided with duty cycling for D.C inverter Twin Rotary/ Scroll compressors capable of changing the rotating speed of compressor by inverter controller to follow variation in cooling & heating loads & switching starting sequence for better stability and prolonging equipment life or similar features if available in D.C Twin Rotary / Scroll will also be accepted.
- f) The unit shall be provided with its own microprocessor control panel with provision for integration with the building management system for Air-conditioning system.
- g) The outdoor units should have anti corrosion paint free or powder coated plate to ensure rusting do not occur on the same.
- h) The machine must have a sub cool feature to use coil surface more effectively through proper circuit/ bridge so that it prevents the flushing of refrigerant from long piping due to this effect thereby achieving energy savings.
- i) The outdoor unit should be fitted with low noise level and should not be more than 67 db (A) at normal operation when measured at 1.5m distance from ground level.
- j) The outdoor unit should be fitted with low noise aero spiral design fan with aero fitting grill for spiral discharge airflow to reduce pressure loss and should be fixed with DC fan motor for better efficiency.
- k) In case of trouble occurs in an indoor units (s), the continuous operation of system should be possible.
- l) The unit shall be designed in such as way that cleaning of drain Pan should be easy & inspection/ replacement of compressor should be easy.
- m) The condensing unit shall be designed to operate safely whey connected to multiple fan coil units.

## **2.1 Compressor**

- 2.1.1 The compressor in inverter based D.C Twin Rotary / Scroll System shall be highly efficient. The system should response efficiently in accordance to the variation in cooling or heating load requirement.
- 2.1.2 All outdoor units shall have multiple steps of capacity control to meet load fluctuation and indoor unit individual control. All parts of compressor shall be sufficiently lubricated stock. Forced lubrication may also be employed.

## **2.2 Oil Recovery system**

- 2.2.1 Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigeration piping lengths.

2.2.2 The system must be provided with oil balancing circuit to avoid poor lubrication.

### **2.3 Refrigerant Circuit**

2.3.1 The refrigerant circuit shall include liquid and gas shut-off valves and a solenoid valves at condenser end.

2.3.2 The equipment must have inbuilt refrigerant stabilization control for proper refrigerant distribution.

2.3.3 All necessary safety devices shall be provided to ensure the safe operation of the system.

### **2.4 Heat Exchanger**

2.4.1 The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminium fins to form a cross fin coil.

2.4.2 The aluminium fins shall be covered by anti-corrosion resin film.

2.4.3 The unit shall be provided with necessary number of direct driven low noise level propeller type fans arranged for vertical discharge.

2.4.4 Each fan shall have a safety guard.

### **2.5 Safety Devices**

2.5.1 All necessary safety devices shall be provided to ensure safe operation of the system.

2.5.2 Following safety devices shall be part of outdoor unit: -

- high pressure switch,
- fuse,
- fan drive overload protector,
- fusible plug,
- crankcase heater,
- over load relay,
- overload protection for inverter.

2.5.3 Noise levels for outdoor units shall not be more than 67 db (measured at a point 1 meter in front of the unit at a height of 1.5 meters).

## **3.0 INDOOR UNITS**

3.1 All indoor units as specified shall have; in general, noise levels less than 46 db.

3.2 The address of the indoor unit shall be set automatically in case of individual and group control.

3.3 In case of centralized control system, it shall be possible to set the address of individual indoor unit through a liquid crystal remote controller.

- 3.4 The fan shall be dual suction, aerodynamically designed, Turbo, multi blade type, statically dynamically balanced to ensure low noise and vibration free operation of the system. The fan shall be direct driven type, mounted directly on motor shaft having support from housing.
- 3.5 Indoor unit shall have cleanable type filter fixed to an integrally moulded/ moulded plastic frame. The filter shall be slide in and neatly insertable type. It shall be possible to clean the filters either with compressed air or water.
- 3.6 Each unit shall have Electronic control expansion valve for variable refrigerant Flow Effect and to control refrigerant flow rate corresponding to load variation of the room.
- 3.7 Each indoor high wall unit shall be with corded/ cordless remote controller as standard features. The remote controller shall memorize the latest malfunction code for easy maintenance. The controller shall have self diagnostic features for each and quick maintenance and service. The controller shall be able to change fan speed and angle of swing flap (for high wall) individually as per requirement.
- 4.0 **Refrigerant Piping**
- 4.1 Refrigerant piping for the air- conditioning system shall be upto 19.1 mm dia of soft seamless copper tubes & for above 19.1 mm dia the pipe material shall be of hard seamless copper tubes with pipes material being hard drawn copper pipe.
- 4.2 The copper tube shall be bright annealed mirror finish product. No polish coating shall be on the inner surface.
- 4.3 The thickness of copper piping shall not be less than 18 SWG for pipes upto 19.1 mm and 16 SWG for larger dia.
- 4.4 Forged copper fittings shall be used for the refrigerant piping.
- 4.5 The refrigerant piping arrangements shall be in accordance with good engineering practices as applicable to the air-conditioning industry, and shall include charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits except Y joint/separation tubes.
- 4.6 Before jointing any copper pipe or fittings, its internals shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently it shall be thoroughly blown out using nitrogen gas.
- 4.7 After completion of installation of the refrigerant piping, the refrigerant piping system shall be pressure tested using nitrogen gas at a suitable pressure as specified by OEM (Original Equipment Manufacturer). Pressure shall be maintained in the system for 48 hours. The system shall then be evacuated to vacuum of not less than 700 mm Hg and held for 24 hours.
- 4.8 The supplier of air-conditioning system shall choose sizes as designed and erect proper interconnections of the complete refrigerant circuit.

- 4.9 The suction line pipe size and the liquid line pipe sizes shall be selected according to the manufacturer's specified diameter.
- 4.10 All refrigerant pipes shall be properly supported and anchored to the building/structure using steel hangers, fasteners, brackets and supports which shall be fixed to the building/structure by means of inserts or expansion shields or anchor fasteners of adequate size and number to support the load imposed thereon.
- 4.11 The refrigerant piping should be laid in such a way that it should not distort the interior of the room, wherever the refrigerant pipe has to be laid across the room, it should be laid in a concealed manner in coordination with interior.
- 4.12 Entire liquid and suction refrigerant pipe lines including all fittings, valves and strainer bodies, etc. shall be insulated with 19mm thick closed cell/Cross linked Elastomeric / Polyethylene or as specified in BOQ/ and as per specification.

## **5.0 Drain Piping duly insulated**

- 5.1 The drain pipe connection of each fan coil unit to the main header should be 25 mm dia/32 mm dia as required. The header pipe should be of 40 mm dia/32 mm dia as required.
- 5.2 The drain -pipe should be heavy duty PVC pipe ISI marked and conforming to relevant IS complete with fitting as required whereas the connection of the fan coil unit to the PVC pipe should be with flexible braided pipe.
- 5.3 The drain piping should be insulated with 6 mm thick tubular nitrile rubber Elastomeric insulation as per specification.
- 5.4 For proper drainage of condensate U trap shall be provided in the drain piping wherever required.
- 5.5 All pipe supports shall be pre-fabricated and pre-painted slotted angle supports, properly installed with clamps.
- 5.6 The condensate drain pipe arrangement for disposal of condensate water be made in such a way that there should not be any leakages of condensate water inside rooms as well in the route of drain water pipe line & water should be discharged at the location jointly decided with Engineer-in-Charge of work.
- 5.7 The arrangement of drain-pipe shall be made in such a way that it should not affect the aesthetic of the building as well as is maintenance friendly & easily accessible.

## **6.0 REFRIGERANT PIPING INSULATION**

- 6.1 All refrigerant and condensate drain piping shall be insulated in the manner specified herein. Before applying insulation, all pipes shall be brushed and cleaned. The thermal insulation thickness shall be

Refrigerant Piping	: 19mm/13mm (As per DBR)
Condensate Drain Piping	: 6mm

- 6.2 Insulating material in tube form shall be sleeved on the pipes. On piping, slit opened tube from insulating material shall be placed over the pipe and adhesive shall be applied as suggested by the manufacture adhesive must be allowed to tack dry and then press surface firmly together starting from butt end and working towards centre. Wherever flat sheet shall be used it shall be cut out in correct dimension using correct tools. Scissors or Hacksaw blade shall not be allowed. All longitudinal and transverse joints shall be sealed as per sealed by providing 6mm thick, 50mm wide nitrile rubber tape. The adhesive shall be strictly as recommended by the manufacturer. The insulation shall be continuous over the entire run of piping, fittings and valves.
- 6.3 **Protective Coating over Insulation in area exposed to atmosphere.**
- 6.3.1 To provide mechanical strength and protection from damage all pipes insulated with nitrile rubber / polyethylene foam in exposed area shall be covered with aluminium foil of 0.05 mm thickness properly wrapped and all joints sealed with aluminium tape.



**DOUBLE SKIN AIR HANDLING UNITS****1.0 SCOPE**

The scope of this section comprises the supply, erection, testing and commissioning double skin construction air handling units, conforming of these specifications and in accordance with drawings and of the DBR.

**2.0 TYPE**

The Air Handling Unit shall be double skin construction, draw – through type comprising of various section such as mixing plenum, filter section, coil section, fan section, filter plenum as per details given in Drawings and DBR.

**3.0 CAPACITY**

The air handling capacities, maximum motor H.P., static pressure shall be as shown on Drawing and in DBR.

**4.0 HOUSING/CASING**

The housing/casing of the Air Handling Unit shall be of double skin construction. The frame work shall be of Extruded Aluminium hollow sections. All the frame shall be assembled using pressure die cast nylon plastic joints to make a sturdy, strong and self-supporting frame work for various section.

25 mm thick double skin panels shall be made of 0.8mm pre-coated GSS on outside and 0.8mm plain GSS sheet inside the CFC free polyurethane foam of 40 Kg/cu.m in-house injected in between. These panels shall be fixed from inside on to the frame work with soft rubber gasket in between to make the joints air tight.

Frame work for each section shall be jointed together with soft rubber gasket in between to make the joints air tight. Suitable air tight access doors/panels with aluminium hinges and nylon locks shall be provided for access to various sections for maintenance. The entire housing shall be mounted on heavy duty aluminium channel base.

**5.0 FAN**

The fan shall be forward / aero-foil blade backward curved, double inlet, double width type. For static pressure up to 50 mm, forward curved blades shall be used and for static pressure more than 50 mm, backward curved aero-foil blade fans shall be provided. The fan shall be AMCA Certified for air and sound, factory tested and assembled by the original manufacturer. The wheel and housing shall be fabricated from heavy gauge galvanized steel. The fan impeller shall be mounted on EN8 or C-40 carbon steel solid shaft supported to housing and heavy-duty ball bearings. The impeller and fan shaft shall be statically and dynamically trim balanced to ISO 1940 quality grade after assembly. A computer printout with vibration spectrum analysis shall be submitted. The fan outlet velocity shall not be more than 10.2 m/sec. Fan housing with motor shall be mounted on a common extruded aluminium base mounted inside the air handling housing on anti-vibration mounts. The fan outlet shall be connected to

casing with the help of fire retardant fabric, mounted on aluminium extruded channels, acting as a flexible connection for anti-vibration.

## 6.0 COOLING/HEATING COILS

Chilled water coils shall have 12.7 mm (1/2") to 15mm (5/8") dia. tubes minimum 27 SWG (0.41 mm) thick with 0.15 mm aluminium fins firmly bonded to copper tubes assembled in a zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and such that the air velocity across each coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory tested at 21 Kg./Sq.cm air pressure under water. Tube shall be hydraulically/mechanically expanded for minimum thermal contact resistance with fins. Fins spacing shall be 11 to 13 fins per inch (4 to 5 fins per centimeter).

## 7.0 FILTERS

### a. PRE-FILTER

Each unit shall have filter section with pre-filters of the following technical specifications.

a)	Frame	:	Aluminium anodized.
b)	Type	:	Box type.
c)	Media	:	Non woven synthetic supported by HDPE mesh on one side and aluminium mesh on the other side.
d)	Sealing of Media	:	By means of epoxy (CIBA make).
e)	Efficiency	:	90% down to 10 micron particle size.

### b. BAG FILTER

Flanged microvee filters 600mm thick with HDPE filter media shall be provided. The filter frame and filter bank framework shall be anodized aluminium construction with neoprene rubber gasket. The efficiency of the filters shall be 95% down to particle size of 5 microns as per IS 7613 and ASHRAE 52.1.

### c. HEPA FILTER

Flanged HEPA filters having Di-Octyl-Phthalate (DOP) test efficiency of 99.97% down to particle size of 0.3 microns, as per FED-STD-209 shall be located at the downstream side of fan section inside the AHU. HEPA filters made of sub-micron glass fibre paper shall be designed for velocities of 1.25 metres per second. The filter framework shall be of aluminium and filter bank shall be of anodized aluminium construction. Three (3) mm thick neoprene rubber gaskets shall be provided to prevent any air leakage.

### d. FILTERS - CODES AND STANDARDS

- |    |                 |  |
|----|-----------------|--|
| a. | ASHRAE 52.1     | Gravimetric and Dust spot procedures for testing Air cleaning devices. |
| b. | IS 7613         | Methods of testing panel type Air filters for HVAC                     |
| c. | FED – STD – 209 | Clean room and work station requirements.                              |

## 8.0 MOTOR AND DRIVE

**All motors shall be IE-3.**

Fan motors shall be 415 +/- 10% volts, 50 cycles, 3 phase, squirrel – cage, totally enclosed fan cooled with class F insulation and IP – 55 protection. Motor shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be provided thorough v- belt – drive arrangement. Belts shall be of the oil-resistant type. The motor rating shall be at least 20% more than shaft load (kw) of fan.

**9.0 MIXING BOX**

Mixing box shall be complete with fresh and return air dampers. Mixing box shall be provided whenever the return air/ exhaust air is ducted back to the AHU.

**10.0 ISOLATORS**

Vibration isolators shall be provided with all air handling units. The fan and motor framework shall be isolated from the AHU framework by means of spring type vibration isolators. The AHU shall be mounted on 6-inch-high PCC block suitable for weight of the AHU. The platform shall be 4 inches bigger than the AHU frame size from all sides. The framework of the AHU and the P.C.C. block shall be isolated by means of neoprene mats of size 150mmx150mm in two layers with 16g G.S.S. sheet sandwiched in between.

**11.0 SAFETY FEATURES**

Each unit must have safety features as under:

1. The fan access door shall be equipped with port hole window and micro-switch inter locked with fan motor to enable switching off the fan motor automatically in the event of door opening.
2. The air handling units shall be equipped with weather proof light for proper illumination inside fan section.
3. The access door shall further have wire mesh screen as an added safety feature bolted on to the unit frame.
4. Fan and motor base shall be properly earthed from the factory.
5. All screws used for panel fixing and projecting inside the unit shall be covered with PVC caps to avoid human injury.

**12.0 ACCESSORIES**

Each air handling unit shall be provided with manual air vent at high point in the cooling/ heating coil and drain plug in the bottom of the coil.

### **13.0 NOISE CONTROL**

Air Handling Units shall be selected for the lowest operating noise level of the equipment. Fan performance rating, power consumption, and sound power data with operating points clearly indicated shall be submitted by the tenders along with technical submittals for approval and verified at the time of testing and commissioning of the installation. The sound level within the AHU room shall be less than 75 dB at a distance of 1 mtr. from AHU.

### **14.0 CONNECTIONS**

Piping installation requirements are specified in other section. The Drawings indicate the general arrangement of piping, valves, fittings, and specialties. The following are specific connection requirements:

- Arrange piping installations adjacent to units to allow unit servicing and maintenance.
- Connect piping to air-handling units with flanges enabling easy removal of the coil.
- Connect condensate drain pans using 50 mm (2-0 inch) minimum, insulated G.I. pipe and extend to nearest floor drain. Construct deep trap (depth as per detail) at connection to drain pan and install cleanouts at changes in direction.
- Duct installations and connections are specified in other sections. Make final duct connections with flexible connections.
- Electrical Connections: The following requirements apply:
- Electrical power wiring is specified in section Electrical.
- Temperature control wiring and interlock wiring is specified in Section "Electrical Control systems."
- Grounding: Connect unit components to ground in accordance with the Indian Electrical Code.

### **15.0 ADJUSTING, CLEANING, AND PROTECTING**

- Adjust water coil flow, with control valves to full coil flow, to indicate lpm (gpm).
- Adjust damper linkages for proper damper operation.
- Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, and coils entering air face.

### **16.0 COMMISSIONING:**

Final Checks before start-up- Perform the following operations and checks before start-up:

- Remove shipping, blocking and bracing.
- Verify unit is secure on mounting and supporting devices, connections for piping, ductwork and electrical are complete. Verify proper overload protection is installed in motors, starters, and disconnects.
- Perform cleaning and adjusting specified in this Section.

- Lubricate bearings and other moving parts with factory recommended lubricants.
- Set outside-air / supply air dampers to minimum outside-air setting.
- Comb coil fins for parallel orientation.
- Install temporary throw away filters for initial run and finally install clean filters.
- Verify manual and automatic volume control, and fire dampers in connected ductwork system are in the full-open position.
- Disable automatic temperature control operators.
- Starting procedures for central-station air-handling units:
  - Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicate RPM.
  - Replace fan and motor couplings as required to achieve design conditions.
  - Measure and record motor electrical values for voltage and ampere.
  - Shut down and reconnect automatic temperature control operators.

## **17.0 PERFORMANCE DATA**

The Air Handling Unit shall be selected for the lowest operating noise level of the equipment. Fan performance rating and power consumption data with operation points clearly indicating shall be submitted and verified at the time of testing commissioning of the installation.

## **18.0 TESTING**

Cooling/heating capacity of various air handling unit models shall be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Flow measurements shall be by anemometer and temperature measurements by accurately calibrated mercury in glass thermometers. Computed results shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

## **19.0 LIMITATIONS**

The filter velocity at face of filter shall be not more than 152 Mtr. / minute (500 FPM).

The coil velocity at face shall be not more than 152Mtr. / minute (500 FPM).

The fan velocity at fan outlet shall be not more than 10.2 m/s (2000 FPM).

**TREATED FRESH AIR UNIT****1.0 SCOPE**

The scope of this section comprises of the supply of double-skin “Treated Fresh Air Units conforming to the following specifications:

**2.0 TYPE**

The Treated Fresh Air Units shall be two stream units in double skin construction, comprising of supply air section, return air section and Heat Recovery Section. The supply air section shall include the following sections: Cooling/Heating Section, Microvee filter section, Mixing Box Section, Sound Attenuator Section (as per requirement), Damper Section, Humidifier Section, Inspection Section.

**3.0 CAPACITY**

The Treated Fresh Air Units shall be of such capacities as mentioned in the DBR.

**4.0 CASING**

The units shall be made of extruded Aluminium hollow profile frames. The profile box size shall be of minimum 30 mm for capacities upto 22000 CMH (13000 CFM), such that it provides the required mechanical strength and rigidity. The unit should be devoid of any welded construction and should be of cabinet type. All the frames should be assembled using pressure die cast aluminium joints/corners to make a self-supporting frame . The Casing leakage shall be in accordance with relevant EUROVENT standard that is CLASS B.

The panels shall be of double skin construction with both inner and outer steel sheets being minimum 0.8mm thick pre coated & plasticized. 25 mm thick fire retardant, fibre glass insulation shall be sandwiched between the sheets. The fibre glass density shall be 48 kg/m<sup>3</sup>.

The Inspection and access panels shall be hinged type . The hinges shall be casted, powder coated Zinc alloy. Flushed Locks and Handles shall be of galvanized steel. Other panels will be screwed on to the frame with sealant and soft rubber gasket thus making the joints air tight . All screws used for panel fixing shall be covered with PVC caps.

Special hollow gaskets and seals shall be used on inspection doors and to create separation between the airstreams to ensure negligible air leakage and mixing.

The entire casing shall be mounted on electro galvanized channel frame work with level screws. Condensate drain pan shall be fabricated from 18 g GSS/SS construction.

**5.0 SUPPLY AIR SECTION**

The supply air section shall comprise of the following:

**5.1 FAN SECTION**

The fan shall be aerofoil blade backward curved, double inlet double width type. The impeller and the fan casing shall be made of hot galvanized sheet steel. The impeller shall be mounted on a solid shaft supported to housing with angle iron frame and pillow block heavy duty ball bearing. The impeller shall be statically and dynamically balanced. The fan shall be selected such that unit noise level is less than 85 db. Fan housing and motor shall be mounted on a common galvanized steel or aluminium block base which can be drawn out from side for ease of maintenance. A quarter pin lock arrangement between the slide and guide pin lock arrangement between Fan and Unit outlet should be provided.

## 5.2 MOTOR AND DRIVE

Fan motor shall be energy efficient **IE3** and suitable for 415 10% volts, 50 cycles, 3 phase squirrel cage, totally enclosed fan cooled with IP-55 protection. Motor shall be designed for quiet operation. Drive shall be provided through belt – drive arrangement. Belts will be of oil resistant type.

## 5.3. FILTER SECTION

The filter section shall be normally designed for deep folded disposable synthetic prefilters (MERV-8), fine filter (MERV-13) & 100 mm thick chemical filter to absorb harmful gases Sox, Nox, H2S etc. & engineered indoor air quality system to remove biological contamination, VOCs, bad odour. The filter elements shall be mounted on rails and shall be easily pulled out for replacement. The rails shall be provided with efficient gaskets to minimize the risk of leakage.

## 6.0 RETURN AIR SECTION

The return air section shall comprise of above sections. The specification for this section shall remain same as defined in 5.1, 5.2 & 5.3

### HEAT RECOVERY SECTION

The Heat Recovery section shall include enthalpy wheels and shall have minimum **recovery of 75 % of total heat, i.e both sensible and latent (each being 75%). The recovery of sensible and latent shall be equal. Necessary computerized selection of the wheel should be provided along with the bid to justify the same.** The wheel shall be made of pure aluminium foil coated with molecular sieve desiccant with pore diameter of 3°A. The cross contamination between the two air streams shall be nil and leakage less than 0.04%. The vertical and radial run of the wheel shall be less than 1 mm per meter of diameter. The wheels shall have non-contact labyrinth seals for effective sealing between the two air streams.

Pre-filter (MERV-8) shall be provided in return air section.

Detailed specification for the wheel shall be as per 7.0 & 8.0 i.e. “HEAT RECOVERY WHEEL”

## 7.0 HEAT RECOVERY WHEEL SPECIFICATIONS:

Rotor/wheel matrix shall be: -

7.1 **The substrate:** The substrate or wheel matrix should **be only of pure aluminum foil** so as to allow:

7.1.1 quick and efficient uptake of thermal energy.

- 7.1.2 sufficient mass for optimum heat transfer
- 7.1.3 maximum sensible heat recovery at a relatively low rotational speed of 20 to 25 rpm.
- 7.2 Non-metallic substrates made from paper, plastic, synthetic or glass fibre media, will therefore, not be acceptable.
- 7.3 The substrate shall not be made from any material which is combustible or supports combustion like synthetic fibrous media.
- 7.4 The wheel has to be certified as per DIN EN ISO 846 with 0% fungal and bacterial growth at 95% Relative humidity and above.
- 7.5 Fire rating :
  - 7.5.1 NFPA - 90A certification with 0% for Flame spread classification should be confirmed by manufacturer.
- 7.6 Pressure Drop :
  - 7.6.1 The pressure drop across the rotary heat exchanger shall not exceed 0.1 inch for every 100 FPM face velocity, or part thereof, for the minimum stated / required latent recoveries / efficiencies

NECESSARY SOFTWARE SELECTION OF THE WHEEL HAS TO BE ENCLOSED TO JUSTIFY THE PRESSURE DROP AND EFFICIENCY CALCULATIONS.

- 7.7 The Desiccant : The desiccant should be water molecule selective and non-migratory.

The desiccant should be molecular sieve 3Å, so as to keep the cross contamination to absolute minimum and also ensure the exclusion of contaminants from the air streams, while transferring the water vapour molecules.

The desiccant, of sufficient mass which should not be less than 5 kg per 1000 cfm of air, should be coated with non masking porous binder adhesive on the aluminum substrate so as to allow quick and easy uptake and release of water vapour. A confirmation has to be provided by manufacturer of wheel to this effect. A matrix with desiccants impregnated in non metallic substrates, such as synthetic fibre, glass fibre, etc. will not be accepted.

**The rotor/wheel matrix shall have equal sensible and latent recovery.**

The weight of desiccant coating and the mass of aluminum foil shall be in a ratio so as to ensure equal recovery of both sensible and latent heat over the operating range. Accordingly, a rotor matrix which has an etched or oxidized surface to make a desiccant on a metal foil and results in insufficient latent recovery and hence unequal recovery, or a rotor matrix made from desiccant integrated in a synthetic fibre matrix which result in insufficient sensible recovery, high rotation speed, and unequal recovery, shall not be accepted.



- 7.8 **Rotor:** With optimum heat and mass through matrix formed by desiccant, of sufficient mass, coated on an aluminum foil, the rotor should rotate at lower than 20 to 25 RPM, thereby also ensuring long life of belts and reduced wear and tear of seals.
- 7.8.1 The rotor shall be made of alternate flat and corrugated aluminum foil of uniform width.
- 7.8.2 The rotor honeycomb matrix foil should be so wound and adhered as to make a structurally very strong and rigid media which shall not get cracked, deformed etc. due to change of temperature or humidity.
- 7.8.3 The rotor having a diameter upto 2800 mm shall have spokes to reinforce the matrix.
- 7.8.4 2000 mm diameter upwards, the option of a special wing structure, to prevent the rotors from wobbling or deforming due to the successive pressure differentials, will be available.
- 7.8.5 Sectioned wheels, with pie segments, capable of being assembled in the field, shall be available as an option, above 2000 mm in diameter.
- 7.8.6 The surface of the wheel/rotor should be highly polished to ensure that the vertical run out does not exceed  $\pm 1$  mm for every 1 metre diameter, thereby ensuring, negligible leakage, if labyrinth non contact seals are provided, and minimal drag, if contact wiper seals are provided.
- 7.8.7 The radial run out also shall not exceed  $\pm 1$  mm for every 1 meter diameter, thereby minimizing the leakage/drag on the radial seals, and minimize the fluctuation in the tension of the drive belt.
- 7.8.8 The number of wraps (of alternative corrugated and flat foil) for every inch of rotor radii shall be very consistent so as to ensure uniform air flow and performance over the entire face in the air stream. Flute height and pitch will be consistent to a very tight tolerance to ensure uniform pressure drop and uniform airflows across the rotor face.
- 7.8.9 The rotor shall be a non clogging aluminum media, having a multitude of narrow aluminum foil channels, thus ensuring a laminar flow, and will allow particles upto 800 microns to pass through it.
- 7.8.10 The media shall be cleanable with compressed air, or low pressure steam or light detergent, without degrading the latent recovery.

7.9 **The Cassette / casing**

- 7.9.1 The recovery wheel cassette/casing shall be manufactured from tubular / sheet metal structure to provide a self supporting rigid structure, complete with access panels, purge sector, rotor, bearings, seals, drive mechanism complete with belt.
- 7.9.2 The rotor/wheel should have a field adjustable purge mechanism to provide definite separation of airflow minimising the carryover of bacteria, dust and other pollutants, from the exhaust air to the supply air. It shall be possible, with proper adjustment, to limit cross contamination to less than 0.04% of that of the exhaust air concentration.

- 7.9.3 The face and radial seals shall be four (4) pass non contact labyrinth seals / brush seals for effective sealing between the two air streams, and also for a minimum wear and tear ensuring long life of the seals.

**8.0 Manufacturer / Principal**

- 8.1 The manufacturer or their principals having at least 10 years experience directly in the product i.e. Energy Recovery Units (Treated Fresh Air Unit with Heat Recovery Wheel) with a two tier two air streams unit design in India shall be preferred. The Heat Recovery Wheel and the box should be from the same manufacturer.

## **FAN COIL UNITS**

### **1.0 SCOPE**

The scope of this section comprises the supply, erection, testing and commissioning of fan coil units conforming of these specifications and in accordance with the requirements of the Drawings and DBR.

### **2.0 TYPE**

The fan coil units shall be vertical type for floor mounting / horizontal type for ceiling suspension. Floor mounted vertical units shall have vertical top discharge; ceiling suspended units shall have horizontal discharge; and horizontal units mounted within ceiling space shall have horizontal discharge. All units shall be complete with chilled water coil. One or more centrifugal fans and motor, cleanable fabric filters, insulated condensate drain pan, ball valve set, 2/3 way motorized valve and wall mounted control with display panel & remote control. The Fan Coil Units shall be Factory Fitted with the Valves Package as per Standards.

### **3.0 CAPACITY**

The air moving and coil capacities shall be as shown on Drawings and indicated in DBR.

### **4.0 CABINETS**

Cabinets shall be constructed of 20 gauge thick G.S.S. sheet pre-coated.

Access panels shall have positive locking fasteners for easy removal. Cabinets shall be provided with all floor mounted vertical units and ceiling suspended horizontal units.

### **5.0 INTERIOR CHASSIS**

The interior chassis shall be constructed of not less than 1.25 mm (18gauge) thick G.S.S Sheet All fan coil units shall be securely mounted from the building structure with top panel set dead level in both directions. The fan deck shall be easily removable from FCU without disturbing the other installations.

### **6.0 DRAIN PAN**

The drain pans shall be fabricated from 16 gauge cold rolled steel with all corners welded, and an additional inner bottom panel of 20 gauge galvanized sheet steel shall be provided to prevent damage to and flotation of the bottom panel insulation. The pans shall be insulated with not less than 9mm. Closed cell insulation sandwiched between top and bottom panels to effectively prevent condensation. The pans shall be of sufficient size to catch all drippage of condensation from any part of the unit, in all cases pans shall be of single piece & large enough to cover cooling coil supply and return water headers, bends, and control valves. An extended condensate pan similar to primary drain pan shall be provided by the manufacturer of those units where coil connections are to be made on both ends of the coil.

### **7.0 COOLING COIL**

All cooling coils shall be standard three or four row staggered seamless copper tube with aluminium sine wave fins. Tubes shall be minimum 9 mm OD & 0.35 mm copper thick. All bends and joints shall

be enclosed within insulated end sections of the base unit for protection against sweating. Each coil shall be provided with an air vent. All coils shall be factory tested at 21 KG per sq.cm (300 psi) air pressure while submerged in water. Fin spacing shall be 4 to 5 fins per cm. Tubes shall be mechanically / hydraulically expanded for minimum thermal contact resistance with fins. Air vent shall be provided in header at a level higher than coils.

## **8.0 FANS**

Fans shall be centrifugal forward curve, direct driven. This shall consist of (2) two light weight impeller of forward curved type both statically & dynamically balanced along with properly designed G.I sheet casing.

## **9.0 MOTOR**

Motor shall be  $220 \pm 10\%$  volts, 50 cycles, single phase, six pole, shaded pole type, speed not exceeding 1000 RPM at maximum airflow. Motors shall have three speed windings and shall be factory wired to a terminal block mounted within the fan section. Motors shall be have extended shaft on both sides.

## **10.0 INSTALLATION**

Ceiling suspended horizontal units and units mounted within the ceiling space shall be hung through rubber in shear vibration isolator suspenders.

## **11.0 ACCESSORIES**

All fan coil units shall be equipped with copper piping connections and manual air vent at the cooling coil. In addition, the following accessories may be required at fan coil unit; their detailed specifications are given in individual sections and quantities separately in Schedule of Quantities.

The contractor or supplier shall install wall mounted thermostat for individual unit.

The fan coil unit shall be complete with ball valve set, 2/3 way motorized valve and wall mounted soft touch control with display panel & remote control.

## **12.0 PAINTING**

Shop coats of paints that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop painted surfaces.

## **13.0 PERFORMANCE DATA**

Fan coil units shall be selected for the lowest operating noise level of the equipment. Fan performance rating and power consumption data, with operating points clearly indicated shall be submitted by the Contractor with Technical Bid and verified at the time of testing and commissioning of the installation.

## **14.0 TESTING**

Cooling capacity of various fan coil unit models shall be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Flow measurements shall be carried out by Velometer and temperature measurements by accurately calibrated thermometer. Computed ratings shall conform to the specified capacities and quoted ratings power consumption shall be computed from measurements of incoming voltage and input current.

### **CHILLED WATER (HYDRONIC) CASSETTE UNITS**

#### **1.0 SCOPE:**

Scope of this section covers the supply, installation, testing & commissioning of Chilled water Cassette type fan coil units.

#### **2.0 GENERAL**

- 2.1 The Chilled Water Cassette Units shall be concealed type, ceiling suspended type and shall be complete with fan, fan casing, fan motor, cooling coil made of copper tube and aluminium fins, filter, built-in condensate water pump, casing, insulated drain pan etc.

#### **3.0 DESCRIPTION & CONSTRUCTION**

- 3.1 The unit shall be 4 way Cassette type. The unit shall comprise of coil section, 3 speed motor, 4 dimension screw fan, circuit box, decorative panel, thermostatic controls, drain pump assembly, galvanized sheet steel casing with GI coated finish.
- 3.2 The Drain pump mechanism shall be ideally suited to lift water up to a height of 500 mm. The pump shall be inter-locked in such a way that if the drain pump mal functions, the unit shall stop functioning and give a warning signal.
- 3.3 The unit shall be fabricated from 18 Gauge G.I. sheets & ABS plastic.
- 3.4 The fan shall be slow speed statically & dynamically balanced directly driven forward curved. The fan shall be able to deliver air @ 400 CFM / TR at the high speed.
- 3.5 Fan motor shall be single phase suitable for 220 V, 50Hz A.C. supply & shall have at least 3 speeds operation.
- 3.6 Cooling coil shall be of copper pipe with min. 7mm O.D. and wall thickness of 0.4mm. Coil shall be min. 2 row deep. The coil shall be suitable for operation on chilled water and accordingly return headers shall be provided. The end connection shall be 3/4". The coil shall be hydrophilic aluminium type for prolonged life of equipment.
- 3.7 The units shall be with a cordless remote controller. The remote shall be able to control set temperature, fan speed and preferable timer on/ off.

#### **4.0 INSTALLATION:**

- 4.1. The Chilled Water Cassette shall be suspended from the ceiling, using anchor fasteners for robust fitting. The unit shall be hung using threaded hangers for height and level adjustment. These hanging accessories have to be factory provided.
- 4.2. An auxiliary drain tray arrangement shall be provided to house the ball valves, strainer and on/off control valve assembly. Water from this aux. tray arrangement shall go back into the Cassette main drain tray and no additional drain pipe outlet shall be provided.
- 4.3. The connection between the Chilled Water Cassette and the valves shall be with 3/4" O.D. 22G heat treated copper tubes, insulated with tubular sections of atleast 12mm. The connection from the head pipe up to the valves may however be of MS class C piping with expanded polystyrene insulation duly provided.
- 4.4. A factory prepared valve station comprising of ball valve with strainer for inlet connection and ball valve without strainer and motorized 2 way valve for outlet connection shall be provided alongwith cassette units.
- 4.5. A one time riser shall be provided for the drain flow to ensure no return of the drain water under any circumstances. A natural gravity slope shall be provided after the riser.

## **5.0 CONTROLS:-**

- 5.1 The controls for Cassette Units shall consists of a combined thermostat and speed switch and motorized 2 way valve.
- 5.2 Water side inlet & outlet of the FCU shall be provided with Brass ball valves suitable for connection to M.S. 'C' Class threaded nipple on one side & flared copper connection on the other. The inlet value shall also be provided with a built-in Y – Type strainer.
- 5.3 A two way on/off diverting valve of recommended make shall be provided to facilitate regulation of temperature in the conditioned area. The value shall be suitable for 220 V, 50 Hz operation. The valve shall be on/ off type valve. No modulating function type valves shall be acceptable for the Cassettes.

**SPLIT TYPE A.C. UNITS**  
**(Energy saving Inverter type compressors)**

**1.0 SCOPE**

The scope of this section comprises the supply, erection, testing and commissioning of air-cooled split units conforming to these specifications and in accordance with the requirements as per DBR.

**1.1 COMPRESSOR**

Energy saving Inverter type compressor shall be hermetic scroll or hermetic reciprocating type using refrigerant R- 410A complete with safety controls oil heater and other accessories, main bearings shall be of generous size and self-aligning type with lining of anti-friction bearing metal complete with forced feed type lubrication system, filters with by-pass relief valves, pressure and control valves as required. Compressor shall be installed in outdoor condenser housing.

**1.2 EVAPORATOR**

Evaporator coils shall have 10 to 15 mm dia copper tubes with aluminum fins firmly bonded to copper tubes assembled in zinc coated steel frame. Fan section shall be made from heavy gauge steel with wheels of forward -curved multi-blade type to ensure smooth air flow into the fan. Housing shall be provided of die-formed side sheets with streamlined inlet and guide vanes.

**1.3 CONDENSER**

Condenser coil shall have 10 to 15mm dia copper tubes with aluminum fins bonded to copper tubes assembled in zinc coated steel frame. Condenser shall be complete with propeller fan and weather proof totally enclosed motor and other accessories as required. Condensate drain piping may be left over condenser if possible at site.

**1.4 FILTERS**

Filters shall be washable of synthetic woven mesh having an efficiency of not less than 90% for particles down to 5 microns. Velocity across filters shall not exceed 2 meters per second.

**1.5 REFRIGERANT PIPING**

Piping shall be of type 'L' hard drawn copper tubing of seamless variety with back seated type brass valves. Brass strainer shall be provided with bronze screen and permanent magnet on upstream of controls and valves, with isolating valves. Expansion valves located with indoor unit, shall be provided with remote bulb external equalizer port and external super-heat adjustment with sight glass and liquid line solenoid valve (if required) in piping preceding expansion valve. Small capacity units shall be provided with Capillary tube expansion device. In such case, Suction line shall be connected to capillary tube inside evaporator unit only. Expansion device shall not be installed in condensing unit.

Liquid line shall be clamped with Suction line or condensate drain pipe, duly insulated, to provide an effective heat exchanger.

**1.6 CONTROLS**

Safety controls shall consist of compressor high-low pressurestat and oil pressure safety switch suitable for manual resetting. Thermostat with tolerance of  $\pm 1$  Deg.C shall be provided. Crank case heater shall switch on when compressor stops.

## **1.7 MISCELLANEOUS**

- 1.7.1 Each split unit shall include suitably designed housing in heavy gauge sheet steel and angle frame work treated for rust prevention and painted, to mount the components.
- 1.7.2 Exposed indoor units shall be provided with factory made supply air grill to distribute the air evenly across large areas, if required.
- 1.7.3 Full charge of refrigerant gas, as required to obtain and maintain design conditions and the required quantity of suitable grade lubrication oil shall be provided.
- 1.7.4 Sheet steel control panel for housing the controls and other operated items.
- 1.7.5 Ribbed rubber vibration isolator pads or springs of 90% efficiency in preventing transmission of vibration.
- 1.7.6 Each unit shall include but not be limited to all the items listed in foregoing paragraphs and shall be complete as required.
- 1.7.7 The refrigerant copper piping of the split unit shall be insulated with closed cell polyflex insulation (tubular type).
- 1.7.8 Winter Heating: Heating shall be provided by either of following methods:
  - 1.7.8.1 HEAT Pump: Split type air-conditioning units shall be provided with Heat pump for models recommended by manufacturer.
  - 1.7.8.2 Tubular Heaters: Duct mounted finned tubular heaters shall be provided in supply air duct close to evaporator fan. Heaters shall be interlocked with duct mounted Airstat, Geysersstat & room mounted heating/cooling thermostat. Proper air flow shall be ensured over heaters.

## **1.8 INSTALLATION AND TESTING**

- 1.8.1 The outdoor unit shall be mounted on floor/foundation. Necessary mild steel frame work for condenser unit, foundation bolts, levelling shims etc. if required for mounting of the same shall be provided by the vendor. M.S. frame work shall be designed to support the condensing units rigidly under all conditions and shall be painted with two coats of anti-rust paint and two coats of enamel paint.
- 1.8.2 The interconnecting refrigerant piping shall be mounted on ladder type galvanized steel saddles with nuts and bolts. Cabling & wiring shall be enclosed in MS conduit fixed to saddle. Ladder type saddles shall be fixed firmly on walls/structure.
- 1.8.3 On installation, the refrigerant circuits and the connected equipment and parts shall be thoroughly pressure tested for leaks. The system pressure shall be reduced by a vacuum pump to within an



absolute pressure of 7.5mm Hg and maintained at this level for (4) four hours. Thereafter the vacuum pumps shall be stopped and vacuum maintained for 24 hours with a pressure drop not exceeding 2.5mm gas absolute.

- 1.8.4 All instruments and switchgear shall be tested for proper functioning and set of design values.
- 1.8.5 On completion of the installation and the above sets, unit shall be tested for performance. The capacity on tons shall be calculated from measurements of temperature difference and air flow rate. The power consumption shall be checked from current measurements of the motor.

### **DOUBLE SKIN FORCED DRAFT VENTILATION UNITS** **(FDV UNITS/AIR-WASHER)**

#### **1.0 SCOPE**

The scope of this section comprises the supply, installation, testing and commissioning of packaged type of specific capacity.

#### **2.0 HOUSING / CASING**

- 2.1 The housing /casing of evaporative unit shall be of double skin construction. The framework shall be of extruded aluminum hollow sections. All the frame shall be assembled using pressure die cast aluminum joints to make a sturdy, strong and self-supporting framework for various sections.
- 2.2 Double skin panels shall be made of 0.8 mm pre-plasticized / pre-coated PVC sheeted galvanized sheet steel on outside and 0.8 mm galvanized sheet inside with insulation of  $25 \pm 2$  mm thick CFC free PUF injected insulation of 40 kg/m<sup>3</sup> density (minimum). These panels shall be screwed on to the framework with soft rubber gasket fixed in built in groove of aluminum frame in between to make the joints airtight.
- 2.3 Frame work for each section shall be jointed together with soft rubber gasket in between to make the joints air tight. Suitable air tight access doors/panels with aluminium hinges and nylon locks shall be provided for access to various sections for maintenance. The entire housing shall be mounted on extruded aluminium channel framework having pressure die cast aluminium joints.
- 2.4 The water tank shall be made out of 1.2mm thick stainless steel SS:304.
- 2.5 The FDV unit shall be suitable to work at outdoor installation.

#### **3.0 FAN SECTION**

- 3.1 The housing shall be fabricated from heavy gauge galvanized steel and wheel of aluminium alloy.
- 3.2 Variable pitch pulley shall be provided to affect reduction in speed in winter if required.
- 3.3 Fan housing with motor shall be mounted on a common steel base mounted inside the air handling housing on anti-vibration spring mounts.
- 3.4 The fan section casing shall be of at least 1.6mm thick galvanized steel sheet.

- 3.5 The entire fan section shall be coated with epoxy (two coats) after two coats of primer from inside and outside.
- 3.6 Inspection door shall be installed with micro-switch arrangement with marine light within the fan section.
- 3.7 Micro-switch shall be interlocked with blower and light with resetting arrangement.
- 3.8 Multi fan unit shall be provided with non-return damper at each fan outlet.

#### **4.0 FAN**

- 4.1 The fans shall be aerofoil blade backward curved floor standing double inlet double width type of imported origin.
- 4.2 The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame and pillow block heavy duty ball bearings.
- 4.3 The impeller and fan shaft shall be statically and dynamically balanced.
- 4.4 The fans outlet velocity shall not be more than 2000 FPM.
- 4.5 The fan outlet shall be connected to casing with the help of fire retardant canvass.
- 4.6 The centrifugal fan inside and outside shall be epoxy coated (two coats after two coats of primer) to avoid moisture abuse in the factory prior to delivery.
- 4.7 The fan shall be provided with access panel and drain plug.
- 4.8 The fan shall have belt guard and inlet screen.
- 4.9 The fan shall have non-overloading characteristics.

#### **5.0 MOTOR & DRIVE**

- 5.1 Fans shall be driven by electric motors as specified in the schedule of quantities.
- 5.2 Motor ratings are only tentative and where a fan required a higher capacity motor, the contractor shall clearly point out the requirement and make his offer accordingly.
- 5.3 Motor ratings shall be at least 10% over limit load plus transmission losses.
- 5.4 Fan motors shall be suitable for operation on 415+ 10% volts  $50 \pm 5$  cycles, 3 phase, Combined Voltage and Frequency fluctuation of 10%, AC power supply and shall be TEFC squirrel case induction type totally enclosed fan cooled with IP-55 protection.
- 5.5 Motors shall be specifically designed for quite operation and motor speed shall not exceed 1440 RPM.

- 5.6 Drive to fan shall be provided through belt drive arrangement.
- 5.7 Belts shall be of the oil-resistant type.
- 5.8 Variable pitch pulley shall be provided to affect reduction in speed in winter if required.
- 5.9 THE MOTORS SHALL BE OF EFFICIENCY CLASS IE3.

## **6.0 AIR-WASHER SECTION**

- 6.1 The Air washer section shall incorporate cellulose base media of European origin having minimum 200mm thickness or as specified in the DBR.
- 6.2 The cooling pads shall be of rigid cross fluted honey comb design, having highly water absorbent cellulose media, impregnated with insoluble antiriot chemicals. It shall provide extended and sufficient wetted surface to provide a water absorbing efficiency of 90% with air velocity not exceeding 500 FPM (2.54 M/Sec)
- 6.3 The cooling pads section and tank shall be fabricated from 18 gauge SS-304A stainless steel sheets with bolted construction having suitable stiffeners.
- 6.4 The section shall be complete with FRP water distribution having parts and sized for uniform and adequate water flow through perforated PVC pipe / G.I. B Class pipe.
- 6.5 The tank shall be fitted with 1" (25 mm) industrial type float valve assembly of commercial grade brass.
- 6.6 The pad section shall have provision for fixing one or two sets of air filter sections as specified.
- 6.7 Drain pan shall be constructed of 18 G stainless steel (SS-304 Grade) with necessary both way slope to facilitate fast removal of drain water.

## **7.0 PUMPS**

- 7.1 The water distribution pumps shall be of heavy duty vertical / monobloc type mounted outside the tank.
- 7.2 The suction portion shall be at the bottom with proper seal arrangement to directly pick up water from the stainless-steel drain pan.
- 7.2 Necessary water bleeding arrangements shall be incorporated with separate drain connection provided in the stainless-steel drain pan to bleed small percentage of total circulated water in order to ensure compulsory water change over during running of the system to prevent concentration of undesirable salts.

- 7.2 The pump shall be provided with single phase preventer, self-tripping starter and shall be suitable to operate at 415(+/-) 10% V, 50 Hz AC supply.

## **8.0 AIR FILTERS**

- 8.1 The standard 50 mm thick washable pre-filters shall be with five layers of aluminium wire mesh at least 50 mm thick fixed in a 20-gauge aluminium frame with handles for ease of removal.
- 8.2 The above set of filters shall be fixed in filter frames made of 20-gauge G.I. sheets shaped to prevent air leakage. The filters shall be easily removable. The filter section shall form part of the pad section
- 8.3 Filter shall fit so as to prevent by pass. Holding frames shall be provided for installing a number of filter cells in banks. These shall be held within the frames by sliding the cells between guiding channels.
- 8.4 Filter face velocity shall not exceed 500 FPM.

## **9.0 ISOLATORS**

Vibration isolators shall be provided for Air washers and pumps.

## **10.0 PAINTING**

Shop coats of paints that have become marred during shipment or erection shall be cleaned off with mineral sprits, wire brushes and spot primed over that affected areas, then coated with epoxy paint on inside & outside.

## **11.0 PERFORMANCE DATA**

Evaporative cooling units shall be selected for optimum operating noise level. Fan performance rating and power consumption data with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the system.

## **12.0 TESTING**

Air washer shall be computed from measurements of air flow, dry and wet bulb temperature of air leaving the air washer. Flow measurements shall be by an anemometer and temperature measurements by accurately calibrated electronic instrument. Computed result shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current. The efficiency of air washer shall not be less than 90%.

### **COOLING TOWERS (COUNTER FLOW TYPE)**

#### **1.0 SCOPE**

The scope of this section comprises the supply, erection, testing and commissioning of cooling towers conforming to following specifications and in accordance with the requirements as per DBR.

## **2.0 GENERAL DETAILS**

### **COOLING TOWER SHALL BE CTI CERTIFIED.**

The Cooling Tower casing shall be of fiber reinforced plastic (FRP) construction with hot dipped galvanized steel structure, forced/induced draft type air flow, complete with FRP basin for cold water, Fan with weatherproof motor & bird screen assembly, PVC fill media, distribution pipes, speed reducing assembly, GI ladder etc. Construction shape shall be octagonal, square, rectangular or round bottle shaped. Sound attenuators shall be provided where specified in schedule of quantities.

## **3.0 GENERAL CONSTRUCTION**

- 3.1 The body shall be made of Fiberglass Reinforced Plastic (FRP) sections of equal segments, all bolted together casing shall be made from Isothelic resin with triple layers of woven mat ensuring smooth surface on both sides for minimum air resistance. Individual panels shall be single piece joint free construction Fan deck shall form an integral part of the body. The structural strength of the body shall be sufficient to withstand wind velocities upto 60 M/Sec., vibrations and earthquakes.

The cold water basin shall be FRP of deep sump construction supporting cooling tower super structure with rigid steel base welded tubular support duly hot dipped galvanized. FRP casing shall be made from Isothelic resin with triple layers of woven mat ensuring smooth surface on both sides for minimum air resistance. Individual panels shall be single piece joint free construction Basin shall be complete with connections for drain, overflow, make up water, quick fill and brass float valve. Easily removable brass suction strainer, bolted to suction housing, shall be provided at the bottom of tower.

Inlet pipe header shall be provided with bleed off pipe connected to drain connection. Battery of cooling towers shall be provided with equalizing pipe with valves as mentioned in schedule of quantities.

The support structure for the tower shall be of mild steel duly hot dipped galvanized. All fasteners shall be of SS.

## **4.0 WATER DISTRIBUTION SYSTEM**

- 4.1 Upper deck for hot water diffusion shall be made of FRP/PVC provided with correctly sized adequate number of nozzles to ensure uniform distribution & drainage of water over fill media by gravity (branch and arm system). Alternately, hot water shall be distributed through sprinklers fixed to rotating headers over incoming pipe. Overflow from basin shall not be permitted.
- 4.2 Rigid PVC fill in honeycomb design shall be arranged in proper alignment for clear water flow & ease of replacement. Assembly shall include louvers to prevent water from escaping the fill sheets and drift eliminators to prevent the costly nuisance of drift loss spilling on the surrounding environment. The fill sheets shall withstand hot water temp as high as 55 deg. C.

These should be adequate support at the bottom of the PVC fill to ensure long term usage without any damage to the fills.

## **5.0 FAN ASSEMBLY**

- 5.1 The fan shall be of axial flow type with cast aluminium a multiple blade of aerofoil design and adjustable pitch. The fan assembly shall be statically & dynamically balanced.
- 5.2 The fan shall be directly mounted on the motor or through speed reduction assembly. In the latter case of speed reduction gears being provided, housing shall be of heavy cast iron construction with large oil reservoir. However, it would be preferable to avoid gear assembly.
- 5.3 The fan motor shall be totally enclosed fan cooled squirrel cage type conforming to I.P. 55 for outdoor operation.
- 5.4 The fan guard shall be hot dipped galvanized and shall have wire mesh arrangements to prevent bird nesting during idling period.
- 5.5 THE FAN MOTOR SHALL BE OF EFFICIENCY CLASS IE3).
- 5.6 The fan motor shall be suitable for VFD operation.
- 5.7 The fan outlet velocity shall not be more than 10 M/S and the tip speed shall be below 4500 m/min.

## **6.0 LADDER**

- 6.1 All towers shall be provided with a ladder made of GI pipes & fixed to masonry base at ground level.

## **7.0 PAINTING**

All FRP towers shall be supplied of colour earlier approved by Architect.

## **8.0 TESTING**

Cooling capacities of the cooling tower shall be computed from the measurements of water flow, rate, temperatures of entering and leaving water and ambient air wet bulb temperature. Water flow rate shall be measured by an accurately calibrated water flow meter. Temperatures shall be measured by digital thermometers. Computed results shall conform to the specified capacities and quoted ratings.

Only type-tested units will be accepted. The type test report of the unit shall be furnished at the time of detailed engineering.

**VARIABLE SPEED PRIMARY / SECONDARY CHILLED WATER PUMPING SYSTEM****1.0 SCOPE**

The scope of this section comprise the supply, erection, testing and commissioning of variable speed primary / secondary chilled water pumping system conforming to these specifications as per DBR.

**2.0 SYSTEM SHALL CONSIST OF THE FOLLOWING:**

- 2.1 Primary / secondary pumps of type and capacity as specified in Equipment Schedule. The pump shall be vertical inline /end suction or horizontal split casing.
- 2.2 Programmable logic pump controller.
- 2.3 Adjustable frequency drives with manual by pass.
- 2.4 Remote sensor / transmitter.
- 2.5 Other items as required to properly execute the sequence of operation.
- 2.6 Sequence of operation.
- 2.7 THE MOTORS SHALL BE OF EFFICIENCY CLASS IE3.

**3.0 PRIMARY / SECONDARY PUMPS**

- 3.1 The capacity of secondary chilled water pumps shall be in accordance with DBR.
- 3.2 The pumps shall be of vertical Inline / end suction or split casing type. Pump casing shall be close-grained cast iron of heavy section, vertically or horizontally split, making possible complete servicing of rotating parts without breaking piping or motor connections. Motor to pump connection shall be of the smooth entry to impeller and increased efficiency. Impeller shall be bronze or brass, single/double suction, enclose type, hydraulically balanced and passages smooth-finished for minimum friction and maximum efficiency. Shaft shall be stainless steel, protected by gunmetal sleeves extending through stuffing boxes. Pumps shall be fitted with an air valve, two grease lubricators, drain plug and water seal connections. Mechanical seals shall be provided with all pumps. Mechanical seal Replacement shall be done externally without need to remove pump/motor from the assembly.
- 3.3 Pump motor shall be energy efficient, totally enclosed, fan-cooled, class -F insulation and suitable for operation on AFD Motor shall be specially designed for quiet operation and its speed shall not exceed 1450 rpm. The motor rating shall be such as to ensure non overloading of the motor throughout its capacity range. Motor shall be suitable for 415 + 10% volts, 3 phase, 50 cycles AC, power supply.
- 3.4 In case of horizontal end suction or split case pumps, pump base shall be of size suitable for the pump, motor and shaft and shall be constructed of cast iron or welded steel. Flexible coupling shall be protected by a guard mounted on the common base.

- 3.5 The pump, if horizontal end suction or split casing, shall be installed on a concrete foundation. In case of vertical inline pumps, the pumps shall be installed on a simple pipe support with no requirement of base-support/foundation as shown in Approved-for-Construction shop drawings.
- 3.6 Each pump shall be provided with certified performance curves showing power absorbed and corresponding flow rates by varying the speed. The tests shall be done at factory and may be witnessed by Consultant/Owner.
- 3.7 End suction or split casing pumps, prior to testing shall be aligned with a dial indicator within 0.05mm. Monobloc pumps shall be factory aligned with motor on common base.
- 3.8 Pump performance curves and power consumption with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the installation.
- 3.9 Pump performance shall be computed from the pump curves provided by manufacturer. All pumps shall be tested at factory as per relevant codes.

#### **4.0 PUMP LOGIC CONTROLLER**

- 4.1 The pump logic controller assembly shall be listed by and bear the label of Underwriter's Laboratory INC. (UL). The controller shall meet Part 15 of FCC regulations pertaining to class A computing devices. The controller shall specifically designed for variable speed pumping application. Pump logic controller shall be suitably interfaced with on Adjustable Frequency Drive housed within same enclosure.
- 4.2 The controller shall function to a proven program that safeguard against hydraulic conditions including:
  - 4.2.1 Pump flow surges
  - 4.2.2 Hunting
  - 4.2.3 End of curve
  - 4.2.4 System over pressure
- 4.3 The pump logic controller shall be capable of receiving up to five remote process variable signals. It shall then select the analogue signal that has deviated the greatest amount from its set point. This selected signal shall be used as the command feedback input for a hydraulic stabilization function to minimize hunting. Each input signal shall be capable of maintaining a different set point value. Controller shall be capable of controlling up to two pumps in parallel.
- 4.4 The pump logic controller shall have an additional analogue input for a flow sensor. This input shall serve as the criteria for the end of curve protection algorithm.
- 4.5 The hydraulic stabilization program shall utilize a proportional-integral-derivative control function. The proportional, integral and derivative values shall be user adjustable over an infinite range.
- 4.6 The pump logic controller shall be self-prompting. All messages shall be displayed in plain English. The operator interface shall have the following features:



- 4.6.1 Multi-fault memory and recall last 10 faults and related operational data.
- 4.6.2 On-screen help function.
- 4.6.3 LED pilot lights and switches.
- 4.6.4 Soft-touch membrane keypad switches.
- 4.7 The display shall have four lines, with 20 characters on three lines and eight large characters on one line. Actual pump information shall be displayed indicating pump status.
- 4.8 The following communication features shall be provided to the BAS:
  - 4.8.1 Remote system start/stop non-powered digital input.
  - 4.8.2 Failure of any system component. Output closes to indicate alarm condition.
  - 4.8.3 One 4-20 mA output with selectable output of:
    - 1.Frequency
    - 2.Process Variable
      - Output Current
      - Output Power
- 4.9 The following communication features shall be provided to Building automation System via an RS-485 port utilizing N2 protocol:
  - a. Individual Analog Input.
  - b. Individual Zone Set Points.
  - c. Individual Pump/AFD on/off status.
  - d. System percent speed.
  - e. System operation mode.
  - f. Individual KW signals.
  - g. System flow, when optional flow sensor is provided.

## **5.0 ADJUSTABLE FREQUENCY DRIVE**

- 5.1 The adjustable frequency drive(s) shall be pulse width modulation (PWM) type, microprocessor controlled design.
- 5.2 The AFD, including all factory installed options, be tested to UL Standard 508. The AFD shall also meet C-UL and be CE marked and built to ISO 9001 standards.
- 5.3 The VFD shall be housed in IP-54/55 enclosure. AFD's with plastic enclosures shall not be acceptable.
- 5.4 The VFD shall employ an advanced sine wave approximation and voltage vector control to allow operation at rated motor shaft output speed with no derating. This voltage vector control shall minimize harmonics to the motor to increase motor efficiency and life. Power factor shall be near unity regardless of speed or load.

- 5.5 The VFD shall have balanced DC link reactors to minimize power line harmonics. VFD's without a DC link reactor shall provide a 3% impedance line reactor.
- 5.6 Automatic motor adaptation (AMA) algorithm shall be utilized. This feature shall allow for automatically optimized drive performance and efficiency leading to additional energy savings.
- 5.7 Input and output power circuit switching can be done without interlocks or damage to the VFD.
- 5.8 The following customer modifiable adjustments shall be provided:
- a. Accel time
  - b. Decel time
  - c. Minimum frequency
  - d. Maximum frequency
- 5.9 The VFD shall be compatible to interface with RS 485 communication Protocol.
- 5.10 An automatic energy optimization selection feature shall be provided. This feature shall reduce voltages when lightly loaded and provide a 3% to 10% additional energy savings.
- 5.11 The AFD shall be suitable for elevations to 3300 feet above sea level without derating. Maximum operating ambient temperature shall not be less than 104 degrees F. AFD shall be suitable for operation in environments up to 95% non-condensing humidity.
- 5.12 The AFD shall be capable of displaying the following information in plain English via a 40 character alphanumeric display:
- Frequency
  - Voltage
  - Current
  - Kilowatts per hour
  - Fault identification
  - Percent torque
  - Percent power
  - RPM

- 5.13 All AFD's shall be warranted for a period of 18 months after shipment. This warranty shall cover parts and labor.
- 5.14 The variable speed drive shall include active harmonic filters to keep total harmonic distortion (THD) within limits conforming to IEEE for airport installation.

## **6.0 SENSOR / TRANSMITTERS**

Pressure transmitters shall be piezo-electric type or diaphragm type. Output shall be 4-20mA or 0-10V DC and the range as specified in the data sheet depending on the line pressure. Power supply shall be either 24 V AC, 24 V DC or 230 V AC. Connection shall be as per manufacturer's standards. The pressure detector shall be capable of withstanding a hydraulic test pressure of twice the working pressure. The set point shall fall within 40%-70% of the sensing range and detector shall have sensitivity such that change of 1.5% from the stabilized condition shall cause modulation of the corrective element. The sensor must be pressure compensated for a medium temperature of -10 °C to 60 °C with ambient ranging between 0°C to 50°C.

## **7.0 SEQUENCE OF OPERATION**

- 7.1 The system shall consist of a pump logic controller, multiple pump/AFD sets, with manual and automatic alternation and pump staging [wherever applicable].
- 7.2 The pumping system shall start upon the closure of customer's contact when the pump logic controller Mode of Operation selector switch is in the REMOTE position.
- 7.3 When the pump logic controller selector switch is in the LOCAL position, and start command on Logic Controller is given via operator interface, the pumping system shall operate automatically.
- 7.4 Sensor / transmitters shall be provided as indicated on the plans.
- 7.5 Each sensor/transmitter shall send a 4-20mA signal to the pump logic controller, indicative of process variable condition.
- 7.6 The pump logic controller shall compare each signal to the independent, engineer/user determined set points.
- 7.7 When all set points are satisfied by the process variable, the pump speed shall remain constant at the optimum energy consumption level.
- 7.8 The pump logic controller shall continuously scan and compare each process variable to its individual set point and control to the least satisfied zone.
- 7.9 If the set point cannot be satisfied by the designated lead pump, the pump logic controller shall initiate a timed sequence of operation to stage a lag pump [wherever applicable].
- 7.10 The lag pump shall accelerate resulting in the lead pump(s) decelerating until they equalize in speed [wherever applicable].

- 7.11 Further change in process variable shall cause the pumps to change speed together [wherever applicable].
- 7.12 When the set point criteria can be safely satisfied with fewer pumps, the pump logic controller shall initiate a timed destage sequence and continue variable speed operation [wherever applicable].
- 7.13 As the worst case zone deviates from set point, the pump logic controller shall send the appropriate analog signal to the AFD to speed up or slow down the pump/motor.
- 7.14 In the event of a AFD fault, the pump logic controller automatically initiates a times sequence of events to start the redundant pump/AFD set in the variable speed mode. The redundant variable speed system shall be started through the pump logic controller.
- 7.15 Upon AFD fault(s), the pump controller shall display an alarm condition through a plain English message.
- 7.16 AFD fault indication shall be continuously displayed on the operator interface of the pump until the fault has been corrected and the controller has been manually reset.
- 7.17 In the event of the failure of a zone sensor/transmitter, its process variable signal shall be removed from the scan/compare program. Alternative zone sensor/transmitters, if available, shall remain in the scan/compare program for control.
- 7.18 Upon sensor failure a plain English warning message shall be displayed on the operator interface of the pump logic controller.
- 7.19 In the event of failure to receive all zone process variable signals, a user selectable number of AFDs shall maintain a user adjustable speed, reset shall be automatic upon correction of the zone failure.

## **8.0 QUALITY ASSURANCE**

- 8.1 The pumping package shall be assembled by the pump manufacturer. An assembler of pumping systems not actively engaged in the design and construction of centrifugal pumps shall not be considered a pump manufacturer. The manufacturer shall assume “Unit responsibility” for the complete pumping package. Unit responsibility for interface and successful operation of all system components supplied by the pumping system manufacturer.
- 8.2 The manufacturer shall have a minimum of 5 years experience in the design and construction of variable speed pumping systems.
- 8.3 All functions of the variable speed pump control system shall be tested at the factory prior to shipment. This test shall be conducted with motors connected to AFD output and it shall test all inputs and program execution specific to this application.
- 8.4 The manufacturer shall be fully certified by the International Standards Organization per ISO 9001. Proof of this certification shall be furnished at time of submittal.
- 8.5 Manufacturer shall be listed by Underwriter’s Laboratories as manufacturer of packaged pumping systems.

- 8.6 Tenderer shall comply with all sections of this specification relating to variable speed pumping systems. Any deviations from these specifications shall be clearly defined in writing at time of bid. If no exceptions are taken at time of bid, the supplier shall be bound by these specifications.

**9.0 PAINTING**

All variable pumping system, pumps, motors and bases shall be supplied with approved finish. Shop coat of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the adjoining areas.

**10.0 AFTER SALE SERVICE**

The bidder shall clearly define the facilities and the set up for providing after sales service with availability of spares with them so as to maintain the system efficiently.

**PHOTOHYDRO IONIZATOIN (PHI) CELLS FOR AHU****1.0 SCOPE**

- 1.1 This Section of the specification covers the supply, installation, testing and commissioning of **Photo hydro ionization** cell based on advanced oxidation technology with broad spectrum UV tube to be fixed in supply air duct/ plenum to enhance the 'Indoor Air Quality' by reducing air pollutants as per ASHRAE 62.1
- 1.2 The Spectrum UV tube shall be duly enclosed with hydrated catalytic matrix cell with the capability to produce friendly oxidizers like hydro peroxides, hydroxides & super oxide ions, the tube should be duly encased in poly tube to prevent glass or mercury leakage into the atmosphere.
- 1.3 The cell shall have built in fiber optic device as remote indication of this operation.

**2.0 TYPE**

- 2.1 The PHI cell should be able to reduce air pollutants such as Gaseous (Odors and VOC's) and Microbial contamination (Bacteria, Virus and Spores) as mentioned in ASHRAE 62.1 standards.
- 2.2 Photo hydro ionization technology should be able to reduce air pollutants such as Gases contamination (odors and VOC's), bacteria, mold, & viruses with the help of broad spectrum UV tube duly encased in hydrated catalytic matrix cell with capability to generate hydro peroxides, super oxide ions, & hydroxide ions.
- 2.3 The double effect technology (to reduce microbial and gaseous contamination) shall be encased in polymer unbreakable casing to prevent mercury leakage into the atmosphere.
- 2.4 It shall be designed to be used for continuous operation with remote operation indication through fiber optic device.
- 2.5 It must be designed to be applied on supply air side of duct/ plenum box with extensive odors reduction capability.

1.	Design Basis	Supply Air side application
2.	UV Tube	Broad spectrum (100-300nm)
3.	Protective tube shield material	Polymer
4.	Metal casing enclosure	Hydrated catalytic matrix (Quad metallic)
5.	Support system	Locally from India
6.	Double effect function	Germicidal + VOC
7.	Capability to generate	Hydro peroxide, super oxide ions, hydroxides ions.
8.	Warranty	Warranty certificate required
9.	Remote indication system	Fiber optic.
10.	Hole dia.	Less than 6" inches.
11.	Certification	TUV / EU certified technology

## **WATER SCALE PREVENTOR**

### **1.0 GENERAL**

- 1.1 The General items of the water scale preventer for the air-conditioning system shall comply with the specifications as given under:

### **2.0 ON-LINE WATER SCALE PREVENTOR**

- 2.1 Scale Preventer shall prevent the formation of hard scale in cooling circuits of Air conditioning equipment.
- 2.2 Scale Preventer shall be a non-chemical on-line type without requiring any chemicals.
- 2.3 Scale prevent or shall work with a combination of adsorption, turbulence and galvanic action.
- 2.4 The inner core of Scale Preventer shall be able to convert the hardness salts into colloidal particles.
- 2.5 The outer casing must be of stainless steel.
- 2.6 Scale Preventer shall not require any electricity or any other source of energy.
- 2.7 The size of the Scale Preventer offered shall be based on the water quality and water flow rate.
- 2.8 Scale Preventer shall be installed in the condenser water circuit as specified in DBR.

**CENTRIFUGAL PUMPS****1.0 SCOPE:**

- 1.1 Scope of this section comprises the supply, erection, testing and commissioning of Water Pumps conforming to these specifications and in accordance with the requirements given in DBR.

**2.0 CAPACITY:**

- 2.1 All pumps shall be of capacity and size in accordance with the requirements indicated in the drawing for Schedule of Quantities. The equipment shall be capable of developing the required total head at rated capacity. The pump shall be suitable for parallel operation & should not overload in single pump operation. The pump shall operate smoothly without undue noise & vibrations. The magnitude of peak vibration at test shop shall be limited to 75 microns at bearing housing. After installation at site the magnitude of vibration shall not exceed 50 microns.

**2.2 MATERIALS:**

Construction of split casing pumps shall be as per BIS:1520 & of end suction pumps shall be as per BIS: 28858 (latest revisions) unless specified specifically in DBR.

Sl. No.	Type	End Suction / Split Casing	Mono Block
1.	Duty	Above 10 HP	Upto 10 HP
2.	Impeller	Bronze / Gun Metal	Bronze / Gun Metal
3.	Shaft	High Tensile Steel / SS-410	High Tensile Steel/ SS-410
4.	Bearings	Heavy Duty Ball/Roller Bearings	Heavy Duty Ball/ Roller Bearings
5.	Shaft sleeves	Bronze / Gun Metal	Bronze / Gun Metal
6.	Pump & Motor Casting	Close grained Cast Iron	Close grained Cast Iron
7.	Seal	Mechanical seal – Factory fitted	Mechanical seal – Factory fitted
8.	Base	Welded Steel	Cast Iron
9.	Flanges	Standard Companion	Standard Companion
10.	Speed Max	1500 RPM	2900 RPM
11.	Motor	TEFC, 415+10 % volts	TEFC, 415+ 10% volts

**3.1 SPLIT CASING PUMPS:**

- 3.1.1 Pump shall be selected for the rated conditions indicated. Efficiency of selected pump shall be high. Peak efficiency shall be obtained at the rated conditions.
- 3.1.2 Pump shall be vertically split casing end suction type, making possible complete servicing of rotating parts without disconnecting piping & motor connections. Suction passages shall be of volute form providing smooth entry to impeller & increased efficiency.



- 3.1.3 Impellers shall be bronze double suction enclosed type, statically and dynamically balanced. Before assembling at works, Impeller shall be securely keyed to the shaft. Impeller fastening nuts (if provided) shall be of cap type & shall tighten in direction of normal rotation for end suction – double shrouded single entry of radial flow.
- 3.1.4 Wearing rings shall be of replaceable type. These shall be held in place by screwing against rotation, press fit & locked with pins, flanged & screwed.
- 3.1.5 Shaft shall be made of steel protected by gunmetal sleeves. Shaft shall be finished to close tolerances for the impeller, coupling & bearing diameters. The impeller, pulley & shaft sleeves shall be firmly secured to the shaft by key/lock nut.

The shaft size shall be calculated on the maximum combined shear stress. This shear stress shall not exceed 30% of the elastic limit in tension or 18% of ultimate tensile strength, whichever is lower.

Shaft shall be equipped with gunmetal Mechanical sleeves securely locked or keyed to the shaft. Rotating shaft & sleeve shall be machined and assembled for concentric rotation.

### 3.2 **BEARINGS:**

- 3.2.1 Bearings may be ball, roller or sleeve type designed to take radial & axial loads. Oil level indicators shall be provided in oil baths of large pumps.
- 3.2.2 Where there is a possibility of liquid entering the bearings, water deflectors or any other suitable accessory shall be provided.
- 3.2.3 Bearings shall be easily approachable without disturbing the shaft alignment.

### 3.3 **COUPLING:**

- 3.3.1 Pumps shall be supplied with spacer type (Love – Joy) coupling to allow dismantling without disturbing pump & motor positions. Coupling guard shall be provided of 20SWG mild steel sheet firmly bolted to common base.

### 3.4 **MONOBLOC PUMPS:**

- 3.4.1 Pump shall be monobloc, end suction design with motor either mounted on common shaft with flanged end casing or connected with direct coupling.

## 4.0 **ACCESSORIES AND FITTINGS:**

- 4.1 The following accessories shall be provided where required with each pump besides other standard accessories:
  - a) Suction and discharge shut off valve, check valve as specified in DBR.

- b) Suction and discharge pressure gauges not less than 150mm diameter and of the appropriate rating with gun metal gate valves etc. in DBR.
- c) 25mm GI drain pipe with funnel. Drain piping for chilled water pump shall be insulated with same insulation material as specified for piping.

## **5.0 MOTOR :**

- 5.1 Motor ratings shown are only tentative and bidders shall select their drives at maximum BHP of the pumps.
- 5.2 THE MOTOR SHALL BE OF EFFICIENCY GRADE IE3.

## **6.0 STARTER:**

- 6.1 The pump motors upto 7.5 HP shall be provided with DOL starter and 10 HP shall have start delta starter.
- 6.2 All pump motors above 10 HP shall be VFD and the system shall be calibrated by vendors for the design conditions.

## **7.0 INSTALLATION :**

- 7.1 Pump shall be installed as per manufacturer's recommendations. Split casing pump sets shall be aligned with motor by competent persons and checked with dial gauge of proper accuracy. Coupling shall be 'Love- Joy' type to enable disconnection without shifting of motor & pump. It would be preferable to procure pump, motor, steel base & coupling guard from same vendor.

The concrete base shall be isolated from main floor with double layer ribbed rubber pads & sand covered with 20SWG GSS.

## **8.0 TESTING :**

- 8.1 Vendor shall submit the performance curves of the pumps supplied by him. He shall also check the capacity and total head requirements of each pump to match the piping and equipment layout.
- 8.2 On completion of the entire installation, pump shall be tested. Test results shall correspond to the performance curves.

## **9.0 PAINTING :**

- 9.1 After complete installation and testing, original paint of the pump shall be retouched by spray painting and accessories, fittings and base frame shall be given two coats of synthetic enamel paint of approved colour as specified under sub-section "Painting".

**COMBINED AIR & DIRT SEPARATOR****1.0 CONSTRUCTION**

- 1.1. The Air and Dirt separator shall be of a solid and robust construction (Mild steel).
- 1.2. It shall be able to remove free air and micro bubbles as well as remove solid particles upto 10 microns and less from water.
- 1.3. Removal of Air via Centrifugal Force shall not be acceptable. The unit shall be able to condition the water to make it highly absorptive at all points in the system, which shall ensure that micro bubbles can no longer exist at any point in the system.
- 1.4. All connections, fittings and heads shall be of carbon Steel.
- 1.5. The medium used to de-aerate and remove dirt shall be manufactured of steel tube & copper wire or stainless steel. This medium should be non-clogging in nature.
- 1.6. An automatic air vent of at least 100 mm free area to be connected at the top for the release of the air separated from the water. The Automatic air vent should be guaranteed not to leak and cannot be closed. The flow should not be obstructed by the dirt collected.
- 1.7. A Drain valve shall be provided at the bottom to remove the accumulated dirt without the need of shutting down the operation of the system.
- 1.8. The Air & Dirt Separator shall be insulated as per specifications of “INSULATIONS” depending upon its location (outdoor or indoor).
- 1.9. The pressure drop on account of the air and dirt separator shall not exceed the values given hereunder :-

<b>Connection (DN) of Air &amp; Dirt Separator</b>	<b>For Max velocity of 1.5m/s</b>	<b>For Max velocity of 3m/s</b>
	<b><math>\Delta P</math> Max. Flow (kPa)</b>	<b><math>\Delta P</math> @ Max. Flow (kPa)</b>
50	3.0	11.8
65	2.7	11.6
80	2.9	12.4
100	3.7	14.6
125	4.2	16.8
150	4.9	19.4
200	5.8	23.1
250	6.9	27.7
300	7.7	31.0
350	7.8	31.0
400	8.4	34.0
450	10.0	39.0
500	11.0	43.0
600	12.0	47.0

For connections larger than DN 600, the contractor must provide the pressure drop calculations in this submittal for approval.

## **PIPE WORK AND VALVES**

### **1.0 GENERAL**

All piping work shall conform to quality standards and shall be carried out as per specifications and details given hereunder:

### **2.0 PIPES**

The pipes and valves shall be of approved make.

Chilled water/condenser water pipes of sizes 150 mm & below shall be M.S. 'C' class as per IS: 1239 and pipes size above 150 mm shall be welded black steel pipe heavy class as per IS: 3589, from minimum 6.35 mm thick M.S. Sheet for pipes upto 350 mm dia. and from minimum 7mm thick MS sheet for pipes of 400 mm dia and above.

### **3.0 FITTINGS**

3.1 The dimensions of the fittings shall conform to I.S. 1239-69 Part-II unless specified otherwise in specifications.

3.2 All bends in sizes up to and including 150 mm dia, shall be ready made of heavy duty, mild steel of same class as specified for pipes.

3.3 All bends in sizes 200 mm and larger dia shall be fabricated from pipes of the same dia and thickness, with a minimum of five sections, each segment making a 17deg bend and having a minimum centre line radius of 1.5 times diameter pipe diameter.

3.4 All fittings such as branches, reducers etc. in all sizes shall be fabricated from pipes of the same dia and thickness, and its length should be at least twice the dia of the pipe.

3.5 The branches may be welded straight to the main line, without making a separate fitting, where specified on drawings or required by Engineer-in-Charge.

Blank ends are to be formed with flanged joints and 6 mm thick blank between flange pair for 150 mm and over in case where, a future extension is to be made, blank end discs of 6 mm thickness are to be welded on, with additional cross stiffeners from 50 mm x 50 mm x 5 mm MS heavy angles, for sizes up to 350 mm, all ends larger than 400 mm Dia shall have dished ends.

### **4.0 FLANGES**

4.1 All flanges shall be of mild steel as per I.S. 6392/71 and shall be steel slip-on-type, welded to the pipes, flanges thickness shall be to suit class-II pressures.

4.2 Flanges may be tack welded into position, but all final welding shall be done with joints dismounted. 5mm thick Neoprene gaskets shall be used with all flanged joints. The gaskets shall be fiber-reinforced rubber as approved by the Engineer-in-Charge. Special adhesive compound shall be used between flanges of steam, air and gas lines.

4.3 Flanges shall be used as follows:

4.3.1 Counter flanges for equipment having flanged connections.

4.3.2 Flanged pairs shall be used on all such equipment, which may require to be isolated or removed for service e.g. pumps, Air washer units etc.

4.3.3 All threaded valves shall be provided with nipples and flanged pairs on both sides to permit flange connections, for removal of valves from main lines for repair/replacement.

## **5.0 VALVES**

### **5.1 BUTTERFLY VALVES**

5.1.1 The butterfly valve shall consist of cast iron body of IS 210 FG220 preferably in two piece construction.

5.1.2 The disc shall consist of disc pivot OF SG iron IS 1865 Gr. 400/12 and driving stem shall be made of SS AISI 410 and in one piece centrally located conforming to IS 13095.

5.1.3 The valve seat shall be synthetic material nitrile suitable for water duty. It shall line the whole body and should be field replaceable/integrally moulded.

5.1.4 The disc should move in slide bearings on both ends with 'O' ring to prevent leakage.

5.1.5 The handle should have arrangement for locking in any set position.

5.1.6 The valve should be suitable for 16 Kg/Sq.M working pressure.

5.1.7 All the valves above 32 mm Dia shall be butterfly type.

### **5.2 MOTORISED BUTTERFLY VALVES**

5.2.1 Motorised Butterfly valves shall be made of cast iron body, SS disc, O-ring, seat of black nitrile rubber (tight shutoff), nylon coated S.G. iron disc, PTEE coated SS (AISI 410) shaft, complete with companion flanges, nuts, bolts, gaskets etc. as required.

5.2.2 These valves shall conform to BS:5155, IS 13095, MSS SP 67 & API 609 and shall be designed to fit without gaskets between mating flanges.

5.2.3 The valves shall be suitable for flow in either direction and seal in both directions.

5.2.4 The valve shall be of integral moulded design.

5.2.5 Actuator shall have potential free contacts for status monitoring.

5.2.6 IP-55 actuator, capable of accepting upto 10V DC, & upto 20 mA electric signal and providing similar transduced feedback output to control system as required

- 5.2.7 The valve shall be complete with (Push Button for ON/OFF arrangement & ON/OFF valve indications) companion flanges, nuts, bolts, gaskets etc.
- 5.2.8 The valve should be suitable for 16 Kg/Sq.M working pressure.

### **5.3 BALL VALVES**

- 5.3.1 All ball valves and ball valves with Y strainer shall be bronze forged body construction with chrome plated bronze ball and handle of stainless steel constructions.

### **5.4 GATE/GLOBE VALVE**

- 5.4.1 All gate valves and Globe valves shall be of gun metal screwed type, and shall have non rising type spindle, conforming to class 2 of I.S. 778 and shall be with I.S.I. marking and certification and tested upto a pressure of 21 kg/sq.cm.

### **5.5 CHECK VALVE**

- 5.5.1 All Check valves upto 50 mm dia shall be of GM screw type and shall be conforming to I.S. 778 and of I.S.I marked and certification.
- 5.5.2 All check valves above 50 mm shall be wafer type dual plate.
- 5.5.3 The body of check valve shall be of cast iron of grade IS 210 FG 220.
- 5.5.4 The flap shall be made of SS AISI 304 or SG iron IS 1865GR 400/12.
- 5.5.5 The hinge and stop pin shall be of SS AISI 304/410 and spring shall be SS AISI 304/316
- 5.5.6 The valve shall be suitable for 16-kg/sq.-cm. Working pressure and shall be factory tested at 21-kg/sq. cm.

### **6.0 BALANCING VALVES**

- 6.1 The balancing valves shall be capable of measuring, regulating and isolating the flow.
- 6.2 The balancing valves up to 40 mm dia shall be of gunmetal screwed type and 50 mm dia. And above shall be C.I double-flanged type confirming to B.S. 1452 or equivalent specifications.
- 6.3 The balancing valves shall be made of stainless steel AISI 410. All other internals shall be non-corrosive material preferably of forged brass.
- 6.4 The port opening shall permit precise regulation of flow rate, by accurately measuring the pressure drop across the port.
- 6.5 The valve shall be complete with two ports for connections to a mercury manometer, to measure the pressure drop, as well as drain port.

- 6.6 The spindle shall have a shielded/concealed locking screw to avoid the tempering of the setting after balancing.
- 6.7 The valves must have easily accessible pressure drop measuring facility.
- 6.8 The balancing valve shall have indication of number of turns on hand wheel preferably digital type.
- 6.9 The balancing valve shall be used in lieu of butterfly/gate/globe valves and shall be suitable for working at 16 kg/sq.cm working pressure.

#### **7.0 PID/2 Way Modulating/Flow Control Valve**

- 7.1 The Self balancing flow control valves shall be pressure independent, 2-way, modulating type to accept input signals from the control system.
- 7.2 Each Air Handling Unit shall be provided with a 2 Way Pressure Independent cum Balancing cum Control Valve integrated in a single Body.
- 7.3 The valve shall be a Globe Type.
- 7.4 Diaphragm based delta p controller shall ensure 100% valve authority & linear characteristics at all loads and setting. The cartridge is not acceptable.
- 7.5 Control - Valve shall be equipped with electronic modulating gear type actuator which can accept either 4(0)-20mA / 2(0)- 10V DC signals. Operating voltage for actuator shall be 24V AC (thermal/wax not acceptable).
- 7.6 All Valve actuators shall be microprocessor based with self-calibrating feature.
- 7.7 Valve Actuator combination shall be able to give logarithmic control characteristic to achieve linear control.
- 7.8 Actuator shall be able to work against pump head or maximum closing pressure.
- 7.9 For Manual override, it shall not involve opening of actuator body.
- 7.10 Each Valve shall have a stepless adjustable maximum flow limitation as per the designed flow rate of coils.
- 7.11 The balancing shall be done only in the valve not in the actuator so that in case of actuator failure the balancing is not lost and easily accessible.

#### **8.0 STRAINERS**



- 8.1 The strainers shall either be pot type or 'Y' type with cast iron or fabricated out of MS 'C' class pipe two sizes higher than that of Strainer pipe size, tested upto pressure applicable for the gate valves as shown on the drawings.
- 8.2 The strainer's screen shall have a perforated SS sheet of 20-gauge thickness with 3mm dia having an area of 60% perforation and with a permanent magnet, to catch iron fillings.
- 8.3 Pot strainers shall be designed to facilitate in easy removal of filter screen for cleaning, without disconnection of pipeline.
- 8.4 All pump shall have suction guide with strainer in pump suction.
- 8.5 The strainers shall be suitable for 16 kg/sq.cm working pressure.

## **9.0 JOINTING**

- 9.1 All pipelines shall be welded type.
- 9.2 Square cut plain ends will be welded for pipe up to and including 100 mm dia.
- 9.3 All pipes 125mm dia. or larger will be bevelled by 35 Deg. for welding.

## **10.0 MISCELLANEOUS**

- 10.1 Providing all piping, required to make the apparatus connected, complete and ready for regular and safe operation, unless otherwise noted, connect all apparatus and equipment in accordance with manufacturer's standard details, as approved by the Engineer-in-Charge.

Consult drawings and specifications to determine number and requirements of all items of equipment, requiring piping, such as bend, drain, relief etc., wherever equipment is provided with connections for such piping.

- 10.2 Providing valves and capped connections for all low points in piping system, necessary or required for draining systems. Provide for all risers isolating valves and drain valves to permit repairs without interfering with the rest of the system.
- 10.3 During construction, temporarily close, open ends of pipes with sheet metal caps, where necessary, or required to prevent debris from entering piping system.
- 10.4 Support piping independently of all equipment so that the equipment is not stressed by the piping weight or expansion.
- 10.5 To facilitate the maintenance, repair and replacement.
- 10.6 Unions, if used, shall be flanged, as required, where indicated and in connections to all equipment, apparatus, and specialties requiring disconnection for repairs or replacement, locate unions between shut-off valves and equipment as directed by Engineer-in-Charge.

- 10.6.1 Provide shut-off valves where indicated and for individual equipment, units at inlet and outlet, to permit unit removal for repairs, without interfering with the remainder of the system. Additional shut-off valves shall be provided as required to enable all systems to be fully sectionalized. Bypass and stop valves shall be provided for all automatic control valves as specified.
- 10.6.2 Arrange piping for maximum accessibility for maintenance and repair, locate valves for easy access and operation. No valves shall be installed with handles pointing down, unless unavoidable.
- 10.6.3 Cut the pipes accurately according to measurements, established at building and work into place without springing or forging.
- 10.6.4 Pipe supports shall be adjustable for height and primer coated with rust preventive paint and finish coated with gray paint, both as approved by Engineer-in-Charge. Spacing of pipe supports shall not be more than that of specified below:-

10.6.5

Nominal Pipe Size mm	Spacing (Meters)
15	1.25
20 & 25	2.00
32,30,50 & 65	2.50
80,100 & 125	2.50
150 & ABOVE	3.00

- 10.6.6 Extra supports shall be provided at the bends and at heavy fittings like valves to avoid undue stresses on the pipes. Pipe hangers shall be fixed on walls and ceiling by means of metallic approved dash fasteners.
- 10.6.7 Insulated pipe shall be supported in such a manner as to not to put undue pressure on the insulation.
- 10.6.8 Where pipes are to be buried under ground following procedure and specifications to be adhered. The top of the pipes shall not be less than 75 Cms. from the ground level. Where this is not practical permission of Engineer-in-Charge shall be obtained from burying the pipes at lesser depth.

The pipes shall be surrounded on all sides by sand cushions of not less than 15 cms. After the pipes have been laid and top sand cushions provided, the trench shall be refilled with the excavated soil, excess soil shall be removed from the site of work by the Contractor.

Apply a coat of bitumen.

Fix the tarfelt sheet with the help of bitumen, followed by another thick coat of bitumen.

## 11.0 **HANGERS & SUPPORTS**

- 11.1 Hangers and supports shall be provided and installed for all piping and tubing wherever indicated, required or otherwise specified. Wherever necessary, additional hangers and supports shall be provided to prevent vibration or excessive deflection of piping and tubing.

- 11.2 All Hangers and supports shall be made of steel or other durable and non- combustible materials, galvanized or plated. Wood wire or perforated strap iron shall not be used as permanent hangers or supports.
- 11.3 Hangers shall be supported from fabricated structural steel secured with expansion bolt in reinforced concrete slab/beams. Similarly, pipe racks shall be fabricated with structural steel and secured with expansion bolts (HILTI or FISHER) in RCC slab/beams.
- 11.4 No hangers shall be secured to underside of lightweight roof decking and lightweight floor glass.
- 11.5 Mechanical equipment shall be suspended midway between steel joints and panel points.
- 11.6 Drilling or punching of holes in steel joist members will not be permitted.
- 11.7 All nuts, bolts and washers shall be of G.I only.
- 11.8 All chilled water piping in A.C. plant room and other areas and also drain piping of ceiling suspended AHU shall be duly supported with high density polyurethane foam (P.U.F.) supports of block type so as to provide insulation as well as take load of piping. these supports would be fixed with rubber sheet and clamps. Placing of these supports are as per design parameters keeping in mind the load factor of bare pipe plus fluid weight and vibratory movement of the pipes. suggested distance for placing these supports as mentioned in 9.6.4.

## **12.0 SLEEVES**

- 12.1 Where pipes pass through floors, provide galvanised steel pipe sleeves 50 mm larger than outside diameter of pipe. Where pipes are insulated, sleeves shall be large enough to ample clearance for insulation.
- 12.2 Where pipes pass through outside walls or foundations, the space between pipe and sleeve shall be caulked with lead wood and oakum.
- 12.3 The center of pipes shall be in the center of sleeves and sleeves shall be flush with the finished surface.

## **13.0 ARRANGEMENT AND ALIGNMENT OF PIPING**

- 13.1 All piping shall be arranged and aligned in accordance with the drawings as specified. Where special conditions are encountered in the field, the arrangement and alignment of piping shall be as directed by the Engineer-in-Charge.
- 13.2 The piping shall be installed in a uniform manner, parallel to or perpendicular to walls or ceilings, and all changes in directions shall be made with fittings. The horizontal piping shall be run at right angles and shall not run diagonally across rooms or other piping. Wherever possible all piping shall be arranged to provide maximum headroom.
- 13.3 All piping shall be installed as directly as possible between connecting points in so far as the work of other trades permits. Where interference occurs with another trade whose work is more difficult

to route, this Contractor shall re-route his pipes as required to avoid interference, at the discretion of the Engineer-in-Charge.

- 13.4 All piping shall be carefully installed to provide for proper alignment, slope and expansion.
- 13.5 The stresses in pipe lines shall be guided and pipes shall be supported in such a manner that pipe lines shall not creep, sag or buckle.
- 13.6 Anchors and supports shall be provided wherever necessary to prevent any misalignment of piping.
- 13.7 Small tubing for gauges, controls or other equipment installed on any apparatus shall not be coiled nor excessive in length, but shall be installed neatly, carefully bend at all changes in direction, secured in place and properly fastened to equipment at intervals to prevent sagging.
- 13.8 The piping shall be grouped wherever practical and shall be installed uniformly in straight parallel lines in either vertical or horizontal positions.

#### **14.0 EXPANSION TANK (OPEN TYPE)**

Expansion tank shall be constructed out of 3 mm thick MS sheet. The bottom of the tank shall be atleast 0.6 M above the highest point of the system. MS tank may be provided unless otherwise specified. Tanks shall be insulated with 75mm thick expanded polystyrene (TF quality) insulation covered with vapour barrier, 0.5mm x 20mm GI wire mesh metting and finished with 0.5m thick GI ladding duly plastered and shall be complete with float valves, drain, overflow and make- up connections complete with gate valves and vent piping wherever required. MS sheet shall be atleast 3mm thick.

#### **15.0 TESTING**

- 15.1 In general, tests shall be applied to piping before connection of equipment and appliances. In no case shall piping equipment or appliances be subjected to pressures exceeding their test ratings.
- 15.2 The tests shall be completed and approved before any insulation is applied. Testing of segments of pipe work will be permitted, provided all open ends are closed, with blank-offs or flanges.
- 15.3 After tests have been completed the system shall be drained and flushed 3 to 4 times and cleaned of all dust and foreign matter. All strainers, valves and fittings shall be cleaned of all dirt, fillings and debris.
- 15.4 All piping shall be tested to hydraulic test pressure of at least one and half times the maximum operating pressure but not less than 10 Kg/Sq. cm for a period of not less than 3 hours. All leaks and defects in the joints revealed during the testing shall be rectified to the satisfaction of the Engineer-in-Charge, without any extra cost.
- 15.5 All the piping systems shall be tested in the presence of the Architect or Engineer-in-Charge or their authorized representative. Advance notice of test dates shall be given and all equipments, labour, materials required for inspection and repairs during the test shall be provided by the Contractor. A test shall be repeated till the entire systems are found satisfactory to the above

authority. The tests shall be carried out for a part of work if required by Engineer-in-Charge in order to avoid hindrance in the work of the insulation Contractor.

- 15.6 Miscellaneous piping, tests with air at 10.5 KG/Sq. CM for a minimum of 24 hours without drop in pressure.
- 15.7 The Contractor shall make sure that proper noiseless circulation is achieved through all piping systems. If due to poor air bond, proper circulation is not achieved, the Contractor shall bear all expenses for carrying out the rectification work including finishing of floors, walls and ceiling damaged in the process of rectification's.
- 15.8 The Contractor shall provide all labour and materials to make provision for removing water and throwing it at the proper place during the testing or/and after the testing to avoid damages to employer or other Contractors properties. Any damages caused by the Contractor to the employer or other Contractors' properties, shall be borne by the Contractor.

#### **16.0 AUTO AIR VENTS**

- 16.1 Air vents for purging of air trapped in piping system shall be provided at the highest point. Globe valves of the size indicated below shall be provided

<b>Pipe Size</b>	<b>Valve Size</b>
Upto 100mm	25mm dia
Above 100mm	40mm dia

#### **17.0 DRAIN PIPING**

- 17.1 The drain piping shall be medium class galvanized steel as per IS 1239/1979.
- 17.2 The fittings shall be of 'R' brand or equal forged with screwed connections.
- 17.3 The gate valves shall be of gun metal as described earlier.
- 17.4 Pipe crosses shall be provided at bends, to permit easy cleaning of drain line.
- 17.5 The drain line shall be provided up to the nearest drain trap and pitched towards the trap along with a P-Trap at the bottom of each vertical drainpipe.
- 17.6 Drain lines shall be provided at all the lowest points in the system, as well as at equipment's, where leakage of water is likely to occur, or to remove condensate and water from pump glands.

#### **18.0 PAINTING**

- 18.1 All pipes supports, hangers, etc. shall be given two coats of Zinc Chromate or Red Lead primer.
- 18.2 All pipes, which are not to be insulated, shall then be given one coat of finish paint, of a type and colour, as approved by the Engineer-in-Charge.

#### **19.0 PRESSURE GAUGES/THERMOMETERS**

### 19.1 Water Pressure Gauges

1. Pressure gauge shall be appropriate range and be complete with U tube, snubber, shut off gauge cocks etc. duly calibrated before installation.
  - a) Pressure gauges shall have micro meter type.
  - b) Scale of gauge shall be white with black letters (printed).
  - c) Pressure gauges shall be as per IS-3624.
  - d) Scale shall be so selected that normal process pressure is approximately 75% of full scale.
2. Pressure gauges shall be not less than 100 mm Dia.
3. Care shall be taken to protect pressure gauges during pressure testing.
4. Pressure gauges shall be installed on suction and discharge sides of pumps, chilled water supply and return at air handling units, inlet and outlet at chillers and condensers & inlet and outlet at hot water generators.

### 19.2 Industrial Type Thermometer

Thermometers shall be direct reading industrial type of appropriate range duly calibrated before installation.

- a) Temperature gauges shall be mercury in glass type with cast brass scale in a steel casing.
- b) Thermometers shall be filled with red reading mercury.
- c) Thermometers shall be of the separable socket type and shall have extended neck, where required, for insulated pipes.
- d) The scale shall be 23 cm long.
- e) Accuracy shall be + 1.0% of full Scale or better.
- f) Minimum over range protection shall be 25% of full scale range.

Thermometers shall be installed at chilled water supply and return at air handling units, supply and return at chillers and condensers & supply and return at hot water generators.

Range of scales shall be suitable for air conditioning applications.

Thermometer shall be suitable for 15mm connection. Thermometer for chilled line shall have long stem, so that thermometer is removable without damaging the insulation.

## 20.0 EXPANSION BELOWS

The expansion bellows shall be flanged type expansion joint. Flanges shall be non-compressible and mechanically strong type and the Neoprene rubber shall be provided in between the flange ends. The below shall work for a temperature range of minus 10°C to 70°C.

Bellows shall be provided with control rods to control the excessive elongation or compression of piping systems.

It shall have torsional movement up to 3° without damage.

## **21.0 BTU METER**

Meter should be a tamper proof meter with Single button design. No tampering can be done on the meter through the keypad. Parameters of the meter can be changed through software only.

Meters need to be calibrated Online after installation to guarantee Accuracy. The calibration have to be done onsite after installation and the same is mandatory for every meter installed.

All meters need to be wet calibrated (temperature sensor and flow meter need to be calibrated together) and calibration certificate to be provided for the BTU meters.

Meters need to have an inbuilt battery backup – guaranteed for a minimum of 6 years. There is no requirement of Power supply.

The flow sensor needs to be a high capacity flow meter and can take velocities as high as 10 m/s.

One single model for line sizes ranging from 15mm to 700mm.

Meters need to be CE certified and needs to have IP68 Protection.

Meter should have the facility to be used as a hot meter as well as a cold meter without any modifications. The meter should have auto switching of Hot/ Cold meters.

## **DUCT WORK AND OUTLETS**

### **1.0 GENERAL**

- 1.1 The work under this part shall consist of furnishing labour, materials, equipment and appliances as specified, necessary and required to install all sheet metal ductwork and other allied work to make the HVAC system complete & ready for operation as per drawings/DBR.
- 1.2 Ductwork shall mean all ducts, casings, dampers, access doors, joint, stiffeners and hangers. All duct work and related items shall be in accordance with these specifications.
- 1.3 The ducting shall be factory fabricated and assembled at site.
- 1.4 Fabrication of ducting at site except “to suite at site” pieces will not be allowed. the “to suite” pieces will require prior approval from engineer-in-charge or architect.
- 1.5 Documentation & Measurements for Ducting

All ducts fabricated and installed should be accompanied and supported by proper documentation viz.

Bill of material/packing list for every duct section supplied.

Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge wise.

Each and every duct piece to have a tag number, which should correspond to the serial number, assigned to it in the measurement sheet. The above system will ensure speedy and proper site measurement and verification.

### **2.0 DUCT MATERIALS**

- 2.1 The ducts shall be fabricated from galvanized steel sheets **class VIII** conforming to IS: 277 latest edition **(120 gm/sq.m)**.

Galvanised sheet shall possess light coating of zinc nominal 120 gm./sq.m surface area (total coating on both sides) 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 Engineer-in-Charge shall be subject to approval and tested for thickness and zinc coating at Contractor's expense.

- 2.2 All duct work, sheet metal thickness and fabrication unless directed otherwise, shall strictly meet requirements, as described in IS: 655-1963 with amendment-I (1971 edition).
- 2.3 The gauges, joints and bracing's for sheet metal ductwork shall further conform to the provisions as shown in 4.0.



- 2.4 Ducts larger than 450mm shall be cross-broken duct sections up to 1200-mm length may be used with bracing angles omitted.
- 2.5 Changes in section of ductwork shall be affected by tapering the ducts with as long a taper as possible but not less than 1:4 ratio. All branches shall be taken off at not more than 45 Deg. angles from the axis of the main duct unless otherwise approved by the Engineer-in-Charge.

### **3.0 INSTALLATIONS**

- 3.1 During the construction, the Contractor shall temporarily close duct openings with sheet metal covers to prevent debris to enter into the ducts and to maintain opening straight and square, as per direction of Engineer-in-Charge.
- 3.2 Great care should be taken to ensure that the ductwork does not extend outside and beyond height limits as noted on the drawings.
- 3.3 All ductwork shall be of high quality approved galvanised sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be tight and shall be made in the direction of airflow. The ducts shall be reinforced where necessary, and must be secured in place so as to avoid vibration of the duct on its support.
- 3.4 All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration. All ducts shall be fabricated and installed in accordance with modern design practice. The sheet metal gauges and fabrication procedures as given in I.S.S. specifications shall be adhered to and shall be considered as an integral part of these specifications. Turning vanes shall also be provided in masonry ducts as per schedule of quantities.
- 3.5 The ductwork shall be varied in shape and position to fit actual conditions at building. All changes shall be in accordance with accepted H.V.A.C. duct design and subject to the approval of the Engineer-in-Charge.
- 3.6 Self adhesive Neoprene rubber/UV resistant PVC foam lining 5mm thickness shall be installed between duct flanges as well as between all connections of sheet metal ducts to walls, floor columns and filter casings. Sheet metal connections shall be made to walls and floors by means of galvanised steel angles anchored to the building structure with anchor bolts and with the sheet bolted to the angles. Sheet metal connections shall be as shown in the drawings or as directed by Engineer-in-Charge.
- 3.7 The ducts shall be supported from the structure by means of suitable supports as mentioned below by means of Galvanised steel wire rope hangers In no case the duct will be rested upon the false ceiling/boxing or on supports grouted in the wall.

### **3.8. HANGERS FOR DUCT SUPPORT-**

#### **Steel Wire Rope Hangers & Supports:**

- 3.8.1. 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.

- 3.8.2. The end fixings and the wire must be of the same manufacturer with several options available.
- 3.8.3. The system should be secured and tensioned with a Hanger self-locking grip at the other end.
- 3.8.4. 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.
- 3.8.5. Only wire and/or supports supplied and/or approved, shall be used with the system.
- 3.8.6. Wire Hangers should have been independently tested by Lloyds Register, APAVE, TUV, UL, CSA, Chiltern International fire, ADCAS, Intertek, ECA, and SMACNA, approved by ULC and CSA and comply with the requirements of DW/144 and BSRIA – wire Rope Suspension systems. Wire rope should be manufactured to BSEN 12385: 2002
- 3.8.7. 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).
- 3.8.8. 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).**

- 3.8.9. 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.
- 3.8.10. 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.

#### **Wire (Gripple) Hanger Safe Working Loads**

	<b>minimum breaking load</b>	<b>working load limit</b>
<b>size</b>	<b>of Wire Rope</b>	<b>(kg/lbs)</b>
No. 1	80kg/176 lbs	0-10 kg / 0-22 lbs
No. 2	260kg/572 lbs	10-45 kg / 23-100 lbs
No. 3	580kg/1276 lbs	45-90 kg / 101-200 lbs
No. 4	1500kg/3300 lbs	90-225 kg / 210-495 lbs
No. 5	2160kg/4752 lbs	225-325 kg / 496-715 lbs

No. 6	2500kg/5500 lbs	325-500 kg / 715-1100 lbs
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- 3.9. 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.

3.9.1. **HVAC Supports – Hanger Supports are suitable for: Rectangular duct, Booster fans, Air Conditioning Units, Plenum Boxes, Fan Coil Units and Diffusers.**

3.9.2. **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 system 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.

- 3.9.3. 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 2000mm centre, for 2001-2250mm 50x50x5 mm angle should be used under the duct, along with neoprene pad in between the duct & MS angle, above 2250mm 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.

- 3.9.4. 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.

3.9.5. **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.

3.9.6. 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.**

3.10. Additional hangers shall be provided in ducts near smoke / fire dampers corrections and at bends.

3.11. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.

3.12. Joints, seams, sleeves, splitters, branches, take off and supports are to be as per duct details as specified or as decided by Engineer-in-charge.

3.13. Joints requiring bolting or riveting may be fixed by hexagon nuts and bolts, stove bolts or buck bolts, rivets or closed centre top rivets or spot welding. Sale tapping screws must not be used. All fixing must have a permanently non- corrosive finish such as cadmium plating or galvanizing as appropriate. Spot welds and bronze welds are to be coated on all surfaces with zinc rich paint as approved by Engineer-in-charge.

3.14. The flexible joints are to be fitted to the suction and delivery of all fans. The material is to be normally double heavy canvass or as directed by Engineer -in-charge. On all circular spigots the m flexible materials are to be screwed or clip band with adjustable screws or toggle fitting. For rectangular ducts the material is to be flanged and bolted with a backing flat or bolted to mating flange with backing flat.

3.15. The flexible joints are to be not less than 75mm and not more than 250mm between faces.

3.16. The ductwork should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling works.

3.17. **INSTALLATION PRACTICE**

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.

#### **4.0 THE GAUGE JOINTS AND BRACING FOR SHEET METAL DUCT WORK SHALL BE AS FOLLOWING**

<b>Maximum Side (mm)</b>	<b>Thickness of GI Sheet (mm)</b>	<b>Type of Transverse Joint Connections</b>
Upto 750 *	0.63	C & SS CLEATS
751 to 1500	0.80	TDF FLANGES
1501 to 2250	1.00	TDF FLANGES
2250 TO ABOVE	1.25	TDF FLANGES

- i. Exposed Ducts for Evaporating Air Cooling and other un-insulated exposed ducts shall have TDF Flanges.
- ii. Ducts 2250mm and larger require special field study for hanging, supporting methods and also bracing for duct size above 1501 mm.

#### **5.0 MOTORISED COMBINED SMOKE AND FIRE DAMPERS – SPRING RETURN TYPE**

- 5.1 All supply air ducts in AHU room crossing shall be provided with approved make fire and smoke dampers of at least 90 minutes fire rating certified by CBRI, Roorkee as per UL555:1973.
- 5.2 The fire damper blades and outer frame shall be formed of 1.6 mm galvanised steel sheets. The damper blade shall be pivoted on both ends using chrome plated spindles in self lubricating bushes. Stop seals shall be provided on top and bottom of the damper housing made of 16G galvanized steel sheet. For preventing smoke leakage side seals will be provided.
- 5.3 In normal operating conditions damper blade shall be held in open position with the help of a 24V operated electric actuators thereby providing maximum air passage without creating any noise or chatter.
- 5.4 The damper shall be actuated through electric actuator. The actuator shall be energized with the help of a signal from smoke detector installed in AHU Room/R.A. Duct. The fire damper shall close due to temp. Rise in S.A. Ducts through the electric ramp. Sensor which is factory set at 165 deg.F.
- 5.5 Each motorized smoke cum fire damper shall have its own panel which will incorporate necessary circuit required to step down voltage available from UPS or emergency power supply to show status of the damper (open or close) to allow remote testing of damper, indication in event of damper closure due to signal from smoke sensor/temp. sensor and reset button. Additional terminal will be provided to have audio cum video signal in Central Control Room.
- 5.6 Damper actuator shall be such that it should close the damper in the event of power failure automatically and open in the same in case of Power being restored.

5.7 The fire damper shall be mounted in fire rated wall with a duct sleeve 600mm long. The sleeve shall be factory fitted on fire damper. The joints at sleeve end shall be slip on type. Minimum thickness of GI Sheet shall be 18G.

5.8 The damper shall be installed in accordance with the installation method recommended by the manufacturer.

## **6.0 ACCESS PANEL**

6.1 Hinged access doors of suitable size complete with air tight gaskets shall be provided in all fire dampers and plenums.

## **7.0 MISCELLANEOUS**

7.1 All ducts above 450mm are to be cross-broken to provide rigidity to the ducts.

7.2 All duct work joints are to be true right angle or approaching with all sharp edges removed.

7.3 Sponge rubber gaskets also to be provided behind the flange of all grilles.

7.4 Each shoot from the duct, leading to a grill, shall be provided with an air deflector to divert the air into the grille through the shoot.

7.5 Inspection doors measuring at least 450mm x 450mm are to be provided in each system at an appropriate location, as directed by Engineer-in-charge.

7.6 Diverting vanes must be provided at the bends exceeding 600mm and at branches connected into the main duct without a neck.

7.7 Proper hangers and supports should be provided to hold the duct rigidly, to keep them straight and to avoid vibrations. Additional supports are to be provided where required for rigidity or as directed by Engineer-in-charge.

7.8 The ducts should be routed directly with a minimum of directional change.

7.9 The ductwork shall be provided with additional supports/Hangers, wherever required or as directed by the Engineer-in-Charge, at no extra cost.

7.10 All duct supports, flanges, hangers and damper boxes etc. shall be given 2 coats of red oxide paint before installation and one coat of aluminium paint after the erection, at no extra cost.

7.11 All iron flanges to be welded electrically and holes to be drilled.

7.12 All the angle iron flanges to be connected to the GSS ducts by rivets at 100 mm centers.

7.13 The GSS ducts should be lapped 6 mm across the flanges.

7.14 The ducts should be supported by approved type supports at a distance not exceeding 2.4 meters.

- 7.15 Sheet metal connection pieces, partitions and plenums required, shall be constructed of 1.25 (18 gauge) sheet thoroughly stiffened with 40mmx40mmx3mm angle iron braces and fitted with access doors.
- 7.16 Splitter damper must be provided wherever ducts are bifurcating. No extra payment shall be made separately since these form part of air-circulating system.

## **8.0 GRILLES, DIFFUSERS, DAMPERS ETC.**

### **8.1 The supply and return air grills and ceiling diffusers**

The supply and return air grills and ceiling diffusers shall be made of powder coated extruded aluminium sections. The supply air grills/diffusers shall be provided with screws operated opposed blade volume control device made of extruded aluminium in black anodized finish.

All grills/diffusers shall have soft continuous rubber/foam gasket between the periphery of the grills/diffusers and surface on which it has to be mounted. The colour of grills/diffuser shall be as per the approval of the Engineer-in-Charge.

### **8.2 Linear supply and return grills**

The linear continuous supply/return air grills shall be made of powder coated extruded aluminium construction with fixed horizontal bars. The thickness of fixed bar louvers shall be 5mm in front and the flange shall be 20mm wide with round edges. The register shall be suitable for concealed fixing and horizontal bars of the grills shall mechanically crimped from the back to hold them.

The colour of grills shall be as per the approval of the Engineer-in-Charge. The volume control device made of extruded aluminium construction in black anodized finish shall be provided in supply air duct collars only.

### **8.3 Front fixed bar rear adjustable louvered grills**

The grills shall be made of powder coated extruded aluminium construction with front fixed horizontal bar at 0 degree inclination with one way or two way deflection with rear vertical individually adjustable louvers in black shade mounted on Nylon bushes to hold deflection setting under all conditions of velocity and pressure.

The colour of grills shall be as per the approval of the Engineer -in-Charge. The volume control device of extruded aluminium construction in black anodised finish shall be provided in supply air duct collars.

### **8.4 Square/rectangular ceiling diffusers**

The square/rectangular ceiling diffusers shall be made of powder coated extruded aluminium construction with flush fixed pattern. The diffusers shall have Anti-Smudge ring and spring loaded removable control core in various pattern for air flow direction. The diffusers shall be mounted by concealed screw fixing arrangement. The volume control device of extruded aluminium

construction in black anodized finish shall be provided in supply air diffusers. The colour of diffuser shall be as per the approval of the Engineer-in-Charge.

#### 8.5 Jet Diffusers

The Jet Diffusers shall be made of powder coated aluminium construction. These diffusers are with reversible cores for long / short throw patterns. For long throw it shall be at Jet made while for small throw diffuser mode shall be utilized. The Jet diffusers shall be used for large spaces preferably industrial application.

#### 8.6 Spot Diffusers

The Spot Diffusers shall be made of powder coated aluminium construction. These diffusers shall be adjustable type for changing the direction of air stream. The spot diffusers shall be aerodynamic shape to ensure low noise level. These diffusers shall be suitable for large throws in atriums, large sized lobbies etc.

#### 8.7 Volume control device

The opposed blade volume control device shall be made of Powder Coated extruded aluminium construction in black anodized finish. Opposed blades shall be pivoted to extruded aluminium frame with Nylon bushes. Specially designed blade shall have an overlapping lip which shall ensure a tight closure.

#### 8.8 Fresh air intake louvers with bird screen

The fresh air intake louvers at least 50mm deep will be made of powder coated extruded aluminium construction. Bird/insect screen will be provided with the intake louvers. The blades shall be inclined at 45 degree on a 40mm blade pitch to minimize water ingress. The lowest blade of the assembly shall be extended out slightly to facilitate disposal of rain water without falling on door/wall on which it is mounted.

The intake louvers shall be provided with factory fitted aluminium construction volume control dampers in black anodized finish.

### 9.0 **PAINTING**

9.1 All grills shall have either anodized finish or powder coated or as specified by Architect.

9.2 All ducts immediately behind the grills etc. are to be given two coats of black paint in matt finish.

### 10.0 **TESTING**

10.1 The entire air distribution system shall be balanced to supply the air quantity as required in various areas and the final balance or air quantity through each outlet shall be submitted to the Engineer-in-Charge for approval.

### 11.0 **FABRIC DUCT**



The Duct shall be made of Fabric with finished seam construction with positive inlet anchoring system and a zippered inlet collar with the addition of final filter and adjustable flow device. The manufacturer should have options of various colours and should be washable. Suspension systems should be available from the manufacturer. Fabric

Construction should be 100% Polyester and 100% Flame Retardant. Manufacturer should be able to offer Permeable/ Non -air permeable fabric. Temperature Range should conform to the ambient temperatures of the location Size, quantity, and location of orifices to be specified and approved by manufacturer. Joints in Lengths should include **leak proof** zippers from reputed manufacturers. Product must be Classified for fire resistance norms. Product Data: Submit manufacturer's specifications on materials and manufactured products used for work. All performance data must be supplied with submittal. This should include inlet velocity, inlet static pressure, velocity pressure, frictional losses, average pressure, maximum pressure, vent size, vent performance and terminal velocities. Manufacturer must provide at least a 10 Year Product Warranty for products supplied for the fabric portion. The filament should be polyester with twill. The weight should be 6.2 oz/sq.yd. The porosity should be 2 CFM / sqft. At 0.5 w.g. It should be classified by underwriter's laboratories in accordance with NFPA 90A and ICC/AC167 and UL 2518. It should also be in accordance with BS 5867 part2 1980 and GB8624-2006.

## **INSULATIONS**

### **1.0 SCOPE**

This section cover the requirements of thermal insulation for chilled water piping, pumps, tanks, duct work, acoustic lining in duct work, AHU rooms etc. This does not cover exposed roof insulation.

### **2.0 MATERIAL TYPES**

The insulation material to be used for various applications shall be as required in accordance with the standards followed.

### **2.1 PIPING INSULATION**

All chilled water piping, condensate drain piping shall be insulated as indicated herein. Prior to application of insulation, all pipe work shall be cleaned on the surface with wire brush to remove dirt.

The insulation for chilled water piping, pump, expansion tank etc., shall be carried out from 25mm thick closed cell elastomeric nitrile rubber, class “O” secured with approved adhesive.

The chilled water piping shall be finished with UV shield using 2 layers of FRP fabric and Epoxy as per manufactures recommendation.

Thermal insulation shall be applied as follows or as specified in drawings or schedule of quantity:

<b>Description</b>	<b>Pipe sizes dia mm</b>	<b>Thickness of Insulation - mm</b>
Chilled water piping	15mm – 32mm	19 mm
	40mm – 400mm	32 mm
	Above 400mm	45 mm
Condensate drain piping	All sizes	6 mm

All valves, fittings, strainers etc. shall be insulated to the same thickness and in the same manner as for the respective piping, taking care to allow operation of valves without damaging the insulation.

### **2.2 METHOD OF INSULATION – CHILLED WATER / CONDENSATE PIPING**

Clean the surface of the pipe to be insulated free of dust, rust, grease and other materials.

Cut the insulation sheet to match the size of the pipe using a sharp knife. Ensure that the cut is straight.

Apply a thin coat of adhesive (POLYBOND V-9 or approved equivalent) on the insulation sheet as well as on the pipe surface using a brush and leave it 2-3 minutes for drying.

Once the adhesive is dry but tacky stick the insulation sheet on to the pipe surface and apply slight pressure to stick them well. Ensure that there are no air pockets in between and that all the joints match properly.

Apply Self Adhesive Black Cotton tape of approved Make on all the joints. On the corner joints 2" wide tape of approved Make is to be applied and on all the other joints 1" tape has to be applied. Before fixing the tapes it must be ensured that all the joints are sealed properly.

The insulation shall be protected / covered with fiberglass fabric. The fabric shall be applied with one coat of epoxy compound. The first coat shall be allowed to cure to nonstick condition subsequent to which the second coat of compound shall be applied to ensure a tough and smooth finish to the insulated surface. The required pigment to be added on to the compound to achieve the finished colour required.

## 2.3 METHOD OF INSULATION – PUMP & EQUIPMENT INSULATION

The specification of insulation as per piping shall be applicable for this section also.

## 3.0 DUCT INSULATION

### 3.1 MATERIAL SPECIFICATION

The insulation for duct insulation shall be carried out from 'O' Class closed cell elastomeric nitrile rubber having a 'K' value of 0.035 W/(M.K) at mean temperature of 10<sup>0</sup> C. and a density of not less than 40 - 60 kgs/cubm.

Duct : Thickness 19 mm

### 3.2 APPLICATION OF INSULATION (THERMAL) ON DUCT

Duct insulation shall be applied as follows:

- i) The surface of duct on which the external thermal insulation is to be provided shall be thoroughly cleaned with wire brush and rendered free from all dust and grease.
- ii) Two coats of cold compound adhesive (CPRX compound) shall be applied over the duct. (Any other adhesive recommended by the manufacturers may also be used with the approval of the Engineer – in – charge ).
- iii) The insulation shall then be wrapped to the duct. The joints shall then be sealed with self adhesive nitrile tape.

## 4.0 DUCT / AHU ROOM & PLANT ROOM LINING

### 4.1 MATERIAL SPECIFICATION

Material for accoustic lining shall be resin bounded fibre glass. The thermal conductivity shall not exceed 0.031 Kcal/hr. deg C m at 10 deg C mean temperature and density shall not be less than 32 Kg./CuM. Thickness of insulation shall be 25 mm for duct lining and 50 mm for AHU room lining.

Accoustical lining of duct shall be done for the initial run of 6.0 meter duct.

#### 4.2 METHOD OF APPLICATION ON DUCTS

1. The inside surface of duct on which the acoustic lining is to be provided shall be thoroughly cleaned with wire brush and rendered free from all dust and grease.
2. Then 25 x 25 sq.mm section of minimum 1.25 mm thick G.I. sheet shall be fixed on both ends of the duct piece.
3. The insulation slab shall then be fixed between these sections of ducts using CPRX adhesive compounds and stickpins.
4. The insulation shall then be covered with reinforced plastic/fiber glass tissue, sealing all joints so that no fiber is visible.
5. The insulation shall finally be covered with minimum 0.5 mm thick perforated aluminium sheet having perforations between 20-40% and joints overlapped and screwed to the frame by means of brass metal screws to produce an even surface.

#### 4.3 METHOD OF APPLICATION OF ACOUSTIC LINING IN AHU ROOMS & PLANT ROOM

- i) The wall / roof surface should be thoroughly cleaned with wire brush.
- ii) A 610 x 610 mm frame work of 25mm x 50 mm x 50 mm x 50 mm x 25 mm shape channel (shape as shown in CPWD specifications) made of 0.6mm thick GSS shall be fixed to walls leaving 610 mm from floor by means of raw plugs in walls and dash fasteners in ceiling. Similar frame work shall also be fixed on ceiling by means of dash fasteners.
- iii) Resin bonded glass wool as specified cut to size will be friction fitted in the frame work and covered with tissue paper.
- iv) Aluminium perforated sheet having perforation between 20-40% of thickness not less than 0.8mm shall be fixed over the entire surface neatly without causing sag / depression in between and held with screws. Sheet joints should overlap minimum 10mm.
- v) Aluminium beading of 25mm wide and thickness not less than 1.00 mm shall be fixed on all horizontal / vertical joints by means of screws.

#### 5.0 SOUND ATTENUATORS

Attenuators shall be installed in ducts in accordance with requirements of drawings and as included in Schedule of Quantities.

Noise levels within conditioned spaces shall be not greater than those set out in schedule below:

##### a. Noise Level Design Criteria

S.No.	Area	Acceptable Noise Levels (NC)
i.	Meeting Rooms	25-30
ii.	Restaurant / Staff Dining	40-45

- |      |                         |       |
|------|-------------------------|-------|
| iii. | Public Circulation.     | 40-45 |
| iv.  | Back-of-the-house areas | 40-45 |
| v.   | Offices                 | 30-35 |
| vi.  | Office Corridor         | 35-40 |
- b. Attenuators shall be of steel construction with casings out of minimum 22 G galvanized steel. Acoustic fill shall be inert, non-hygroscopic, vermin proof, fibre glass of required density adequately protected against corrosion and covered with 26 gage perforated aluminium sheet. Attenuators shall be supplied complete with flanges.
- c. Acoustic performance of the attenuators (net insertion loss) shall meet or exceed the values listed below:

## OCTAVE BAND CENTRE FREQUENCY HZ

	63	125	250	500	1K	2K	4K	8K
Insertion loss dB 900 mm long attenuators	2	7	12	19	23	23	18	11
Insertion loss dB 1500 mm long attenuators	6	10	18	30	42	34	23	14

The pressure drop values of the silencers shall be indicated for each duty.

Manufacturers shall submit a test certificate for acoustic and aerodynamic performance of the attenuators. Attenuators shall be tested in accordance with ACMA test methods/BS 4718 and insertion loss and self generated noise for each octave band and pressure drop shall be stated in the schedule.

### 5.1 MEASUREMENT OF INSULATION

Unless otherwise specified measurement for duct and pipe insulation for the project shall be on the basis of centre line measurements described herewith

- a. Pipe Insulation shall be measured in units of length along the centre line of the installed pipe, strictly on the same basis as the piping measurements described earlier. The linear measurements shall be taken before the application of the insulation. It may be noted that for piping measurement, all valves, orifice plates and strainers are not separately measurable by their number and size. It is to be clearly understood that for the insulation measurements, all these accessories including cladding, valves, orifice plates and strainers shall be considered strictly by linear measurements along the centre line of pipes and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.

- b. Duct Insulation and Acoustic Lining shall be measured on the basis of surface area along the centre line of insulation thickness. Thus the surface area of externally thermally insulated or acoustically lined be based on the perimeter comprising centre line (of thickness of insulation) width and depth of the cross section of insulated or lined duct, multiplied by the centre-line length including tapered pieces, bends, tees, branches, etc. as measured for bare ducting.

## **ELECTRICALS**

### **1.0 SCOPE**

- 1.1 The scope of this section comprises supply, erection, testing and commissioning electrical equipment's, and wiring installation conforming to these specifications and in accordance with the requirements and Schedule of equipment.

### **2.0 ELECTRIC SUPPLY**

- 2.1 Electric supply system shall be AC 415V  $\pm$  10% variation, 3 phase, 4 wire, 50 Hz with solidly earthed neutral.
- 2.2 A.C 220 V  $\pm$  10%, single phase, 50 Hz with neutral electric supply wherever specified shall be provided.

### **3.0 MOTORS**

#### **GENERAL**

- 3.1 The rating of motors shall be in accordance with the Technical Schedule of Equipment's and Schedule of Quantities. Where the equipment supply needs a high rating motor, the Contractor shall clearly point out and make his offer accordingly with justification.
- 3.2 The motors shall conform to I S: 325 with latest amendment. The motor shall be rated for continuous duty at its maximum output.
- 3.3 Frame shall be of close grained cast and the starter and the rotor core shall be built of low-loss high permeability steel sheet laminations. The winding shall preferably be pre-formed coils and baked in position. The squirrel cage rotor shall preferably be of die -cast aluminium. Ventilation shall be by means of fans - integrally built and designed - to give maximum ventilation with quiet operation.
- 3.4 The frame size of the motor shall conform to IS:1231 with vibration limits as per IS:4729 with latest amendment. The insulation of motor shall be class B as per I S:325 with latest amendment unless specified otherwise.

### **4.0 SLIP RING MOTORS (WHEREVER SPECIFIED)**

- 4.1 The motors shall be of slip ring type, having screen protected enclosure and conform to IS 3225/1978 with latest amendment.
- 4.2 The body shall be of rugged cast iron construction. The rotor shall be of dia cast aluminium. The motor and cooling fan (if any) shall both be jointly balanced statically and dynamically at the factory of the manufacturer.

- 4.3 The windings of the starter and the rotor shall both have class 'B' insulation, the starter being connected in star and the rotor winding in delta. The winding shall be cooled by a fan installed on the non drive end of the motor.
- 4.4 The slip rings shall be made of superior quality material and the brush holders shall be so arranged as to permit easy replacement of brushes, when required.
- 4.5 The shaft and bearings shall be of generous size and easy to lubricate.

## **5.0 SQUIRREL CAGE MOTORS**

- 5.1 Up to 5.5 KW these shall be started direct on line and beyond 5.5 KW on Star Delta or (auto transformer starting where so specified). When started on Star Delta, the starting current of the motor shall not exceed 1.5 times the rated current when started direct on line, the starting current of the motor shall not exceed 4.5 times the rated current.

All motors installed indoors shall be TEFC with degree of protection IP 44 while motors installed out door shall be weatherproof with degree of protection IPW 55 as per IS 4691.

It shall be the responsibility of the Contractor to supply the motors and starters to satisfy the local regulations pertaining to the limitation on the starting current and indemnify the Owner from all liabilities arising out of any objections raised by the local authorities in this regard.

## **6.0 INSTALLATION**

- 6.1 The motor and its driven equipment shall be installed on a common foundation. Flexible coupling shall be provided in the case of direct drive and V belts in the case of belt drive. The alignment of the motor and the driven equipment shall be carried out conforming to IS:900 with latest amendment. The motor insulation resistance, as measured by a 500 V meggar shall be more than 1 Mega ohm. In case it is less than this value, the motor shall be dried as per IS 900.
- 6.2 The three phase motor shall be earthed at two separate places as per with latest amendment. The area of cross section of each earth conductor, if GI strip shall be equal to that of phase conductor if it were of copper, minimum area of cross section of each conductor earth shall be as per clause 20.1 under subheading "Earthing". The cable connection for the motor shall have enough flexibility for adjustment during alignment etc. The connection shall be such that it shall prevent any vibration on the motor to be passed on to the cable conductor by use of proper size cable gland etc.
- 6.3 All moving parts shall be provided with proper safety guards.

## **7.0 STARTERS (GENERAL)**

- 7.1 The material used in the starter shall generally conform to IS 13947 Part II and IS 0544 Part I for D.B.L., Part 2 for S.D.J and Part three Rotor starter with latest amendment.
- 7.2 All starters shall be totally enclosed, metal clad, dust proof and vermin proof, solenoid operated, air break type and shall be suitable for the specified system and the ambient conditions.



- 7.3 Starters shall be provided with built-in manually reset thermal overload relays on all the three phases with adjustable elements for overload protection, manually reset single phase preventors, sufficient extra contacts for interlocks, indicating lamps and Ammeters.
- 7.4 Starters for Squirrel cage induction motors shall be provided with push button and shall be suitable for remote operation in the case of A.H.U., pumps or other equipments as specified. The 'no -volt coil' of the starters shall be 220 volts whenever any controls or safety devices are connected in the starter circuit otherwise standard 415 volts coil may be used.
- 7.5 The starters to be provided for the different types and rating of the motors shall be as follows:-

For slip ring motors - stator Rotor starter.

For Squirrel Cage Motors upto 5.5 KW - Direct on Line starter.

For Squirrel Cage Motors above 5.5 KW up to 37 KW- Automatic Star Delta starter.

For Squirrel Cage Motors above 37 KW - Soft Starter / closed transition star Delta starter / auto transformer starter / part winding starter.

#### 7.6 STATOR ROTOR STARTER

These starters shall have an air operated stator switch or oil immersed rotor resistance switch.

The stator switch shall be complete with trip free mechanism. The rotor starter handle shall not reset on tripping unless returned to off position. The resistance winding of the motor switch shall be of non corrosive material with low thermal coefficient and matching the resistance of the motor winding.

#### 7.7 AUTOMATIC STAR DELTA STARTER

These Starters shall have heavy duty air break contactors of suitable ratings along with an adjustable timer of automatically switched with motor connections from star to Delta connections.

Each starter shall be complete with adjustable overload relays on all three phases and under voltage release. The starters should be "Hand Reset" type.

The "No Volt Coil" shall be 230 volts rating, wherever any controls of safety device are connected in the starter circuit otherwise standard 415 volts coil may be used.

#### 7.8 DIRECT-ON-LINE STARTERS

These starters shall have a heavy duty air break contactors of suitable ratings.

Each starter shall be complete with adjustable overload relays on all three phases, single phase preventing device and under voltage release. The starters should be Hand Reset Type.

## 7.9 SOFT STARTER

The soft starter shall be with the following modes of operation:

### Soft Start

In this method motor shall be raised to an initial torque value which should be adjustable between 5% 90% of locked rotor torque. The motor voltage then gradually increase during the acceleration ramp time. Which is also to be adjustable from 2 to 30 seconds.

### Soft Start with Selectable Kick Start

A kick start or boost shall be provided for current pulse of 500% of full load current and adjustable between 0.4 to 2 seconds.

### Current Limit Starting

It is necessary to limit the maximum starting current adjustable between 50 to 500% of full load ampere.

### Across the Line Starting

This mode shall be provided for applications requiring across the line starting.

## 8.0 **SWITCH PANEL BOARD**

- 8.1 The panel board shall be of cubicle type having in it all accessories and completely factory pre wired. It shall be suitable for voltage systems upto 500 volts, 3 ph. 50 Hz, 4 wire supply capable of functioning satisfactorily in temperature of 45 Deg.C. and rupturing capacity, not below 31 MVA.
- 8.2 The Contractor shall get shop drawings approved from the Consultant before undertaking manufacture of the switch board as per approved manufacturers from list of approved makes of equipment.
- 8.3 The panels of the switch board shall be single front non-open-able from the back (except for ACB panel or if otherwise specified) floor mounted or wall mounted as specified.
- 8.4 The panels shall be totally enclosed, completely dust and vermin proof and synthetic rubber gaskets shall be provided beneath all covers to make the joints vermin and dust proof. The panel shall be powder coated with desired shade (thickness between 40-50 microns) after sheet metal treatment through seven tank process.
- 8.5 The panels shall be fully compartmentalized and shall preferably be arranged in Multi tier formation. The top and bottom of each compartment shall have barrier of minimum 1.6 mm CRC sheets. General fabrication shall be of CRC sheets of minimum 2.00mm and adequately reinforced to provide necessary strength to the structure and a rigid support for all components. A base frame of minimum 3mm thickness 50mm height folded sheet steel shall be provided at the bottom.
- 8.6 The operating height of the panel should be limited between 300mm and 2000mm. Joints of any kind in sheet metal shall be seam welded all welding slag grounded off and welding pits wiped smooth with plumber metal.

- 8.7 All panels and covers shall be properly fitted and square with the frame. Holes in the panel shall be correctly positioned and tapped into an adequate thickness of metal or provided with welded nuts, for convenient fixing of screws. Self threading of screws shall not be used in the construction of the panels.
- 8.8 Steel sheet hinges lockable doors shall be duly interlocked with breaker/switch fuse unit to prevent opening of the panel when the switch in 'ON' position. Safety interlocks shall be provided to prevent the breaker or switch fuse unit or contractor from being drawn out when the panel is in 'ON' position. The door shall not form an integral part of the draw out operation of the panel.
- 8.9 The panel shall have cable alley of adequate width but not less than 300mm for floor mounted and 200mm for wall mounted panels. Separate cable compartment shall be provided for incoming and outgoing cables. Bus bar alley shall be adequate size but not less than the width of the cable alley.
- 8.10 Each panel in-comer section shall be provided with voltmeter 0-500 volts with 3-way and off selector switch, Ammeter of appropriate range with selector switch, and phase indicating lamps. Ammeter of suitable range shall be provided to indicate current drawn by each item of equipment. For loads above 25 HP the Ammeters shall be provided with suitable cast resin current transformers. All Ammeters meant for heating loads like boilers shall be provided with selector switches.
- 8.11 Horizontal wire way with screwed cover shall be provided at the top to take interconnecting control wiring between different vertical sections.
- 8.12 The panels shall be of adequate size with a provision of approximately 20% spare space for MCCBs/Motor Circuit Breakers, to be decided by the CONSULTANTS/OWNERS to accommodate possible future additional switch gear. Undrilled removable gland plate shall be provided in the panels in conformity with the location of incoming and outgoing conduits/cables. All the MCCBs shall be provided with vertical operation and with front drive kit.
- 8.13 Care shall be taken to achieve the neat and symmetrical arrangement to the satisfaction of the CONSULTANTS/OWNERS. Facility shall be provided for termination of all normal types of cables from both above and below the panel.
- 8.14 Where the cable enter from below cable boxes/compression glands shall be fitted at the rear and arranged in tiers to facilitate making connections to the upper and lower units. Clamps shall be provided to support the weight of the cables.
- 8.15 All incoming and outgoing feeders shall be brought out to a terminal block of adequate size at suitable location inside the panel.
- 8.16 All wiring inside the panel shall be colour coded and labeled with approved plastic beads for identification.
- 8.17 Laminated circuit diagrams showing the arrangement of circuits shall be pasted on the inside of panel door and all labeling shall be provided on the front of the panel board.

- 8.18 Separate and adequate compartments shall be provided for accommodating instruments, indicating lamps, control contractors 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, switch fuse unit, bus bar and connections.
- 8.19 Schedule of requirement of 'ON' - 'OFF' push buttons, indicating lamps and alarm systems required to be provided on the control/indicating panels is given in table enclosed. The central control cum indicating panel shall preferably be of desk type.

## **9.0 CIRCUIT BREAKER**

- 9.1 The rating of the circuit breaker shall be as per the schedule of equipment and schedule of quantities.
- 9.2 The circuit breaker shall be air-break type, manually operated spring charged and shall be mounted in a cubical in the switch-gear having fully drawn out feature and with front panel operating handle. It shall conform to IS 2516 with latest amendment.
- 9.3 The clearance between phases and phase to earth as also the insulation levels shall conform to IS code of practice with latest amendment respectively. The circuit breaker mechanism shall be mechanically and electrically trip free.
- 9.4 The circuit breaker shall be equipped with mechanical trip device, mechanical ON/OFF indication and 'spring charged' indications. A.C. shunt trip coil shall also be provided to trip the circuit breaker in different conditions.
- 9.5 The main arcing contact surface shall be of silver. The main contacts shall be enclosed in arc chutes made of fire proof material shrouding all the live metal parts during arcing such that any fault between phases and phase to earth is prevented due to involving gas/ionization in the area.
- 9.6 The circuit breaker shall be equipped with 2 Nos. overload relays one in each phase and one no. Earth fault relay. These O/L relays shall be operated through proper current transformer with secondary at 5 amps. The breaker shall have adjustable time delay tripping, earth fault and under voltage protections.
- 9.7 The breaker shall be equipped with voltmeter & ammeters through cast resin CTS. The meters shall be square flush mounted 96x96mm dimensioned with class of accuracy 'A' conforming to IS: 1248 with latest amendment.
- 9.8 The cubical shall have indicating lamps for showing the position of the breaker. It shall be complete with spring charging handle.
- 9.9 The cubical shall be fabricated out of heavy gauge CRC steel sheet and shall be dust and vermin proof duly painted to make it corrosion proof.
- 9.10 The breaker shall be complete with the connecting terminals at incoming and outgoing sides through properly segregated cable etc.

- 9.11 Space heater with thermostat, toggle switch and protection fuse shall be provided in each cable alley.
- 9.12 Automatically operated safety shutters shall be provided to screen the live cluster when the breaker is withdrawn from cubicle.

## **10.0 BUSBARS**

- 10.1 The bus bars and connections shall consist of extruded high conductivity electrolytic aluminium strip 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 insulation tapes and colour coded.
- 10.2 All bus bars shall be supported on glass reinforced polyester (SMC) sheet moulding compound insulators at regular intervals to withstand the forces arising from short circuit in the system. All bus bars shall be provided in separate chamber with properly ventilation.
- 10.3 All bus bars connection in main control panels shall be done by clamping, no holes shall be drilled in bus bars. If holes have to be drilled for making connections, extra cross section of bus bars shall be provided. All bus bar connections in smaller control panels shall be done by drilling holes and connecting by cadmium plated bolts and nuts. The bus bars shall be air insulated and made of high conductivity high strength aluminium alloy of current density not less than 1 Amps/Sq. mm complying with the requirement of grade E91E of IS:5082 with latest amendment.
- 10.4 Additional cross section of bus bars shall be provided in small control panels to cover up the holes drilled in the bus bars.

## **11.0 MOTOR PROTECTION CIRCUIT BREAKERS (MPCB) (35 KA)**

Load up to 7.5 h.p. shall be provided with motor circuit breaker with necessary push button, contactor and indicating light etc.

### **11.1 MOULDED CASE CIRCUIT BREAKERS (MCCB)(35 KA)**

Load above 7.5 h.p. shall be provided with moulded circuit breaker with necessary ON/OFF push button, starter and indicating light etc.

## **12.0 PROTECTING DEVICES**

- 12.1 All feeders shall be protected by appropriate protective devices like fuses, combined bimetallic thermal overload and single phase preventor relays.
- 12.2 Single phase preventor shall operate when the supply voltage drops down to 90% its rated value or failure of one of the phases. The single phase preventor shall operate on the principle of unbalanced voltage.
- 12.3 The SPP shall have facility for hand resetting and/or auto resetting.

**13.0 INDICATING LAMPS AND METRES**

- 13.1 Indicating lamps shall be of L.E.D. type of different colours as required.
- 13.2 The meters shall be flush mounted and squared in shape. They shall have industrial grade of accuracy class 'A' conforming to IS 1240 with latest amendment. Ammeters shall be used with suitable CTS for rating of 15 HP motor and above. Selector switch shall be provided with meters in the incomer, meters meant for heaters or wherever specified.

**14.0 TOGGLE SWITCHES**

- 14.1 These shall conform to IS 3854 with latest amendment and shall be of 5 amps. rating.

**15.0 EARTHING**

- 15.1 Earthing shall be carried out as per IS:3043 with latest amendment. Generally the main panel shall be connected to the main earthing grid by means of two nos. GI strips of suitable size. There shall be a continuous separate earth bus throughout the length of the switch gear board made of Aluminium or GI strip of adequate size to take up the fault currents during phase to phase or phase to earth short circuit as per requirement.
- 15.2 This earth bus shall be extendable on either side.
- 15.3 All the non current carrying metallic parts of the switch gear shall be connected to this earth bus through adequately sized conductors. The connections to this earth bus shall be through proper sized lugs and bolts.

**16.0 SUBSIDIARY PANELS**

- 16.1 In the air handling unit rooms, all starters on subsidiary panels shall be remote controlled from the main air-conditioning plant room.

**Notes:**

Rubber mats shall be provided and laid in front of all switch panels for which nothing shall be payable extra.

Danger plate shall be provided in all panels for which nothing shall be payable extra.

**17.0 CAPACITORS**

1. Power factor correction capacitors shall conform in all respects to IS 2834-1964, IS : 13340, 13341 & IEC 831 – 1&2. The shunt capacitors shall be suitable for 3 phase 440V at 50Hz. frequency and shall be available in units as per B.O.Q. to form a bank of capacitors of desired capacity. All these units shall be connected in parallel by means of high conductivity electrolytic copper busbars of adequate current carrying capacity having S.C rating of 50 KA for 1 sec. Each capacitor bank terminal shall be suitable for connecting aluminium conductor cable/solid bus

connections. Two separate earthing terminals shall be provided for each bank for earth connection.

2. The capacitor bank shall be subject to routine & type tests as specified in relevant Indian Standard, the bidder shall submit testing procedure for type & routine tests at factory and at site to the consultant for approval. The capacitor shall be suitable for indoor use upto 45 Deg.C over and above ambient temperature of 50 degree C. The permissible overloads shall be as given below:

Voltage overload shall be 10% for continuous operation and 20% for every 6 hourly in a 24 hours cycle.

3. Current overload 15% for continuous operation and 50% for 6 hours in a 24 hours cycle.

The capacitor banks shall be floor mounting type indoor housing using minimum floor space.

4. Capacitors shall be of aluminium foil and craft paper (heavy duty self healing type). Hermetically sealed in sturdy corrosion-proof sheet steel 2mm thick containers and impregnated with non-flammable synthetic liquid and of low power loss version. Every element of each capacitor unit shall be provided with its own built in in-rush current inductor with discharge resistor and silvered fuse against short circuit % / over load protection. The capacitor shall have suitable discharge device to reduce the residual voltage from crest value of the rated voltage to 50 V or less within one minute after capacitor is disconnected from the source of supply. The loss factor of capacitor shall not exceed 0.005 for capacitors with synthetic impregnates. The capacitors shall withstand voltage of 2500V AC supply for 1 minute.

The insulation resistance between capacitor terminals and containers when test voltage of 500V A.C. is applied shall not be less than 50 megohms.

5. Capacitor shall be rated at 650 volts a.c. at 50 Hz.
6. Capacitor bank and switching equipments shall be housed in separate cubicle compartment having degree of protection IP-41 and constructed with sheet steel of minimum 2mm thickness.
7. Capacitors shall be unit type having non-PCB, non-flammable non-toxic dielectric.
8. Necessary discharge register shall be provided externally to reduce the terminal voltage to or less than 50V in 60 seconds of disconnection from supply.
9. Each capacitor shall be provided with built-in/externally provided inductor coil to limit inrush current within safe limit.
10. Testing shall be done as per applicable standards for shunt capacitors.
11. Insulation test etc.
12. For harmonic suppression inductive reactor with tapping shall be provided along with capacitor. These shall be switch on or off in case of 3<sup>rd</sup> Harmonic distortion is increasing more than 3%.

**CAPACITOR CONTROL PANEL**

The capacitor control panel shall generally comprises of the following::

13. Automatic power factor correction relay microprocessor based for 4 quadrant operation with built-in step controller with forward & backward operation and shall display on screen as;

Target Cos phi	:	Cos phi, Kvar missing.
Transformer ratio	:	Electric supply parameter.
Switching settings	:	Temperature.

14. Relay should have inbuilt facility to check phase sequence when every time switched on and adjust the phase sequence automatically to get the proper PF.
15. The relay shall decide the no. of capacitor banks to switched on or off according to the set power factor requirements.
16. Time delay and no-volt relays.
17. Protection MCCB with static O/C and S/C.
18. Capacitor duty contactor for individual capacitors with MCCB control.
19. Changeover switch for either automatic operation or manual operation with push button control.
20. C.T.s with ammeter and selector switch.
21. Voltmeter with selector switch. Indicating lights RYB.

In the manual mode also timer to be incorporated to allow discharge time of capacitors.

All the capacitors and contactors shall be interconnected with PVC insulated copper conductor wires of adequate size in a neat and acceptable manner.

Three phases and neutral bus bar (copper) shall be provided in panel as required.

The above control gear, P.F. meter, Digital Microprocessor based P.F. correction relay, push button station etc. shall be housed in a sheet steel metal enclosure cubical type, free standing front operated with lockable doors. The panel shall be fabricated from MS sheet steel 2mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet steel shall be seam-welded. The panel shall be totally enclosed design completely dust tight and vermin proof. Gaskets between all adjacent units and beneath all covers shall be used to render the joints effectively.

Ventilation fan with a thermostat any toggle switch shall be provided inside panel to maintain internal temperature mentioned else where.

All sheet steel material used in the construction of capacitor control panel should have undergone a rigorous rust proofing process comprising Alkaline Degreasing, descaling in dilute sulphuric acid and recognised phosphating process. The steel work should then receive two coats of primer before applying final coat of epoxy paint of approved shade.



**QUALITY ASSURANCE (Q.A.)**

Quality Assurance shall follow the requirement of Client/ Consultant. Q.A. documents as applicable.

Q.A. involvement will commence at enquiry and follow through to completion and acceptable thus ensuring total conformity to purchaser's requirement. DEVIATIONS

Deviations from the specification must be stated in writing at the quotation stage.

In the absence of such a statement it will be assumed that the requirements of the specifications are met without exception.

**18.0 WIRING FOR MOTORS ETC.**

- 18.1 The wiring for above equipment's shall be carried out in conduits or using PVC insulated PVC sheathed aluminium conductor FRLS armoured cables.
- 18.2 The PVC armoured power cable for use on 415 volt system shall be 3 or 3.5 or 4 core with aluminium conductors and be of 1100 volts grade, as per IS 1554 Part-I, 1964.
- 18.3 The cables shall be laid as per IS-1255/1967, with latest amendment Indian Standard Code of Practice.
- 18.4 The cables shall be laid, as per drawings or along a short and convenient route between switch board and the equipment, either in trenches, on wall or on hangers supported from the slab. Cable routing shall be checked on the site to avoid interference with structure, equipment etc. Where more than one cables are running close to each other proper spacing should be provided between them.
- 18.5 The radius bends of the cable should not be less than 12 times the radius of cable to prevent undue stress and damage at the bends. The cables should be supported with cleats fixed on MS supports, when running in trenches, wall or ceiling suspended hangers, when laid underground the cables should be covered with fine soft earth and protected with cement concrete covering. Suitable GI pipe shall be used wherever cable comes out of the connected surface and clamped properly.
- 18.6 Wooden bushes shall be provided at the ends of pipes through which cables are taken.
- 18.7 The wiring in conduits shall be 660/1100 volts grade FRLS copper conductor cable.
- 18.8 The conduits used shall be of high quality, all joints shall be made with sockets. The bends and elbows shall have inspection covers fixed with grease free screws. The joints shall be water tight approved metal saddles shall be used to secure the exposed conduits at a space of 1 Meter or less. The connection of the conduit to switches etc. shall be secured by a check nut and PVC bushes provided at the ends of conduits.

- 18.9 Flush inspection covers shall be provided in case of concealed, recessed conduits. The staples for the conduits shall not be spaced more than 0.60 meters apart. Before filling up the chase with concrete the conduits should be given a coat of rust proof paint.

The wire shall be drawn only after all the conduits have been properly fixed in position.

## **19.0 CONTROL WIRING**

- 19.1 Control cables shall be 1100 volts grades FRLS as per IS:1554 made from copper conductor of 1.5 Sq. mm PVC insulated wire/strip armoured with an overall PVC sheathing.
- 19.2 The cables and conduits wiring shall be carried out as per details given above.

## **20.0 EARTHING**

- 20.1 All equipment connected with electric supply shall also be provided with double earthing continuity conductors. The size of GI earthing conductors shall be:

Size of Phase Wire Sq. mm (Aluminium)	Size of GI Strip/ Wire (Swg)
400	50 mm x 6 mm
240	32 mm x 6 mm
150	32 mm x 6 mm
120	25 mm x 3 mm
95	25 mm x 6 mm
70	25 mm x 3 mm
50	25 mm x 3 mm
35	6 SWG
25	6 SWG
10	8 SWG
4	8 SWG

## **21.0 EARTH PIT**

- 21.1 There shall be an independent earthing station atleast 3M from the plant room. The earthing shall consist of an earth tape connected to an independent plate made of GI or copper as per item of work. All electrical apparatus, cable boxes and sheath/armour clamps shall be connected to the main bar by means of branch earth connections of appropriate size.

All joints in the main bar and between main bar and branch bars shall have the lapping surface properly tinned to prevent oxidation. The joints shall be revetted and sweated.

- 21.2 G.I. earth plates shall be of 600x600x6 mm and copper of 600x600x3mm and shall be buried at minimum depth of 3.5M below ground. The pit shall be provided with coke breeze, salt and loose soil. A G.I. pipe of 20 MM dia shall be placed vertically over the plate to reach ground level for watering.
- 21.3 A brick masonry manhole 30x30x30 CMS size with MS heavy duty shall be provided to surround the pipe for inspection. A bolted removable link connections main bar outside the pit portion

leading to the plates shall be accommodated, in this manhole for testing. The earth resistance shall not exceed 1 ohms at each point.

## **22.0 INSTALLATION**

- 22.1 The entire installation shall be carried out by duly licensed electricians as per Indian Electricity Rules with latest amendment and local regulations, in a perfect workman like manner. Necessary precautions will be taken to strictly observe safety rules.
- 22.2 Wherever conduits are passing, these shall be electrically continuous and joints shall be made of sockets. All threads shall be water tight. Conduits shall be secured to the switches, junction boxes etc. by means of suitable check nuts. At the end of conduits, rubber or ebonite bush shall be provided. Conduit shall be electrically bended at the end to the switches, junction boxes etc. with suitable clamps and wires.
- 22.3 The equipment inside AHU rooms shall be connected to the control panel by means of insulated aluminium conductor wires of adequate size in exposed conduits rigidly clamped at both end. Isolators shall be provided near each motor/equipment, wherever the motor/equipment is separated from the supply panel by a partition or ceiling construction.
- 22.4. Generally straight through joints shall be avoided in power as well as control cables in laying.
- 22.5 Wherever cables are laid underground in uncommented dug trenches, cables shall be laid at minimum 750mm depth from ground level. A gap of 150mm between cables shall be left. The cables shall be covered loosely by fine sand/earth and protected by baked bricks in the trench.
- Wherever underground masonry trenches are provided for cables, the cables shall be laid on both side walls or on cable strays in multi-tier configuration.
- 22.7 Wherever the cables cross walls or roads, the cable shall be passed through GI pipe sleeve of heavy gauge.
- 22.8 For laying cables on walls or in over head cable trays, the distance between the supports shall not be more than 400mm in horizontal runs and 1.5 Mt in vertical runs.
- 22.9 Care shall be taken not to twist the cable during unrolling from the drum when laying. The bending radius of the cable shall not be less than 12 times its diameter.
- 22.10 Some extra length of cable shall be left near each end termination for future use.
- 22.11 The final connections to the equipment shall be through flexible connections in case of conduit wiring and also where the equipment is likely to be moved back and forth, such as slide rails.
- 22.12 An isolator switch shall be provided at any motor which is separated from the main panel by a wall or partition or other barrier or is more than 15 metres away from the main panel.
- 22.13 Two separate and distinct earthing conductors shall be connected from the equipment up to the main switch board panel.

22.14 The branch lines from the main panel to each equipment shall be separated and should not criss cross other lines.

22.15 The entire installation shall be tested as per electricity 'rules' and ISS 732-1973 with latest amendments 1,2 & 3 prior to the commissioning of the plant and a suitable test report furnished by a competent and authorised person. The Contractor shall arrange to get the entire electrical installation approved by a competent electrical inspector and shall obtain the test reports at his own expense.

22.16 All exposed switch boards, conduits, hangers, cable trays etc. shall be given 2 coats of suitable paint of approved colour, when all work has been completed.

### **23.0 TESTING**

23.1 Before commissioning of the equipment; the entire electrical installation shall be tested in accordance with code of Practice IS 732 (Revised) and test report furnished by a qualified and authorised person.

23.2 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 CONSULTANTS/OWNERS.

23.3 The cables shall be meggered for continuity and values of insulation obtained shall be above one megohm between phase to Armour or between phase to phase, when tested with 500 volts meggar.

### **24.0 CERTIFICATE OF INSPECTION**

24.1 The Contractor shall be responsible for getting the installation inspected and approved by the Electrical Inspector and other, level electric supply company as required.

24.2 The Contractor shall obtain and deliver to the architect the certificate of final inspection and approval of the local electrical authorities concerned. The inspection fees etc. shall be borne by the Contractor.

24.3 In case of any defects are pointed out by the Electrical Inspector, the Contractor shall remove these defects at his own cost and arrange for re-inspection or inspection by the Electrical Inspector, till such time the installation is finally approved and the required certificate is issued. The Contractor shall bear all expenses and deposit the necessary fees for subsequent inspections by the Electrical Inspector.

### **25.0 DRAWING**

Shop drawing for Control Panel and wiring of equipment showing the route of conduit/cables shall be got approved by the Consultant before starting the fabrication of panel and starting the work. On completion six sets of completion "As Installed" drawings incorporating all details like conduit routes, number of wires in conduit, location of panels, switches,

junction/pull wires in conduit, location of panels, switches, junction boxes and cable route etc. shall be furnished by the Contractor.

## **26.0 PAINTING**

- 26.1 All sheet steelwork shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphatising, passivating and then sprayed with a high corrosion resistant primer. It shall then be baked in an oven. The finishing treatment shall be by application of synthetic enamel paint of approved shade.

## **27.0 FIRE PROTECTION**

All cables and wires shall be quoted with approved quality fire resistant materials.

## **AXIAL FLOW FANS**

### **1.0 GENERAL**

#### **1.0 AXIAL FANS MUST BE AMCA CERTIFIED FOR AIR & SOUND PERFORMANCE.**

Fan shall be complete with motor, motor mount, belt driven (or direct driven) and vibration isolation type, suspension arrangement as per approved for construction shop drawings.

### **2.0 Casing:**

The casing shall be constructed of continuously welded galvanized steel (or steel duly hot dip galvanized or powder coated) and include integral punched inlet and outlet flanges to prevent air leakage. The motor shall be supported in the center of the casing by an inner tube (in case of flange mounted motors), or through motor mounting brackets (for foot mounted motors) made out of heavy duty steel plate of minimum 20 mm thickness.

Support brackets for ceiling suspension shall either be welded or bolted to the casing for connection to hanger bolts. All fans shall have straightening vanes for better efficiency. The straightening vanes shall be aerodynamically designed for maximum efficiency.

### **3.0 Rotor:**

Hub and blades shall be fabricated aluminum OR cast aluminum. Blades shall be airfoil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. The entire propeller assembly should be statically & dynamically balanced.

### **4.0 Motor:**

Motor shall be energy efficient (IE3 for normally operated fans & IE2 for pressurisation / smoke extraction fans) squirrel-cage, totally-enclosed, fan cooled standard round frame, constant speed, continuous duty, single winding, suitable for 415+10% volts, 50 cycles, 3 phase AC power supply, provided with class 'F' insulation. Motor shall be specially designed for quiet operation. Fans should be selected for maximum efficiency, lowest sound power and minimum horse power. Motor conduit box shall be mounted on exterior of fan casing and lead wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible conduit. For HT motors, the flexible conduit should be able to withstand the high air stream temperature.

### **5.0 Fan Performance:**

Fan performance shall be based on tests conducted in accordance to AMCA 210 for air performance and AMCA 300 for Inlet sound power levels. These fans shall be licensed to bear the AMCA seal for air and sound performance.

All the High temperature Fans should either be EN-12103-3 or UL certified for High temperature (UL Power & smoke Ventilation listed) for a minimum of 250 Deg C for a minimum of 2 Hrs. All fans shall be vibration run tested before dispatch and vibration report to be submitted to the customer.

**6.0     Vibration Isolation:**

The assembly of fan and motor shall be suspended from the slab by vibration isolation suspension of rubber-in-shear type.

**7.0     Accessories:** The following accessories shall be provided with all fans:

Outlet cone for static pressure regain.

Inlet Bell for non- ducted fans.

**8.0     Silencers:-**

Fan silencers may be provided where specifically called for in schedule of Quantities. Fans shall be factory assembled and shipped with all accessories factory-mounted.

## **JET FANS**

### **1.0 SCOPE**

The scope of this section comprises of supply, erection, testing and commissioning of Jet Fans conforming to these specifications and in accordance with the requirements equipment schedule, schedule of quantities and drawings.

### **2.0 GENERAL**

Jet Fans shall be furnished as factory assembled having characteristics as of high performance ventilation with small air volume. Each unit shall consist of fan having inlet bell mouth with protective screen, two silencers, terminal box and mounting brackets.

### **3.0 FAN**

- 3.1 Fan shall be axial flow type balanced dynamically and statically.
- 3.2 The fans shall have Die cast Aluminium impeller for standard temperature applications for minimum 250 Deg. C.
- 3.3 The complete fan & motor assembly shall be imported from manufacturer and certified as tested for minimum 250 Deg. C for 2 hours operation.
- 3.4 The fan shall have discharge nozzles made of Aluminium round shaped aerodynamically and finished with polishing coat`.

### **4.0 CASING**

- 4.1 The casing of Jet Fans shall be made Aluminium die casing extruded or spun from galvanized sheet steel with flanges at both ends.

### **5.0 MOTOR**

The motor shall be totally enclosed fan cooled type, H Class insulation and shall run on the electrical power suitable for 220 volts  $\pm 5\%$  or 415 volts  $\pm 10\%$  50Hz. It should be suitable to operate at two speed or single speed as specified in schedule of quantities.

### **6.0 PROTECTIVE BIRD SCREEN**

The fans shall have protective screen of chrome coat.

### **7.0 SILENCERS**

- 7.1 The Jet Fans shall have silences at inlet and outlet discharge nozzle.
- 7.2 Silencer casing shall be of 1.0mm thickness.



- 7.3 The silencers shall be manufactured from galvanized sheet steel and it shall be able to maintain noise level of maximum 60 dBA at 2 metre distance.

## **8.0 INLET BELL MOUTH**

Jet Fans shall have Inlet bell mouth made of aluminium or G.S.S and should be shaped to reduce air turbulence in the inlet of the fan.

## **9.0 TERMINAL BOX**

The pre-wired Terminal box shall be fitted at the outside of the fan casing.

## **10.0 MOUNTING ARMS / BRACKETS**

The unit shall be with mounting brackets for ceiling suspension and for permitting adjustment of air stream.

## **11.0 CABLING**

- 11.1 All cables shall be MICC (Mineral Insulated Copper Conductor) suitable for high temperature fire condition.
- 11.2 The control cable shall be run in conduits. The control cable shall be adequately shielded to prevent Radio Frequency interference and malfunctioning.

## **12.0 ELECTRONIC CONTROL PANELS**

- 12.1 The control panel housing the electronics shall be adequately populated with CPU, Input / Output Modules, Timers, Logic Function Modules, Power Supply Modules.
- 12.2 The logic program shall be loaded on the CPU at the time of trial runs.
- 12.3 Facility shall be provided for changing the control logic. Necessary display / touch screens shall be provided.

## **13.0 POWER CONTROL PANELS**

- 13.1 The power control panels shall be adequately populated for the central and logic functions.
- 13.2 The panels shall be manufactured according to relevant Indian Standards and shall have adequate space for termination of cables and maintenance.

**CENTRIFUGAL FANS****1.0 GENERAL**

**THE CENTRIFUGAL FANS MUST BE AMCA CERTIFIED.**

**2.0 TYPE**

Centrifugal fans shall be non-overloading type backward curved or forward curved and will conform to class of construction as specified and shall be complete with motor, belt drive, belt guard, motor mounting and vibration isolators.

**3.0 MATERIAL**

- 3.1 Housing and gauges of sheet steel used in the housing for Class I construction. Inside and outside surface of fan casing and impeller should be spray galvanised.
- 3.2 Fan wheel shall be forward curved or non-overloading type backward curved as mentioned Schedule of Quantities. Fan wheel, housing and the shaft shall be statically and dynamically balanced.
- 3.3 Shaft shall be constructed of SAE 1040/EN8/C -40 steel (unless specified otherwise) turned, ground and polished. Shaft shall not pass through first critical speed through full range of specified fan speeds.
- 3.4 Bearings shall be of the sleeve/ball bearing type mounted directly on the fan housing. Bearing shall be designed specifically for quite operation and shall be of self aligning, grease pack, pillow block type.
- 3.5 Drive to fan shall be provided through belts with adjustable multi-speed variable pitch motor pulley and an approved belt guard. Belts shall be of the oil resistant type

**4.0 MOTORS**

- 4.1 **THE MOTOR SHALL BE IE3.**
- 4.2 Fan motor shall be suitable for  $415 \pm 10\%$  volts 50 cycles, 3 phase, AC power supply squirrel cage TEFC with IP-53 protection. Motors shall be especially designed for quiet operation and motor speed shall not exceed 1440 rpm.

**5.0 INSTALLATION**

- 5.1 The concrete foundation wherever required to the fans will be prepared by the Owner to the drawings supplied by the Contractor. However, the Contractor shall supply the foundation bolts, base-plate wherever required, vibration eliminators etc., and he shall also ensure that all the above accessories are placed securely in proper position while the foundation is cast.
- 5.2 Vibration isolation base for both fan and motor shall be built as an integral part and shall be mounted on concrete foundation through anti-vibration isolator having an efficiency of 90%.

5.3 Fan outlet connections shall be by means of flexible fire retardent canvas connections.

**6.0 TESTING**

Fans shall be tested for the capacity, power consumption, noise level and vibration isolation and result shall conform to the approved data furnished by the Contractor.

**7.0 PAINTING**

On completion of the erection and testing, the assembly shall be painted with two coats of an appropriate paint of approved make and colour.

## **INLINE FANS**

### **1.0 SCOPE**

The scope of this section comprises of supply, erection, testing and commissioning of Inline Fans conforming to these specifications and in accordance with the requirements, Equipment Schedule, Schedule of Quantities and drawings.

### **2.0 TYPE**

- 2.1 Fan shall be single inlet single width (SISW) type. Fan shall have directly driven forward curved centrifugal impeller, running in a metal scroll balanced to give quite and vibration free operation. Fan motor assembly shall be statically and dynamically balanced.
- 2.2 The fan shall be assembled in such a manner that the motor and impeller can be easily removed and reinstalled after servicing.

### **3.0 MATERIAL**

- 3.1 Fan casing shall be manufactured from galvanised steel sheets.
- 3.2 All other metal parts shall be hot dip galvanised.

### **4.0 MOTOR**

- 4.1 The fan shall be equipped with motor with speed regulator giving volume control from 0 to 100% of output.
- 4.2 Motors shall be with Class F insulation wired to an externally mounted weather proofed terminal box

### **5.0 INSTALLATION**

- 5.1 Fan shall have rigid supports and fitted to both ends of the casing.
- 5.2 Wherever the fans are to be suspended from ceiling or mounted on the wall, the Contractor shall include supply and fixing of all the material that may be required to complete the installation in all respects.
- 5.3 Fan inlet and outlet connections shall be by means of flexible canvas connections.

### **6.0 TESTING**

- 6.1 Fan after installation shall be tested for capacities, power consumption, noise level and vibration and results shall confirm to the approved data furnished by the Contractor.

### **7.0 ELECTRIC POWER CONNECTIONS**

Single phase, 220 V, 50 Hz power supply point within 2 meter from the fan shall be available.

## **PROPELLER FANS**

### **1.0 SCOPE**

Scope of work comprises the supply, erection, commissioning and testing of propeller fans of the capacities set forth in the Equipment Schedule.

### **1.2 TYPE**

Fan shall be of the broad type; ring or diaphragm mounted and of the capacity shown in the schedule of equipment. Fans shall be provided with gravity type louvers unless otherwise stated.

### **1.3 TESTING**

Fans shall be tested for the capacity, power consumption, noise level and vibration isolation and result shall conform to the approved data furnished by the Contractor.

### **1.4 ELECTRICAL POWER CONNECTIONS**

Single phase 220V, 50Hz power supply point within 2 meters from the fan shall be available.

**PAINTING WORK**

This section deals with painting of various equipment / material supplied under this contract. It gives basic guidance for painting as specified below:

- a) Application: The original colour of all equipments like water chilling machines, air-handling units etc. which if get damaged during installation shall be painted in original shade with the two coats of paint to give a final finish.

All chilled water pipes shall be painted as per standard code of practice and arrows shall be marked to indicate direction of flow of water.

**COLOUR SCHEME FOR THE EQUIPMENTS/MATERIALS**

<b>S.No.</b>	<b>Chilling M/C</b>	<b>:</b>	<b>As per manufacturer's standard</b>
1	Pump-sets	:	Battle ship grey.
2	Chilled water pipes	:	Light blue.
3	Condenser water pipes	:	Light green.
4	Direction of flow of water	:	Black arrows.
5	Electrical panels / sub-panel / remote control console	:	Light grey powder coated.
6	Cable trays	:	Cadmium plated.
7	Supports for ducts	:	Silver.

**SCHEDULE OF REQUIREMENTS (Basis of Design)****1.0 EQUIPMENT SCHEDULE**

Based upon the requirement as furnished in the tender, the contractor will carryout detailed heat load calculations, ventilation calculation etc and furnish schedule of equipment for approval by IRCON before placing order for procurement.

**2.0 LIST OF APPROVED MAKES OF EQUIPMENT**

Please refer list of approved makes for HVAC Works specified elsewhere.

**3.0 SCHEDULE OF TECHNICAL DATA**

Please refer Data Requirement Sheets for HVAC Works of this Tender.

**4.0 TEST DATA****4.1 GENERAL**

The Contractor must perform all inspection and tests of the system as a whole and of components individually as required, under the supervision of the Consultant/Owner, in accordance with the provisions of the applicable as per standards or approved requirements.

Contractor shall allow the Owners and their Consultants to inspect and test the assembled equipment's at the works of the Contractors. For all bought out items from the approved manufacturers they shall produce manufacturers test certificates.

**4.2 PIPING SYSTEM**

In general pressure tests shall be applied to piping only before connection of equipment and appliances. In no case shall piping, equipment or appliances be subjected to pressures exceeding their test ratings.

Tests shall be completed and approved before any insulation is applied.

After tests have been completed, the system shall be drained and cleaned of all dust and foreign matter. All strainers, valves and fittings shall be cleaned of all dirt, fittings and debris.

The balancing must be done with computer programmed balancing system comprising digital manometer with LCD display and differential pressure sensor unit other accessories required for on line measurement and documentation of flow with digital display. The software should be compatible with Windows 95/98 suitable for two way communication facility with PC.

The contractor must submit the print of each valve after balancing indicating valves identity, size, no. of turns, design flow, differential pressure and actual flow.

**4.3 WATER PIPING**

All water piping shall be tested and proven tight under hydrostatic pressure of 1-1/2 times the design pressure unless stated otherwise in the specifications, prescribed pressure shall be maintained for four hours.

#### 4.4 DUCT WORK

All branches and outlets shall be tested for air quantity and the total of the air quantities shall be within plus five percent (5%) of fan capacity.

Fire dampers, volume dampers and splitter dampers shall be tested for proper operation.

#### 4.5 BALANCING AND ADJUSTMENT

All Air Handling ventilation equipment, duct work and outlets shall be adjusted and balanced to deliver the specified air quantities indicated, at each inlet and outlet, on the drawings. If these air quantities cannot be delivered without exceeding the speed range of the sheaves of the available horse power, the Consultant/ Owner shall be notified before proceeding with the balancing of air distribution system.

#### 4.6 ELECTRICAL EQUIPMENT

- All electrical equipment shall be cleaned and adjusted on site before application of power.
- The following tests shall be carried out,
  - a. Wire and cable continuity tests.
  - b. Insulation resistance tests, phase to phase and phase to earth, on all circuits and equipment, using a 500 volt meggar. The meggar reading shall be not less than one Mega ohm.
- Earth resistance between conduit system and earth must not exceed half (1/2) CMH.
- Phasing out and phase rotation tests.
- Operating tests on all protective relays to prove their correct operation before energising the main equipment.
- Operating tests on all starters, circuit breakers, etc.

#### 4.7 PERFORMANCE TEST

The installation as a whole shall be balanced and tested upon completion, and all relevant information including the following shall be submitted to the Consultant/ Owner.

- a. Air volume passing through each unit, duct, grilles, apertures.
- b. Different pressure readings across each filter, coil and through each pump.
- c. Static pressure in each air duct.



- d. Electrical current readings, in Amperes of full and average load running and starting together with name plate current of each electrical motor.
- e. Continuous recording over a specified period of ambient wet and dry bulb temperatures under varying degrees of internal heat loads and use and occupation, in each zone of each part of the building.

Daily records should be maintained of hourly readings, taken under varying degrees of internal heat load and use and occupation, of wet and dry bulb temperatures, upstream "On-Coil" of each cooling coil. Also suction temperatures and pressures for each refrigerating unit. The current and voltage drawn by each machine.

Any other readings shall be taken which may subsequently be specified by the Consultant/Owner.

#### 4.8 MISCELLANEOUS

The above tests are mentioned herein for general guidance and information only but not by way of limitation to the provisions of conditions of contract and specification.

The date of commencement of all tests listed above shall be subject to the approval of the Consultant/Owner and in accordance with the requirements of this specification.

The Contractor shall supply the skilled staff and all necessary instruments and carry out any test of any kind on a complete system if the Consultant/Owner requests such a test for determining specified or guaranteed data as given in the specification or on the drawings.

Any damage resulting from the tests shall be repaired and/or damaged material replaced, all the satisfaction of the Consultant/Owner.

In the event of any repair or any adjustment having to be made, other than normal running adjustment, the tests shall be void and shall be recommenced after the adjustment or repairs have been completed.

The Contractor must inform the Consultant/Owner when such tests are to be made, giving sufficient notice, in order that the Consultant/Owner or his nominated representative may be present.

Complete records of all tests must be kept and 3 copies of these and location drawings must be furnished to the Consultant/Owner.

The Contractor may be required to repeat the test as required, should be ambient conditions at the time not giving in the opinion of the Consultant/ Owner, sufficient and suitable indication of the effect and performance of the installation as a whole or of any part, as required.

Suitable manpower tools and instruments to carry out the tests satisfactorily whether at site or at manufacturers works shall be provided by the Contractor.

## 5.0 **TESTS**

All types of routines tests shall be carried out at the work of the Contractor or the manufacturers of the components .The Engineer-in-Charge/ Architect shall be free to witness any or all test if he so desires.

On the completion of the installation, the contractors shall arrange to hold three days continuous run to carry out various tests as detailed below, in the presence of and to complete satisfaction of the Engineer-in-Charge and their Architects.

The initial tests shall be include but not be limited to the following:

To operate and check the proper functioning of all electrically operated components viz.

To test and check the switch gears, safety and other controls.

To check the air distribution in the system and to provide design air flow in all areas specifically shown on the drawings .Also check and ensure the inside conditions as specified are achieved.

To check the systems against leaks in different circuits, alignment of motor, 'V' belt adjustments control setting etc.

Besides the initial tests the contractor shall offer three seasonal tests during worst summer, monsoon & winter condition for 12 hours every day for consecutive 3 days.

To record the readings as detailed under 'TEST DATA'.

## **RUNNING IN PERIOD & GUARANTEE**

### **1.0 RUNNING IN PERIOD & DATE ACCEPTANCE**

- 1.1 After the installation work has been completed by the contractor, he will conduct tests and make adjustments as may be necessary to satisfy himself that the plant including low side equipments is capable of continuous running. There after he will offer to the department a running-in period of 7 days subject to a minimum aggregate of 120 hrs. at his cost. All the compressors shall be run by rotation. The plant will be operated and a log of all parameters will be maintained during this the period. The contractor will be free to carry out necessary adjustment during this period without stopping the plant. The plant will be said to have successfully completed the running –in-period, if no break down or abnormal/unsatisfactory operation of any machinery occurs during this period. After this the plant will be made available for beneficial use. After the plant has operated without any major breakdown/trouble for the above specified running -in-period it shall be taken over by the department subject to guarantee clause mentioned below. This date of taking over of plant after trouble free operation during the running-in-period shall be the date of acceptance.
- 1.2 Any loss of refrigerant or oil during the running in period shall be made good by the contractor free of charge.
- 1.3 Capacity test of the chiller may be carried out as and when conditions become stabilized.
- 1.4 **Seasonal testing may be carried out as & when outside conditions become suitable.**
- 1.5 Seasoned Test: Contractor shall offer the plant for 3 seasonal test run. Once during worst summer, next during, worst monsoon and last during winter. Each test run to be given for 3 consecutive days at 8-10 hours per day and should be able to maintain inside conditions as specified.

### **2.0 GUARANTEE**

- 2.1 The contractor shall guarantee the complete system to maintain the specified conditions under all conditions of ambience and internal loads. Also the inlet/outlet temperatures at the specified flow of water in the chiller unit shall be guaranteed.
- 2.2 All equipments shall be guaranteed for a period of **12 months** from the date of acceptance and taking over of the installation by the Department against unsatisfactory performance and/or breakdown due to defective design, material, manufacture, workmanship or installation. The equipment or component or any part thereof so found defective during the guarantee period shall be repaired or replaced free of cost to the satisfaction of the Engineer-in-Charge. In case it is felt by the department that undue delay is being caused by the contractor in doing this, the same will be got done by the department at the risk & cost of the contractor. The decision of Engineer-in-charge in this regard shall be final.
- 2.3 Any leakage of refrigerant and/or oil due to defective design, manufacture, workmanship or installation during the guarantee period shall be made good by the contractor free of charge.
- 2.4 If the defects are not removed within a reasonable time, the Owner may arrange to do at Contractor's risk and cost without prejudice to any other rights.

**3.0 POWER SUPPLY, WATER SUPPLY AND DRAINAGE****3.1 Power Supply**

- 3.1.1 3 Phase, 415 Volts, 50 Hz. power supply shall be arranged by the Contractor.
- 3.1.2 The power supply for erection and testing of the complete installation shall be arranged by the contractor. For this purpose nothing extra shall be paid on this account.
- 3.1.3 All further power distribution to the various equipment shall also be done by the contractor.
- 3.1.4 The contractor shall not use the power supply for any other purpose than that for which it is intended for. No major fabrication work shall be done at site. Power shall be used only for welding/cutting works.

**3.2 Water Supply and Drainage**

- 3.2.1 Water supply for erection and testing shall be arranged by the contractor.
- 3.2.2 Further connections including providing valves from drain points to respective equipment shall be done by the contractor.

**4.0 DATA MANUAL AND DRAWINGS TO BE FURNISHED BY THE CONTRACTOR**

- 4.1 The contractor shall furnish detailed technical literature, pamphlets and performance data, computerized selection of chilling unit and blowers for EIC's approval before start of the particular work.
- 4.2 Drawings for approval on award of the work :

The contractor shall prepare & submit the following drawings and get them approved from the Engineer-in-Charge before the start of the work:-

- Ducting drawings showing sizes, locations of dampers, air-terminators.
- Plumbing drawings showing the layout of entire piping, dia& length of pipes, valves and isometric drawings showing connections to various equipment.
- Drawings including section, showing the details of erection of entire equipments including their foundations, water basin for the cooling towers etc.
- Layout drawings of the equipment to be installed in various rooms such as plant room, AHU rooms, hot water generator room, cooling tower and other equipment.
- Electrical wiring diagrams for all electrical equipment and controls including sizes and capacities of the various cables and equipment.
- Dimensioned drawings of all electrical and control panels.
- Drawings showing the details of all insulations and vapour barrier works, and

- Drawing showing details of supports for pipes, cable trays etc.
- Any other drawings relevant to the work.

## **5.0 BEFORE COMMENCEMENT OF HVAC WORK**

The contractor shall furnish well in advance the detailed instructions and manuals of manufacturers for all items of equipment regarding installation, adjustments operation and maintenance i/c preventive maintenance & trouble shooting together with all the relevant data sheets, spare parts catalogue and workshop procedure for repairs, assembly and adjustment etc. all in triplicate.

## **6.0 EXTENT OF WORK**

- 6.1 The work shall comprise of entire labour including supervision and all materials necessary to make a complete installation and such tests and adjustments and commissioning as may be required by the department. The term complete installation shall not only mean major items of the plant and equipment covered by specifications but all incidental sundry components necessary for complete execution and satisfactory performance of installation with all layout charts whether or not those have been mentioned in details in the tender with document in connection with this contract.
- 6.2 Minor building works necessary for installation of equipment, foundation, making of opening in floors and restoring to their original condition, finish and necessary grouting etc. as required.

## **7.0 INSPECTION AND TESTING**

- 7.1 Initial Inspection at Manufacturer's works

### **7.1.1 Centrifugal Compressor**

Salient features such as model, capacity control, provision of crank, case heaters, type of lubrication etc. shall be verified against the requirements visually without opening the compressors.

Manufacturer's internal test certificates shall be scrutinized to check compliance with the requirements as specified in the order.

Free running test shall be carried out at the speed for which the motor is available with manufacturer but the speed shall not be less than that specified in contract. This test shall be carried out for 30 minutes in open space. During this running test following operations are to be noted:

- Manual operation of capacity control.
- Lubrication oil pressure.
- Pneumatic test pressure test at 21 Kg/Sq.cm. for casing of compressor.
- Vacuum test for the compressor for 0.5mm.Kg.

### 7.1.2 Condensers

Salient features like number of tubes, inside diameter of tubes (from which the gauge of the tube can be verified) No. of passes, material of fins, length of condenser, provision of fittings like safety valve, water, gas connection shall be verified during stage inspection. The tube thickness shall be checked.

Manufacturer's internal test certificate shall be furnished and it shall be valid against contract requirements.

Pneumatic pressure test at twice the normal condensing pressure for gas side of condenser.

Hydraulic test at 10 Kgs./Sq.cm. for water side of the condenser.

### 7.1.3 Chiller

Salient features like type of chiller, inside diameter of tubes (from which the gauge of the tube can be verified) material of tubes, type material and number of fins, wherever applicable length of chiller and provision of fittings to be verified against requirements specified in the contract during stage inspection. The tube thickness shall be checked.

Manufacturer's internal test certificate shall be furnished and it shall be checked as per the contract requirements.

Pneumatic pressure test at twice the normal condensing pressure for gas side of condenser.

Hydraulic test at 10 Kg/sq.cm. for water side of chiller.

### 7.1.4 Chiller Unit

Full load shall be carried out to verify the capacity and I KW/Ton.

### 7.2.1 Air Handling Unit

Salient features such as model, size, physical dimension, and other details of various sections, fan motor details, fan dimensions etc. shall be verified against the contract requirements.

Manufacturer's internal test certificate for the motor and air handling unit shall be furnished and scrutinized as per contract requirements.

Test certificate for static and dynamic balancing of the fan/blower should be furnished.

Salient features like, type, material, No. and gauge of fins and tubes and No. of rows of cooling coil shall be furnished and verified with reference to contract requirement during stage inspection.

Hydraulic pressure to the extent of 10 Kgf/sq.cm. shall be applied to cooling coil and this pressure should be maintained for 1 hour and no drop should be observed indicating any leaks.

### 7.3 Initial Inspection at Site

#### 7.3.1 Ducting

The sheet used for ducting shall be checked for physical test at site. The physical test should include the sheet thickness and bend test as per relevant IS specifications.

Class of GSS sheet as per IS 277 may be got tested from a laboratory to verify that same meets the contract requirements.

#### 7.3.2 Pumps

Salient features such as model and make shall be checked as per contract requirements.

The manufacturer's test certificate with Sr.No., head, discharge will be furnished and verified against contract requirements.

#### 7.3.3 Cooling Tower

Salient features such as dimensions, materials used, constructional details, number and size of nozzles, headers, size of tank, etc. should be verified against the requirements. Inspection of cooling tower in knocked down condition would be carried out at the site.

Manufacturer's test certificate certifying the capacity of cooling tower and static balancing of fan should be furnished.

#### 7.3.4 Switch Gear, Control Gear and Measuring Instruments.

They should be specified make. For air circuit breaker manufacturer's test certificate shall be furnished by contractor and the same shall be verified as per contract requirements.

#### 7.3.5 Electric Motors

Electric Motors should be specified make, manufacturer's test certificate for electric motor shall be furnished.

#### 7.3.6 Pipes and Valves

It should be checked that the same is as per makes specified in contract.

Dimensions including weight shall be checked for pipes against the requirements of contract.

#### 7.3.7 Insulation and Acoustic Lining

Physical verification for thickness and make should be made as per contract before application of insulation.

Manufacturer's test certificate for density should be furnished.

### 7.3.8 Work at Site – General

All electrical items shall be subjected to inspection at any stage during manufacturing activity. Routine electrical test as per relevant codes. Inspection of Manufacturer's test certificate.

Pressure testing of pipe fit used for the refrigerant and water services.

Pressure testing, leak testing of complete piping network for chilled water, condenser water, hot water, and refrigerant/services.

Vacuumising and gas/oil charging /topping up for refrigeration system.

Checking of electrical circuits (Power & Controls) and checking functioning of controls of refrigerant systems and other circuits of Refrigeration Plant.

Checking of calibration of controls and instrumentation.

Checking of assemblies for electrical control panel, instruments panels, local panels (dimensional and functional) annunciator panels etc.

Inspection of complete electrical installation at site.

Installation of main equipment's like compressor, condenser, ice reserve coil.

Performance testing of complete Air conditioning plant as per specifications.

- 7.3.9 The above inspection procedure is given for general guidance and information of vendors and inspection of purchaser/consultant is strictly not limited to these and Inspection Engineer of purchaser/consultant will have full right to have detailed inspection at any stage right from placement of order to completion of project as desired by Inspection Engineer. Co-ordination of inspection agency of purchaser/consultant with his factory/sub-vendor's factory/erection site will be his sole responsibility of successful vendor after placement or order for complete air-conditioning plant covered under these technical specifications.

### 7.4 Final Inspection

After completion of the entire installation as per specification in all respects, the contractor shall demonstrate trouble free running of the AC equipments and installation for a period of minimum 120 hours of running as detailed under para 3.1.

After the trial run as para (i) above, the contractor shall offer the plant for the seasonal test, namely test for summer or monsoon season whichever occurs earlier. The test results shall be furnished.

The input KW of the unit/TR at full load shall also be checked against contract requirement.

Pressure drops across chiller and condenser at specified flow rates shall be checked.



All instruments for testing shall be provided by the contractor. The accuracy of the instruments shall be as follows:

- a. Temperature liquid in glass thermometer having the accuracy plus or minus 1 deg.C as per IS: 4825.
- b. Wet bulb temperature: whirling psychrometer conforming to IS: 6617. Scale Error: 0.2 deg.C plus or minus 0.1 deg.C.
- c. Pressure Gauge: With the accuracy of plus or minus 1% for maximum scale value from 10 to 90%, and plus 1.9% for maximum scale value on rest of the scale conforming to IS:3695.
- d. Water flow meter: Water flow shall be measured using the arrangement installed as per Schedule of Work.

The equipment capacity computation shall be done from above test results.

## 7.5 Testing Requirements and Procedure

7.5.1 Balancing of all air and water systems and all tests as called for in the agreement shall be carried out by the contractor in accordance with the agreement. Performance tests of individual equipment and control shall be carried out as per manufacturer's recommendation. All tests and balancing shall be carried out in the presence of the representative of the department Engineer-in-Charge.

### 7.5.2 Air Systems

Systems are to be balanced by first adjusting the total flow at the fan, then by adjusting main dampers and branch dampers. Only final minor adjustments are to be made with register and diffuser dampers. Balancing of the air system shall be accomplished without causing objectionable air noise. Basically the following tests and adjustments are required.

Test all fan systems to provide proper cfm/cmh.

Adjust fresh air, return air and exhaust dampers to provide proper air quantities in all modes of control.

Test and record fresh air, return air and mixed air temperature at all air handling units Test and record data at all coils after air and hydronic systems are balanced. Measure wet and dry bulb temperature on cooling coils.

Make point tube transverse at all main supply and return ducts to set proper air quantities. Adjust all zone and branch dampers to proper CFM.

Test and adjust each register, grills, diffuser or other terminals equipment to within 5% of design air quantity. Each opening shall be defined on the test report by size, manufacturer's model, room location, design cfm and actual CFM. Outlets shall be adjusted to minimize objectionable drafts.

Test and record static pressure drop across all filters and major coils.

#### 7.5.3 Water System

Systems are to be balanced by opening all valves, closing all by-pass and setting all mixing valves to full coil flow. Water systems shall be cleared of air. Verify that the system has been properly cleaned, flushed and treated before testing. Basically, the following tests and adjustments are required.

Test and adjust all pumps to deliver the proper gpm. Record rpm, motor amperage, discharge and suction pressure. Pumps shall operate without objectionable noise or cavitation. Plot actual pump and system performance points on manufacturer's pump curves.

Check all expansion tanks for proper filling pressurization. Verify operation of automatic fill and relief valves.

Check the operation of all automatic valves.

Test and adjust correct water flow through chiller, major items of equipment and main water circuit. The balancing valves, provided on the equipment shall be used for adjustment.

Check capacity output of chiller and set water flow rate for proper data.

Check and adjust each coil to provide proper gpm. Record water and air temperature changes and water pressure drop.

Set pressure drops across coil by-pass to match coil full-flow pressure drop.

7.5.4 Unit capacity in Tons Refrigeration shall be computed from the temperature readings, pressure readings and water/flow measurements. Flow measurements shall be preferably through flow meters. Pumps shall be tested for the discharge head, flow and BHP.

#### 7.5.5 Reports

Provide 3 copies of the complete balancing and testing reports to the department. Report shall be neatly typed and bound suitable for a permanent record. Report forms shall contain complete test data and equipment data as specified.

#### 7.5.6 Final documentation

The contractor shall leave the system operating in complete balance with water and air quantities as shown on drawings. Set stops in all balancing valves and lock all damper quadrants in proper position. Secure all automatic damper and valve linkages in proper positions to provide correct operating ranges. Proper damper positions shall be marked on ducts with permanent indication. Notify the department of any areas marginal or unacceptable system performance.

The above tests and procedures are mentioned herein, for general guidance and information only, but not by way of limitation to the provisions of conditions of contract and design/performance criteria.

Upon commissioning and final hand over of the installation, the contractor shall submit (within 4 weeks) to the Engineer-in-Charge 6 (six) portfolios of the following indexed and bound together in hard covering binder (300 x 450 mm.)

Comprehensive operation and maintenance manual.

As built drawings including one set on compact disc and two sets of reproduction drawings of the same showing therein the modification and correction during the course of execution.

Test certificates, consolidated control diagram and technical literature on all controls.

Equipment warranties from manufacturers.

Technical documents and descriptions accordingly to which the work was carried out.

Set of certificates of testes performed for various works.

Commissioning and testing reports.

Rating charts for all equipment.

Log books as per equipment manufacturers standard format.

List of recommended spares and consumables.

At the close of the work and before issue of final certificate of completion by Engineer-in-Charge, the contractor shall furnish a written guarantee indemnifying the department against defective materials and workmanship for defects liability period. The contractor shall hold himself fully responsible for reinstallation or replace free of cost to the department.

Any defective material or equipment supplied by the contractor.

Any material or equipment supplied by the department which is proved to be damaged or destroyed as a result of defective workmanship by the contractor.

Completion certificate shall be issued to the contractor on completing the formalities at stated above.

The plant is deemed to have been taken over from the date of completion certificate is issued to the contractor.

## **8.0 COMPLIANCE WITH REGULATIONS AND INDIAN STANDARDS, INDEMNITY & INSURANCE**

### **8.1 Conformity with statutory Acts, Rules, Standards and Codes**

All components shall conform to relevant Indian Standard Specifications, wherever existing, amended to date.

All electrical works shall be carried out in accordance with the provisions of Indian Electricity Act, 1910 and Indian Electricity Rules, 1956 amended to date. They shall also conform to CPWD General Specifications for Electrical Works, Part-I: Internal, 1994 and Part-II: External, 1994 and Part IV (Sub-Station) as amended to date.

## 8.2 Safety Codes and Labour Regulations

All relevant safety procedures outlined in the safety codes shall be complied with.

In respect of all labour employed directly or indirectly on the work for the performance of the air conditioning part of the work, the contractor at his own expense, will arrange for the safety provisions as per the statutory provisions, I.S.I. recommendations, factory act, workman's compensation act, CPWD code and instructions issued from time to time. Failure to provide such safety requirements would make the tenderer liable for penalty of Rs.50/- for each violation. In addition the Engineer- in-Charge, shall be at liberty to make arrangements and provide facilities as aforesaid and recover the cost from the contractor.

The contractor shall provide necessary barriers, warning signals and the safety measures while laying pipe lines, ducts etc. or wherever necessary so as to avoid accident. He shall also indemnify CPWD against claims for compensation arising out of negligence in this respect. Contractor shall be liable, in accordance with the Indian Law and Regulations for any accident occurring due to any cause. The department shall not be responsible for any accident occurred or damage incurred or claims arising there from during the execution of work. The contractor shall also provide all insurance including third party insurance as may be necessary to cover the risk. No extra payment would be made to the contractor due to the above provisions.

## 9.0 VERIFICATION OF CORRECTNESS OF EQUIPMENT AT DESTINATION

The contractor shall have to produce all the relevant records to certify that the genuine equipment from the manufacturers has been supplied and erected.

The contractor shall provide all equipments, instruments, labour and such other assistance required by the Engineer-in-Charge for measurement of the works, materials etc.

## 10.0 STORAGE OF MATERIALS/ EQUIPMENT

Plant room/Air handling unit room, if ready can be used for storage of materials/equipment brought to site by the contractors. Watch and ward of the same shall be the contractor's responsibility. In case the plant room space is not readily available, it shall be contractor's responsibility to make his own temporary structure at site with approved location from the department at his own cost.

## 11.0 WORKS TO BE DONE BY THE CONTRACTOR

The following works are deemed to be included in the scope of contractor.

Foundations bolts and vibration isolation spring/pads for foundation of equipment.

Suspenders and brackets for suspending/supporting ducts, pipes and cables trays.

Excavation and refilling of trenches wherever the pipes are to be laid directly in ground including necessary base treatment and supports.

Sealing of all floor slab, wall openings provided by the department or contractor for pipes and cables from fire safety point of view after laying of the same.

Painting of all exposed metal surfaces of equipment and components with appropriate colour.

Making good the damages caused during installation and restoring the same to their original finish.

Floor/wall supports for pipes and ducts.

Providing wooden/metallic frame for fixing grills/diffusers.

Making opening in the wall for passage of pipes/cables.

Make up water tanks/connections near cooling towers if necessary.

Drain points in AHU Room and in the vicinity of cooling towers.

Floor and slab openings wherever required for laying of pipes, cables and ducts.

Opening in walls for passage of ducts and return air only.

Supports structure / foundation / pre cast PCC Blocks for chilling machine, cooling tower, pumps, AHUs etc.

Any other work as necessary for functioning of the system

**GUARANTEE PERFORMA****GUARANTEE FOR HVAC INSTALLATION**

We hereby guarantee the year-round Air-Conditioning System which we have installed in the Complex described below:

Building	-	_____
Location	-	Jaipur, Rajasthan
Owner	-	Client /IRCON

For a period including DLP & O&M from the date of acceptance of the total installation, WE AGREE TO repair or replace to the satisfaction of the Owner, any or all such work that may prove defective in workmanship, equipment or materials within that period, ordinary wear and tear and unusual abuse or event of our failure to comply with the above mentioned conditions within a reasonable time, after being notified in writing. We collectively and separately, do hereby authorize the owner to proceed to have the defects repaired and made good at our expense and we shall pay the cost and charge thereof, immediately upon demand.

WE ALSO HEREBY UNDERTAKE to test the entire installation in first SUMMER, MONSOON AND WINTER on following the completion of the installation, to check and do everything necessary to ensure that the specified indoor conditions in all spaces are maintained, that all water and air systems and properly balanced, that all controls are calibrated accurately and that all units are functioning satisfactorily.

SIGNATURE OF CONTRACTOR  
For HVAC INSTALLATIONS

SEAL

DATE

**TECHNICAL DATA****(TO BE FURNISHED BY CONTRACTOR IN METRIC SYSTEM FOR EIC APPROVAL)****Please mention the make and country of origin of all the equipment.****1.0 ROTARY SCREW CHILLER**

Kindly attach the following:

- 1.Computer Selection of the Unit :
- 2.Details of safeties and protection. :
- 3.Detailed functions of Micro Processor Controller. :

**2.0 COMPRESSOR**

- a)Manufacturer Name :
  - b)Model :
  - c)Type of Compressor Hermatic :  
/Semi Hermatic/Open
  - d)No.of Compressor per Machine :
  - e)Nominal capacity of each compressor in TR :
  - f)Actual capacity of each compressor in TR Operating Conditions :
  - g)Saturated Suction Temperature Deg.C :
  - h)Saturated Discharge Temperature Deg.C :
  - i)Max.RPM :
  - j)Mode of Start :
  - k)Refrigerant used :
  - i)Qty. of Refrigerant used :
  - m) Power Consumption IKW/TR : Reduced Entering Constant Entering
- |                   | Cond Water Temp. | Water Temp. |
|-------------------|------------------|-------------|
| At Full Load 100% |                  |             |
| 90%               |                  |             |
| 80%               |                  |             |
| 70%               |                  |             |
| 60%               |                  |             |
| 50%               |                  |             |
- n) NPLV of the M/C :
  - o) Type of capacity control :
  - p) Range of capacity variation :
  - q) Safety devices & controls :
  - r) Monitoring Devices :
  - s) Type of bearings :

**3.0 MOTOR (COMPRESSOR)**

- a) Make of Motor :

- b) Type of Motor :
- c) Motor KW :
- d) Class of Insulation :
- e) R.P.M :
- g) Type of starter (Star Delta or Part Winding) :
- h) Electrical characteristics Voltage/  
Frequency Fluctuations permissible :
- h) Full load current (Amp) :
- i) Starting current (Amp) :

#### 4.0 CONDENSER

- a) Manufacturer Name :
- b) Model :
- c) Number of Condensers :
- d) Fouling Factory MKS :
- e) Heat rejection capacity Kcal/Hr. :
- f) Pressure drop Mts. :
- g) Water flow rate (LPM) :
- h) No. of passes :
- i) Water temperature in Deg.C :
- j) Water temperature out Deg.C :

#### 5.0 COOLER

- a) Manufacturer Name :
- b) Model :
- c) Type of cooler :
- d) Water Flow LPM :
- e) No. of Passes :
- f) Water Temperature Out Deg.C :
- g) Water Temperature in C :
- h) Pressure Drop in Mt. Of water :
- i) Cooling Capacity Kcal/Hr. :
- j) Fouling factor MKS :
- k) Type of vibration :
- l) Isolator for Rotary :
- m) Screw Water chilling :
- n) Machine recommended  
by manufacturer. :

#### 6.0 OVERALL SIZE OF WATER CHILLING MACHINE

- a) Overall dimensions MM :
- b) Opening Wt. Kg. :
- c) Service Clearance required in mm :



a) Operating Conditions :

b) Actual Capacity of water Chilling machine at above Operating conditions

**8.0 COOLING TOWER**

- a) Make of Cooling Tower :
- b) Type of Cooling Tower :
- c) Model of Cooling Tower :
- d) Capacity of Cooling tower :
- e) Approach of Cooling tower :
- f) Wet Bulb (Design) :
- g) Fan Motor (Type & Rating) :
- h) Fan Diameter (Each) :
- i) Fan capacity (Each) :
- j) Material of casing & basin :
- k) Overall dimension in MM :
- l) Dry weight KG :
- m) Operating weight KG :
- n) Water flow rate USGPM :
- o) No. of fans :
- p) R.P.M. of Motor :
- q) Drift loss :
- r) Evaporation loss :
- s) Total Water Loss in LPH :
- t) Type of drive :

**9.0 CONDENSOR WATER PUMP SETS**

- a) Make :
- b) Type :
- c) Model :
- d) Discharge (LPM) :
- e) Head (Mt.) :
- f) Efficiency :
- g) Brake Horse Power :
- h) Horse Power of motor :
- i) Make/Type of motor :
- j) Type of starter :
- k) Impeller Diameter (mm) & Material :
- l) Material of Bearing & Seal :
- m) Type of Bearing :
- n) Speed (RPM) :
- o) Material of Shaft :

**10.0 HOT WATER PUMP SETS**

- a) Make :
- b) Type :
- c) Model :
- d) Discharge (LPM) :
- e) Head (Mt.) :
- f) Efficiency :

- |    |                                   |   |
|----|-----------------------------------|---|
| g) | Brake Horse Power                 | : |
| h) | Horse Power of motor              | : |
| i) | Make/Type of motor                | : |
| j) | Type of starter                   | : |
| k) | Impeller Diameter (mm) & Material | : |
| l) | Material of Bearing & Seal        | : |
| m) | Type of Bearing                   | : |
| n) | Speed (RPM)                       | : |
| o) | Material of Shaft                 | : |

**i) 11. VARIABLE SPEED PRIMARY / SECONDARY CHILLED WATER PUMPING SYSTEM**

**I Secondary Chilled Water Pump**

- |    |  |   |
|----|--|---|
| a) | Manufacturer   | : |
| b) | Type/Model   | : |
| c) | Capacity (USGPM) for SCHWP<br>indicate capacity at varying speed | : |
| d) | Head (M)   | : |
| e) | Efficiency (%)   | : |
| f) | Pump (RPM)   | : |
| g) | B.H.P.   | : |
| h) | Motor (HP)   | : |
| i) | Motor Make   | : |
| j) | Current Characteristics  | : |
| k) | Motor Efficiency & Class of<br>insulation                        | : |
| l) | Bearing Material   | : |
| m) | Impeller Material  | : |
| n) | Shaft Material   | : |
| o) | Type of Water Seals  | : |
| p) | Vibration Isolation  | : |
| q) | Operating Weight (Kg)  | : |
| r) | Overall Dimensions (M) (LxWxH)                                   | : |

**II Adjustable Frequency Drive for Variable Speed Secondary Chilled Water Pump**

- |    |                                  |   |
|----|----------------------------------|---|
| a) | Make/Country of Origin           | : |
| b) | Model No.                        | : |
| c) | Type                             | : |
| d) | Motor Rating                     | : |
| e) | Maximum Output                   | : |
| f) | Slip Compensation                | : |
| g) | Energy Save Mode                 | : |
| h) | PID Controller                   | : |
| i) | Interface with BAS               | : |
| j) | Fault Indication                 | : |
| k) | Historic Fault and Parameter Log | : |
| l) | Key & Display                    | : |
| m) | Dimensions (mm)                  | : |

## III AFD by Pass

- a) Make / Country of Origin :
- b) Model No. :
- c) Type :
- d) Motor Rating :

## IV Pump Logic Controller

- a) Make / Country of Origin :
- b) Model No. :
- c) Microprocessor :
- d) Radio Interference Standards :
- e) Power Supply :

## V Differential Pressure / Sensors / Transmitters

- a) Make / Country of Origin :
- b) Model No. :
- c) Type :
- d) Sensing Element Material for Pressure & Flow Rate :
- e) Maximum Static Pressure :
- f) Power Supply :
- g) Degree of Protection :

**12.0 PRIMARY CHILLED WATER PUMP SETS**

- a) Make :
- b) Type :
- c) Model :
- d) Discharge (LPM) :
- e) Head (Mt.) :
- f) Efficiency :
- g) Brake Horse Power :
- h) Horse Power of motor :
- i) Make/Type of motor :
- j) Type of starter :
- k) Impeller Diameter (mm) & Material :
- l) Material of Bearing/Seal :
- m) Type of Bearing :
- n) Speed (RPM) :
- o) Material of Shaft :

**13.0 CONTROLS****Makes**

- a) Three way Mixing Valve  
With Actuator (Part of BMS work) :
- b) Pressure gauge :
- c) Thermometers :

**14.0 PIPES**

- |    |       |   |
|----|-------|---|
| a) | Make  | : |
| b) | Class | : |

**15.0 VALVES**

Make

- |    |                 |   |
|----|-----------------|---|
| a) | Check Valve     | : |
| b) | Butterfly Valve | : |
| c) | Balancing Valve | : |
| d) | Y-Strainer      | : |

**15.1 Material/Gauge/Perforation of basket & Make**

- |     |                  |   |
|-----|------------------|---|
| i)  | Pot Strainer     | : |
| ii) | Suction strainer | : |

**16.0 GRILLS/DIFFUSERS/DAMPERS**

Please indicate make/material/gauge of the following:

	Make	Material
a) Duct Dampers	:	
b) Grills/Diffusers	:	
c) Fire Dampers	:	
d) Smoke & Temperature Sensor	:	

**17.0 DUCT INSULATION**

a) Manufacturers Name	:
b) Material	:
c) Density Kg. Per Cmt	:
d) Thermal Conductivity Kcal/Hr.Deg.C	:

**18.0 DUCT LINING**

a) Manufacturers Name	:
b) Material	:
c) Density Kg. Per Cmt	:
d) Thermal Conductivity Kcal/Hr.Deg.C	:

**19.0 PIPE INSULATION**

a) Manufacturers Name	:
b) Material	:
c) Density Kg. Per Cmt	:
d) Thermal Conductivity Kcal/Hr.Deg.C	:

**20.0 ELECTRICAL ACCESSORIES**

- a. Panel Manufacturer's name

**DOUBLE SKINNED AIR-HANDLING UNITS**

	TAG NO.					
A.						
	Make of AHU					
	Capacity CMH					
	Material/Gauge Casing Drain Pan					
	Overall size (LxBxH) mt					
	Type of AHU, vertical/ horizontal/Ceiling suspended					
	Over all weight in Kg.					
B.	COOLING COIL					
	Make					
	Material of Tube/Fins					
	No. of Fins/cm					
	No. of Rows deep					
	Dia of Tubes (mm)					
	Face Area (SMT)					
	Cooling Capacity (Kcal/hr.)					

	TAG NO.					
	Chilled Water Flow Rates LPM					
	Face Velocity MPS					
	Test Pressure Kgs./Sq.cm					
C.	FILTER SECTION					
	Make					
	Type of Filters					
	No. of Filters					
	Size of Filters					
	Air Velocity through Filter EPM					
	Efficiency of Filter %					
D.	FAN & FAN MOTOR					
	Make of Fans & Motor					
	Type of Fan					
	No. of Fan					
	Width and dia of fans (mm)					
	Type of Blade					
	Air Quantity CMH					



	TAG NO.					
	Static Pressure in wg					
	Fan Discharge Velocity					
	Type of Balancing					
	Brake Horse Power in HP					
	Hose Power of Motor in HP					
	Motor RPM					
	Fan Speed					
	Type of Drive Ball Driven/Direct Driven					

**PERFORMANCE TEST READINGS**

The Test Readings shall be recorded on hourly basis during the summer/ monsoon seasons after commissioning of AC System at site as per the Performa indicated below.

**1.0 OUTSIDE DESIGN CONDITIONS**

- a) Season :
- b) Dry bulb temp Degree C :
- c) Wet bulb temp Degree C :

**2.0 INSIDE DESIGN CONDITIONS IN EACH AREA**

- a) Dry bulb temp Degree C :
- b) Wet bulb temp. Degree C :
- c) Relative Humidity % :

**3.0 COMPRESSOR**

- a) Suction temp. Deg. C :
- b) Suction pressure Kg/Sq.cm :
- c) Discharge temp. Deg.C :
- d) Discharge pressure Kg/Sq.cm :
- e) R.P.M. of compressor :

**4.0 COMPRESSOR MOTOR RATING AT VARIOUS LOADS**

- a) Motor current - AMPs :
- b) Voltage - AMPs :  
AC LOAD STATUS

**5.0 CONDENSOR**

- a) Water flow rate LPM :
- b) Entering water temp. Deg.C :
- c) Leaving water temp Deg.C :
- d) Pressure drop through  
Condenser Kg/Sq.cm (PSI) :

- |    |  |   |
|----|--|---|
| a) | Water flow rate LPM                                | : |
| b) | Entering water temp. Deg.C                         | : |
| c) | Leaving water temp Deg.C                           | : |
| d) | Pressure drop through<br>evaporator Kg/Sq.cm (PSI) | : |

100% load	TR of M/CCurrent Drawn by M/C
0.98	0.76
0.97	0.75
0.96	0.74
0.95	0.73
0.94	0.72
0.93	0.71
0.92	0.70
0.91	0.69
0.90	0.68
0.89	0.67
0.88	0.66
0.87	0.65
0.86	0.64
0.85	0.63
0.84	0.62
0.83	0.61
0.82	0.60
0.81	0.59
0.80	0.58
0.79	0.57
0.78	0.56
0.77	0.55
0.76	0.54
0.75	0.53
0.74	0.52
0.73	0.51
0.72	0.50
0.71	0.49
0.70	0.48
0.69	0.47
0.68	0.46
0.67	0.45
0.66	0.44
0.65	0.43
0.64	0.42
0.63	0.41
0.62	0.40
0.61	0.39
0.60	0.38
0.59	0.37
0.58	0.36
0.57	0.35
0.56	0.34
0.55	0.33
0.54	0.32
0.53	0.31
0.52	0.30
0.51	0.29
0.50	0.28
0.49	0.27
0.48	0.26
0.47	0.25
0.46	0.24
0.45	0.23
0.44	0.22
0.43	0.21
0.42	0.20
0.41	0.19
0.40	0.18
0.39	0.17
0.38	0.16
0.37	0.15
0.36	0.14
0.35	0.13
0.34	0.12
0.33	0.11
0.32	0.10
0.31	0.09
0.30	0.08
0.29	0.07
0.28	0.06
0.27	0.05
0.26	0.04
0.25	0.03
0.24	0.02
0.23	0.01
0.22	0.00
0.21	0.00
0.20	0.00
0.19	0.00
0.18	0.00
0.17	0.00
0.16	0.00
0.15	0.00
0.14	0.00
0.13	0.00
0.12	0.00
0.11	0.00
0.10	0.00
0.09	0.00
0.08	0.00
0.07	0.00
0.06	0.00
0.05	0.00
0.04	0.00
0.03	0.00
0.02	0.00
0.01	0.00
0.00	0.00

- |    |                                    |   |
|----|------------------------------------|---|
| a) | Air quantity CFM                   | : |
| b) | Air velocity ft/min.               | : |
| d) | Entering air temperature DB/WB C : |   |
| d) | Leaving air temperature DB/WB C    | : |
| e) | Entering water temp. C             | : |
| f) | Leaving water temp C               | : |
| g) | Entering water pressure Kg/Sq.cm   | : |
| h) | Leaving water pressure Kg/Sq.cm    | : |

- a) Actual voltage/current :

- |    |                             |   |
|----|-----------------------------|---|
| a) | Flow rate LPM               | : |
| b) | Suction pressure Kg/Smt     | : |
| c) | Discharge pressure Kg/Sq.cm | : |
| d) | Actual voltage/current      | : |

## **TECHNICAL SPECIFICATIONS**

### **IRRIGATION WORKS**

#### **SECTION – 7**

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## 1.0 Irrigation network

The irrigation network shall be from treated water of S.T.P Highly efficient, irrigation system shall be provided by using:-

- Soil moisture sensors integrated with irrigation system.
- Turf and bedding areas shall be segregated into independent zones, as per water demand of plants.
- Drip irrigation to be adopted wherever necessary.
- Programmer and time controller to ensure minimum evaporation losses.

Sewer Treated Water will be used for irrigation.

Entire piping shall be HDPE/GRP, to be laid with suitable mechanical protection.

## 1.1 Documents

Drawings indicate the green areas/plantation/trees requiring irrigation.

## 1.2 Scope contractor to carry for:

To carry out soil investigation report for: Soil conditions. Including:

- a) Type
- b) Texture
- c) Density
- d) Moisture content
- e) Infiltration rate

Piping upto point of connection, backflow devices, isolation valves, filters, master control valves, flow sensors, etc;-

Providing of Irrigation Pressure Main Lines

Pull Boxes for Control wires.

Air/vacuum release valves and pressure relief valves.

Isolation valves (mainline and manifold).

- Automatic remote-control valves (indicate flow, station number and size).
- Drip system filters to be installed in separate boxes from the control valves.
- Quick coupling valves.
- Drip system air relief and flush valves.
- Providing of control wires and conduits from irrigation mainline.
- Irrigation controllers for each area. No of controller to be specified in shop drawing.
- Moisture sensors in turf areas.
- Electrical power supplies for the irrigation system.
- Irrigation Pumping Units.
- Electromechanical Items inside Pump Room
- Auto Backwash Screen Filters
- Irrigation Central Control System
- Licensed Software with Computer & Printer
- Consumables for 12 months
- Contractor shall submit shop drawing for approval.

## 1.2 Performance Requirements

Irrigation zone control shall be automatic/manual operation. Controller and computerized central control in Plant room of STP.

Working Pressures and flow rates:

For pipe sizing, mean velocity of flow in main or lateral pipes shall not exceed 1.5 m/sec.

The total head loss in main line shall not exceed 0.5 metre/100metre and not to exceed 1.0 m.

- 1.3 Total friction loss from the far end of the lateral up to solenoid valve shall not exceed 1 m. The total head loss in solenoid valve assembly shall not exceed 3.0m.

1.4 The total head loss in pump station shall not exceed 7m.

The Contractor shall provide detailed calculations for head loss including all necessary breakdowns for Engineer review.

Type of irrigation for each type of plantation shall be as per shop drawings.

Water requirement for the plantation at maximum (peak) demand shall be considered as follows:

Palm trees 180 ltr./day

Ornamental trees 80 ltr./day

Shrubs 15 ltr./day

Ground covers & Ornamental Grass 16 ltr./day

Lawn 12 ltr./day/sqm

Hedges 13 ltr./M/day

Cactus & Succulents 7 ltr./plant/day

**1.4 Shop Drawings**

Shop Drawings: The Contractor shall prepare shop drawings for approval by the IRCON / Consultant. Shop drawings to include but not limited to:

Detailed layout of main, sub-main and lateral pipes, valves, irrigation heads and other typical connections, including hydraulic pressure loss calculation

Wiring diagram including conduits, pull boxes, sizing and calculations to verify that cable sizing is in accordance with cable and valve manufacturer's recommendations.

Details for connection to the main line network and control system.

Electric power and control wiring diagrams system for irrigation controller, site wiring and grounding and computerized system control components.

Approved materials and equipment to scale.

Product Catalogue/Data: For each type of product indicated, Include rated capacities, operating characteristics, electrical characteristics & furnished specialties and accessories.

Zoning Chart: Show each irrigation zone and its control valve.



Controller Timing Schedule: Indicate timing settings for each automatic controller zone.

Operation and Maintenance Data: For sprinklers, controllers, and automatic control valves to include in operation and maintenance manuals.

Detailed valve schedule to show the daily timing for irrigation system and to ensure achievement of the daily water requirement for each plant type.

## **1.5 Quality Assurance**

A. Installer Qualifications: Certified irrigation designer qualified by The Indian Irrigation Association.

## **1.6 Polyethylene Pipes and Fittings**

Polyethylene pipes and fittings for emitter lines to have a working pressure of 10kg/cm<sup>2</sup>

PE risers connecting the secondary uPVC pipe with the PE tertiary pipe shall be as follows:

12mm size for sprayers, sprinklers and bubblers and 16mm for drippers

An independent riser shall be allowed for each sprayer, sprinkler bubbler and for drippers if used for irrigating palm tree

A common riser for ornamental trees, shrubs, ground covers, seasonal flowers, rockery plants and succulents.

All PE fittings shall be compression fitting suitable for pressure rating up to 10 bar.

## **1.7 GRP Pipes and Fittings**

All pipes and fittings shall have a resin rich inner layer, having a minimum thickness of 1.0 mm and resin rich outer layer having a minimum thickness of 0.25 mm incorporating one layer of "C" glass. The remainder of the liner shall consist of at least one layer of 450 gm powder bound acid resistant chipped glass strand mat having a glass content between 25 and 30% by weight.

All glass reinforcement shall be of the "ECR" type. All pipes and fittings shall have a stiffness of not less than 2500 N/M and satisfy the requirement of BS 5480.

Pipes shall withstand longitudinal tensile force of 100 N/mm of circumference. All flanges shall be PN16.

## **1.8 Control Valves**

"normally closed" valves that open on signal from the controller.

Solenoid Valves:

Automatic remote control valves shall be of the sizes as per pipe size.

Be a normally closed 24 volts 50 cycles, unless otherwise specified, solenoid actuated globe pattern with a balanced pressure diaphragm design.

Pressure rating 15 kg/sqm.

Have both internal and external manual open/close control (internal and external bleed) for manually opening and closing the valve without electrically energizing the solenoid. The internal manual bleed shall prevent flooding of the valve box.

It shall have a contamination-proof (CP) self-flushing nylon filter screen located at the valve inlet to filter out grit and prevent clogging of hydraulic control ports.

PRV to regulating downstream pressure between 1 kg / sqm to 4 kg / sqm (within an accuracy of +or- 5 PSI) regardless of upstream pressure.

Isolation Gate Valves:

Gate valves 80mm dia and above:

Be double flange, ductile iron waterworks valves, with wedge type gate and non-rising stem

Coated with epoxy internally and externally to average DFT 300 microns for protection against corrosion of body components

Valves installed below ground shall be provided with stem cap for key operation while the valves above ground shall be provided with hand wheel.

Stem shall be stainless steel and stem nut is brass or cast aluminum bronze with gunmetal

Gate valves 50mm dia. and smaller:

Have a non-rising stem manufactured from brass or bronze according to Indian standard

Inlet and outlet shall be screwed BSP

Pressure nominal rating at PN 16

Quick Coupling Valves:

Made of solid red brass with a rubber or thermoplastic cover marked with "DO NOT DRINK "warning.

Lockable, Used for non-potable water.

Made of a strong corrosion-resistant stainless steel spring to prevent leakage.

Sized 12mm or 25mm and shall be operated at pressure ranging from 0.5 kg/cm<sup>2</sup> to 4 kg/cm<sup>2</sup>.

For every five valve assemblies, contractor shall provide one set of key, swivel elbow and 50 mtr of 20mm reinforced garden hose.

Check Valves:

Check valves 75mm and above :

Be double flanged single door swing type having ductile iron body and gun metal seat (BS 1400)

Pressure nominal rating 16 bars

Coated with epoxy internally and externally to average DFT 300 microns for protection against corrosion of body components

Nut bolts made of a stainless steel type 316.

Check valves of 50mm dia and smaller:

To be of spring type manufactured from Brass or Bronze

Inlet and outlet to be BSP female threaded

The spring shall be a stainless steel

Pressure nominal rating 16 bars

Air valves to be provided at all high points on the pressure mains –Rating PN-16

Pressure Relief Valve –Rating PN-16-Specification as per plumbing

Flanged and of ductile iron body, diaphragm type, hydraulically operated, pilot control and modulating type, epoxy coated, fasteners –SS-316

Wash-Out Valve:

Wash-out valves shall be installed at the lowest point of the irrigation main pipe in order to clean the pipe periodically. The size of the valve shall match the pipe size

## **1.9 Miscellaneous Piping Specialties**

Water Hammer Arresters: ASSE 1010 or PDI WH 201, with bellows or piston-type pressurized cushioning chamber and in sizes complying with PDI WH 201, Sizes A to F.

Pressure Gages: 96mm diameter dial,

Underground Warning Tape:

Warning tape shall be laid above the irrigation main and sub-main pipes. Tapes shall be of laminated polyethylene, durable and flexible with at least 15cm wide and 250 microns thick and shall have the phrase “CAUTION – IRRIGATION PRESSURE MAIN BELOW” stamped in black letters and repeated at maximum intervals of 1.0 m.

The text of tape shall be made using a permanent ink bonded to resist prolonged chemical attack by corrosive acids and alkaline. The text shall be in Hindi and English. The tape shall be laid continuously over pipelines and at joints and there shall be a minimum of 1.0m overlapping. Tape shall be terminated inside valve boxes to allow clipping of detector equipment to the tape

Thrust Blocks:

A thrust block shall be provided for all pipes sized 75mm or more with rubber ring sockets at each bend deviation or at the end of a pipeline

Heavy- duty polyethylene sheet shall be used to wrap the pipe at the point of contact between pipeline fittings and the thrust blocks for a minimum of three layers

#### **1.10 Irrigation Fixtures**

General Requirements: Designed for uniform coverage over entire spray area indicated at available water pressure.

Bubblers:

The bubbler shall be a pressure compensating type capable of providing a consistent flow rate

The bubbler shall have a “trickle” pattern or an “umbrella” pattern discharge

The bubbler assembly shall have a plastic inlet filter screen to protect the nozzle against clogging

The pressure compensating bubbler shall be of a permanently assembled design constructed of durable, UV-resistant plastic with an integral rubber flow washer for regulating the flow rate at an operating pressure range of 1.5 to 6.0 Bars

The pressure compensating bubbler shall have a 15 mm female threaded inlet for connection to the piping system riser

Stakes for bubblers shall be constructed from strong temperature resistant polypropylene plastic construction with protective stop collar, length shall be 300 mm each side of inlet with barbed side inlet suitable for class C polyethylene pipes, and outlet shall be 15 mm external male thread

**Emitters:**

All emitters shall be pressure compensating with different flow 0.5, 1, 2, 4 and 8 (GPH) gallons per hour or equivalent

The capacity and spacing of emitters shall be as follows:

Palm 22 nr. X 1 GPH in-line drip tube per palm (Only If not Bubbler)

Trees 15 nr. X 1 GPH in-line drip tube per tree (Only If not Bubbler)

Shrubs  $\geq 1.0$  m spacing 3 nr. X 1 GPH in-line drip tube per plant

Shrubs 0.75 m spacing 2 nr. X 1 GPH in-line drip tube per plant

Shrubs  $\leq 0.6$  m spacing 4 nr. X 0.5 GPH in-line drip tube per m<sup>2</sup>

Groundcover & Seasonal 4 nr. X 0.5 GPH in-line drip tube per m<sup>2</sup>

Shrub Hedge 2 nr. X 1 GPH in-line drip tube per L.M.

Note: GPH = 3.7 Ltr/Hr.

**Pop-up Sprayers:**

The sprayers shall have a high level impact strength corrosion body, stem and nozzle

Height shall be 100mm.

The sprayer shall have a heavy-duty stainless steel retraction spring and piston with step clutch to facilitate nozzle positioning

Standard or rotary nozzle capable of covering 4.5m radius at 2.0 bar pressure

Spacing for the sprayers with standard nozzle 4m. For small areas, sprayers with low flow nozzles shall be used.

Sprayer shall have a pressure-activated co-molded wiper seal to clean debris from the pop up stem as it retracts

Sprayer shall be provided with built-in seal-a-matic check valve when installed on mounds or slope areas

Sprayer shall also have PRS pressure regulator built into the stem and matched precipitation rates nozzles

Rotor Sprinklers:

Minimum 100 mm POP UP, HT, complete with retraction spray. Body, stem and nozzle heavy duty, UV resistant ABS plastic material

Rotor shall be equipped with ultra mechanism to have full and part circle in same rotor, non-strippable back drive to avoid gear broken and automatic arc return.

Rotor shall be a closed water lubricated gear drive, rotary type and capable of covering area as per shop drawing at a pressure range of 2.1 to 4.0 bars with discharge rate of 1.9 to 54.5 ltr. per minute.

The sprinkler shall be available with 8-12 standard interchangeable nozzles or 8 built-in different nozzles

### **1.11 Irrigation Pumps**

Filters:

Mesh Type

Mesh type shall be self- cleaning using a hydraulically powered suction scanner, automatically activated when the differential pressure across the filter reaches an adjustable level, nominally less than 5 psi.

Work only during the irrigation hours of the system.

Shall have a maximum operating pressure of 7 bar or as per design and a maximum operating temperature of 150-160 F.

Shall have a minimum back-flushing operating pressure of around 3 bar.

Shall have a flow and size as per shop drawings.

Shall have a stainless steel grade 316L screen with 150 - 200 mesh size.

Shall have a stainless steel body and internal parts including flanged connection.

Shall be specially designed for use with organic contaminants.

Shall have isolation valves in the suction as well as delivery side for easy maintenance.

Disc Type

Disk type shall be made of epoxy coated or stainless steel units with Anodized Aluminum body.

Shall be automatic, self-cleaning, self-flushing system triggered by pressure differential and / or pre-set time.

Work only during the irrigation hours of the system.

Shall have a maximum operating pressure of 7 bar and a maximum operating temperature of 150-160 F.

Shall have a minimum back-flushing operating pressure of 3 bar.

Shall have a flow and size as per the drawings, tender specifications.

Shall have a short back flush cycle with regulated volume.

Shall be specially designed for use with organic contaminants.

Shall have isolation valves in the suction as well as delivery side for easy maintenance.

## **1.12 Irrigation Control Systems**

Irrigation Controllers:

The Field Controller shall be a hybrid type that combines electromechanical and microprocessor-based circuitry capable of fully automatic and manual operation.

Have four fully independent programs and each with separate day cycles and 8 start times.

Have a 365-day calendar with Event day off option to set any day of the month as a non-watering day for all programs. Programs will run on an ODD/EVEN day cycle, day-of-the-week ON/OFF cycle, or in cycles from 1 to 99 days.

Capable of running a variable system test program without affecting the normal program and have Cycle + Soak water management software which is capable of operating each station for a maximum cycle time and a minimum soak time to reduce water run-off.

Have an internal nonvolatile memory that shall retain the irrigation program and the programmed date and time for a minimum of 100 years without power. A 9-VDC rechargeable batteries and recharging circuit shall also be included for counting down the program-in-progress during a power outage and shall allow programming of the controller when it is disconnected from the main power supply.

Shall indicate when it is operating under central control. It shall also display which Field Controller and station is in operation at such time.

## Cabling

One spare cable shall be provided for every five cables and it shall run up to the last valve on each main / sub-main

Irrigation control cables shall be color coded as follows:

Common wire for sprayers / sprinklers Green

Common wire for drip / bubbler Black

Drip valve wire Red

Spray valve wire Yellow

Sprinkler valve wire Orange

Spare wire White

## Valve Boxes

Air valves (50mm dia or smaller), QCV, Solenoid valves and Wire Pull Boxes shall be installed in an access box of sufficient size to permit readily removal of the valve inner assemblies without removing the box from the ground.

Valve name and numbers to be marked inside and outside of the boxes:-

Valve boxes shall be fabricated from reinforced plastic

Description	Cover	Depth
QCV Round Valve Box	254 mm	260 mm
Pull Box, Air Valve 25mm and Flush Valve	430 x 295 mm	300 mm
Solenoid Valves up to 50mm	650 x 406 mm	380 mm
Solenoid Valves 75mm and above	825 * 495 mm	457 mm

## 2.0 Earthwork

To install warning tape 300mm below finished grades; 150mm below subgrade under pavement and slabs.

Drain Pockets: Excavate to sizes indicated. Backfill with cleaned gravel or crushed stone, below grade. Cover gravel or crushed stone with sheet of asphalt-saturated felt and backfill remainder with excavated material.



Provide minimum cover over top of underground piping according to the following:

Irrigation Main Piping: Minimum depth of 600mm below finished grade.

Circuit Piping: 300mm.

Drain Piping: 300mm

Sleeves: 600mm.

## **2.1 Piping Installation**

As per approved shop drawings.

Install piping at minimum uniform slope of 0.5% down toward drain valves.

Install unions adjacent to valves and to final connections to other components with (DN 50) or smaller pipe connection.

Install expansion loops in control-valve boxes.

Lay piping on solid sub-base, uniformly sloped without humps or depressions.

Provide water regulators with shutoff valve and strainer on inlet and pressure gauge on outlet.

Provide Water Hammer Arresters: As per approved shop drawing.

Install piping in sleeves of schedule of 80 PVC Pipes under parking lots, roadways, and sidewalks.

## **2.2 Sprinkler Installation**

To install after hydrostatic test is completed.

## **2.3 Automatic Irrigation-Control System Installation**

A. Equipment Mounting: Install interior controllers on wall.

## **2.4 Performance Tests**

The following Tests to be carried out during the course of the works and certificates to be submitted for review.

Pressure Test for Irrigation Main Line Piping

Pressure Test for Irrigation Secondary Lines

Coverage/Uniformity Test for Sprinklers/Sprayers

Coverage/Uniformity Test for Bubblers & Emitters.

Teepol Crack Resistance Test report/certificate for Drip Line Tubing

Holiday Test report for Gate Valves

Complete System run Test in Auto mode.

## **2.5 Commissioning**

Commissioning of fieldwork and equipment shall include all works required to bring the system into service and to make sure that the system is operating efficiently and shall include but not be limited to the following:

Flushing of system

Adjustment of valve pressure  $\pm 10\%$  of normal

Replacement of all clogged or partially clogged lines

Adjustment of sprayers / sprinklers and replacement of clogged / broken sprayers/ sprinklers

Replacement of all clogged or partially clogged emitters/ Bubblers

Preparation of Irrigation Schedules

Adjustment of controllers to give an optimal flow regime

Assurances that all valves and sprayers/sprinklers are flushed with finished grade and after all valves' pressures have been adjusted.

## **2.6 Demonstration**

Train Client's maintenance personnel to adjust, operate, and maintain automatic control valves and controllers.

**TECHNICAL SPECIFICATIONS  
LANDSCAPE (HARD & SOFTSCAPE) AND HORTICULTURE  
SECTION – 8**

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## **1.0 SPECIFICATION FOR LANDSCAPING & HORTICULTURE**

### **1.1 Materials**

#### **1.1.1 PLANT MATERIALS**

Plant materials shall be well formed and shaped true to type and free from disease, insect and defect such as knots, sun-cold, windburn, injuries, abrasion or disfigurement.

All plant materials shall be healthy, sound, vigorous, free from plant diseases, insect pests, or their eggs, and shall have healthy well developed root systems. All plants shall be hardy under climatic conditions similar to those in the locality of the project. Plants supplied shall conform to the names listed on both the plan and the plant list. No plant materials will be accepted if branches are damaged or broken. All material must be protected from the sun and weather until planted.

All nursery stock shall have to be got inspected and approved before planting.

All plants shall conform to these requirements specified in the plant list. Except that plants larger than specified may be used if approved, but use of such plants shall not increase the contract price. If the use of the larger plant is approved the spread or roots or ball of earth shall be increased in proportion to the size of the plant.

#### **1.1.2 Providing and display of following plant details as per given below.**

All supplied plants shall be developed as directed.

##### **Description of Items**

##### **TREE (Stem height to be considered for height)**

Azadirachta indica having height of 10-12ft straight & sturdy branches big poly bag well developed.

Cassia simia having height of 10-12ft straight & sturdy branches big poly bag well developed.

Chorisia speciosa having height of 10-12ft straight & sturdy branches big poly bag well developed.

Delonix regia having height of 10-12ft straight & sturdy branches big poly bag well developed.

Ficus infectoria having height of 10-12ft straight & sturdy branches big poly bag well developed.

Jacaranda mimosaeifolia having height of 10-12ft straight & sturdy branches big poly bag well developed.

Plumeria alba multi branched in height 6-8ft in gunny bags

Washingtonia filifera (palm) having height of 8-10ft trunk with 60-70 leaves well developed in big container pot bond condition.

### **Shrubs plant**

*Calliandra haematocephala* of height 80-90 cm in big size polybag well developed.

*Cassia biflora* ht of plants 90-100 cm in big size polybag well developed.

*Ficus benjamina* ht of plants 150-180 cm in big size polybag well developed.

*Ficus reginald* topiary single ball topiary well branched (bushy) of height 120-135 cm in big size polybag well developed.

*Hamelia patens* ht of plants 35-45 cm in big size polybag well developed.

*Tecoma capensis* ht of plants 50-60 cm in big size gunny bag well developed.

*Tecoma gaudichaudi* ht of plants 50-60 cm in big size gunny bag well developed.

T.M.C. variegated ht of plants 50-60 cm bushy in big size gunny bag well developed.

### **Ground cover plants**

*Clerodendron inerme* well-developed of height 25- 30 cm in big poly bag. (24 Nos./sqmt)

*Crassula argentea* well-developed of height 30-40 cm in poly bag of size 20 cm. (24 Nos./sqmt)

*Euphorbia milii* well-developed of height 30-45 cm in polybag (24 Nos./sqmt)

*Ficus Panda* well-developed of height 30-40 cm in poly bag of size 20 cm (24 Nos./sqmt)

*Ficus Longisland* well-developed of height 30-40 cm in poly bag of size 20 cm. (24 Nos./sqmt)

*Sansevieria* well-developed of height 30-40 cm in poly bag (24 Nos./sqmt)

Deliver plants with legible identification labels.

#### **1.1.3 TOPSOIL (GOOD EARTH)**

Topsoil or good earth shall be a farmable loam, typical of cultivated topsoils of the locality containing at least 2% of decayed organic matter (humus). It shall be taken from a well-drained arable site. It shall be free of subsoil, stones, earthsckides, sticks roots or other objectionable extraneous matter or debris. It shall contain no toxic materials. No topsoil shall be delivered in a muddy condition.

#### **1.1.4 FERTILISER**

Dry sludge or Cow dung or similar shall be used. Measurement of manure shall be in stacks with 8% reduction for payment. It shall be free from extraneous matter harmful Bacteria, insects or chemicals.

### **1.1.5 ROOT SYSTEM**

The root system shall be conducive to successful transplantation. Where necessary, the root ball shall be preserved by support with hessian or other suitable material. On soils where retention of good ball is not possible, the roots should be suitably protected in some other way which should not cause any damage to roots.

### **1.1.6 CONDITION**

Trees and shrubs shall be substantially free from pests and diseases, and shall be materially undamaged. Torn or lacerated roots shall be pruned before dispatch. No roots shall be subjected to adverse conditions, such as prolonged exposure to drying winds or subjection to water logging, between lifting and delivery.

### **1.1.7 SUPPLY & SUBSTITUTION**

Upon submission of evidence that certain materials including plant materials are not available at time of contract, the contractor shall be permitted to substitute other material and plants with an equitable adjustment of price. All substitutions shall be of the nearest equivalent species and variety to the original specified and shall be subject to the approval of the Landscape Architect.

### **1.1.8 PACKAGING**

Packaging shall be adequate for the protection of the plants and such as to avoid heating or drying out.

### **1.1.9 MARKING**

Such specimen of tree and shrub, or each bundle shall be legibly labelled with the following particulars:

- A. Its name;
- B. The name of the supplier, unless otherwise agreed;
- C. The date of dispatch from the nursery.

## **1.2 Tree Planting & General Shrub Planting**

### **1.2.1 Tree and Shrub**

Trees should be supplied with adequate protection as approved after delivery. If planting is not to be carried out immediately, balled plants should be placed cheek to cheek and the ball covered with sand to prevent drying out. Bare rooted plants can be heeled in by placing the roots in a prepared trench and covering them with earth which should be watered in to avoid air pockets around the roots.

### **1.2.2 DIGGING OF PITS**

Tree pits shall be dug a minimum of three weeks prior to backfilling. The pits shall be 90 X 90 X 120 cm. While digging the pits, the top soil upto a depth of 30 cms may be kept aside if found good (depending upon site condition), and mixed with the rest of the soil.

If the soil is bad below, it shall be replaced with the soil mixture as specified further herein. If the soil is normal it shall be mixed with manure; river sand shall be added to the soil if it is heavy. The bottom of the pit shall be forked to break up the sub soil.

### **1.2.3 BACKFILLING**

The soil is backfilled, watered through and gently pressed down, a day previous to planting to make sure that it may not further settle down after planting. The soil shall be pressed down firmly by treading it down, leaving a shallow depression all round for watering.

### **1.2.4 PLANTING**

No tree pits shall be dug until final tree position has been pegged out for approval.

Care shall be taken that the plant sapling when planted is not buried deeper than in the nursery or in the pot.

Planting should not be carried out in water logged soil.

It is most important to plant trees at the original soil depth; the soil mark on the stem is an indication of this and it should be maintained on the finished level allowing for setting of the soil after planting. All plastic and other imperishable containers should be removed before planting. Any broken or damaged roots should be cut back to sound growth.

The bottom of the planting pit should be covered with 50mm to 75mm of soil. Bare roots should be spread evenly in the planting pit; a small mound in the center of the pit on which the roots are placed will aid an even spread. Soil should be placed around the roots, gently snaking the tree to allow the soil particles to shift into the root system to ensure close contact with all roots and to prevent air pockets. Backfill soil should be firmed as filling proceeds layer by layer care being taken to avoid damaging the roots. Organic material should be applied, according to soil requirements.

### **1.2.5 STACKING**

Newly planted trees must be held firmly although not rigidly by staking to prevent a pocket forming around the stem and newly formed fibrous roots being broken by mechanical pulling as the tree rocks.

Methods :

The main methods of staking shall be:

- a) A single vertical stake 900mm longer than the clear stem of the tree, driven 600mm to 800mm into the soil.



- b) Two stakes as above driven firmly on either side of the tree with a cross-bar to which the stem is attached. Suitable for bare - rooted or balled material.
- c) A single stake driven in at an angle of 45 degrees and leaning towards the prevailing wind, the stem just below the lowest branch being attached to the stake. Suitable for small bare - rooted or balled material.
- d) For plant material 3m to 4.5m high with a single stem a three-wire adjustable guy system may be used in exposed situations.

The end of stake should be pointed and the lower 1m to 1.20m should be coated with a non-injurious wood preservative allowing at least 150mm above ground level.

#### **1.2.6 TYING**

Each tree should be firmly secured to the stake so as to prevent excessive movement. Abrasion must be avoided by using a buffer, rubber or hessian, between the tree and stake. The tree should be secured at a point just below its lowest branch, and also just above ground level; normally two ties should be used for each tree. These should be adjusted or replaced to allow for growth.

#### **1.2.7 WATERING**

The contractor shall allow for the adequate watering in of all newly planted trees and shrubs immediately after planting and he shall during the following growing season, keep the plant material well-watered.

All shrubs which are supplied pot grown shall be well soaked prior to planting.

Watering in and subsequent frequent watering of summer planted container grown plants is essential.

### **1.3 Shrub Planting in Planters and Beds**

All areas to be planted with shrubs shall be trenched to a depth of 600mm. Tall shrubs may need staking; which shall be provided if approved by the Contracting Architect, depending upon the conditions of individual plant specimen. Shrubs and ground cover shrubs in beds and planters. Positions of shrubs to be planted shall be marked out in accordance with the planting plan. Shrubs are set out, precautions should be taken to prevent roots drying. Planting holes 40cm dia and 40cm deep should be excavated for longer shrubs. Polyethene and other non perishable containers should be removed and any badly damaged roots carefully pruned. The shrubs should then be set in holes so that the soil level, after settlement, will be at the original soil mark on the stem of the shrub. The hole should be backfilled to half its depth and firmed by treading. The remainder of the soil can then be returned and again filled by treading.

### **1.4 Grassing**

#### **1.4.1 PREPARATION**

During period prior to planting the ground shall be maintained free from weeds.

Grading and final levelling of the lawn shall be completed at least three weeks prior to the actual sowing. Regular watering shall be continued until sowing by dividing the lawn area into portion of approx. 5mts. square by constructing small bunds to retain water. These 'bunds' shall be levelled just prior to sowing of grass plants. At the time of actual planting of grass, it shall be ensured that the soil has completely settled.

#### **1.4.2 SOIL**

The soil itself shall be ensured to the satisfaction of landscape Architect to be a good, fibrous loam, rich in humus.

#### **1.4.3 SOWING THE GRASS ROOTS**

Grass roots (Cynodon dactylon or a local genus approved by the landscape architect) shall be obtained from a grass patch, seen and approved beforehand.

The grass root stock at site shall be manually cleaned of all weeds and water sprayed over the same after keeping the stock in a place protected from sun and dry wind.

Grass stock received at site may be stored for a maximum of three days. In case grassing for some areas is scheduled for a later date fresh stock of grass roots shall be ordered and obtained.

#### **1.4.4 EXECUTION**

Small roots shall be debbled about 15 cms apart into the prepared grounds. Grass areas will only be accepted as reaching practical completion when germination has proved satisfactory and all weeds have been removed.

#### **1.4.5 MAINTENANCE**

As soon as the grass is approximately an inch high it shall be rolled with a light wooder, roller in fine, dry weather and when it has grown to 2 to 3 inches above the ground, weeds must be removed and regular cutting with the scythe and rolling must be begun. A top dressing of announce of guano to the square yard on well decomposed well broken sludge manure will help on the young grass. The scythe must continue to be used for several months until the grass is sufficiently secure in the ground to bear the mowing machine. It should be possible to use the inch above the normal level for the first two or three cuttings. That is to say the grass should be cut so that it is from 1 to 2 inches in length, instead of the 1/2 to 3/4 of an inch necessary for mature grass.

In the absence of rain the lawn shall be watered every ten days heavily, soaking the soil through to a depth of at least 25 cms.

Damage failure or dying back of grass due to neglect of watering especially for seeding out of normal season shall be the responsibility of the contractor.

Any shrinkage below the specified levels during the contract or defects liability period shall be rectified at the contractor's expense.

The contractor is to exercise care in the use of rotary cultivator and mowing machines to reduce to a minimum the hazards of flying stones and brickbats. All rotary mowing machines are to be fitted with safety guards.

#### **1.4.6 ROLING**

A light roller shall be used periodically, taking care that the lawn is not too wet and sodden.

#### **1.4.7 EDGINGS**

These shall be kept neat and must be cut regularly with the edging shears.

#### **1.4.8 FERTILIZING**

The lawn shall be fed once a month with liquid manure prepared by dissolving 45 grams of ammonia sulphate in 5 litres of water.

#### **1.4.9 WATERING**

Water shall be applied daily during dry weather. Watering whenever done should be thorough and should wet the soil at least up to a depth of 20 cms.

#### **1.4.10 WEEDING**

Prior to regular mowing the contractor shall carefully remove rank and unsightly weeds.

### **1.5 Maintenance**

#### **1.5.1 General**

The contractor shall maintain all planted areas within the landscape contract boundaries until the period of one year after the complete plantation. Maintenance shall include replacement of dead plants. Watering, weeding, cultivating, control of insects, fungicide and other diseases by means of spraying with an approved insecticide or fungicide, pruning and other horticulture operations necessary for the proper growth of the plants and for keeping the landscape sub-contract area neat in appearance.

#### **1.5.2 PRUNING & REPAIRS**

Upon completion of planting work on the landscape sub-contract all trees should be pruned and all injuries repaired where necessary. The amount of pruning shall be limited to the minimum necessary to remove dead or injured twigs and branches and to compensate for the loss of roots and the results of transplanting operations. Pruning shall be done in such a manner as not to change the natural habit or special shape of the trees.

#### **1.5.3 TREE GUARDS**

Where tree guards are necessary, care should be taken to ensure that they do not impede movement or restrict growth.

#### **1.5.4 NURSERY STOCK**

Planting should be carried out as soon as possible after reaching site. Where planting must, of necessity, be delayed, care should be taken to protect the plants from pilfering or damage from people or animals. Plants with bare roots should be heeled in as soon as received or otherwise protected from drying out, and others set closely together and protected from the wind. If planting should be unpacked, the bundles opened up and each group of plants heeled in separately and clearly labelled. If for any reason the surface of the roots becomes dry the roots should be thoroughly soaked before planting.

#### **1.5.5 PROTECTIVE FENCING**

According to local environment shrubs may have to be protected adequately from vandalism until established.

#### **1.5.6 COMPLETION**

On completion the ground should be formed over and left tidy.

**Note:** Refer Landscape Drawing

### **2 SPECIFICATION FOR LANDSCAPING**

(Refer Landscape Drawing):

**2.1 Earth work** in excavation in all types of soils (i.e. soft loose soil / hard dense soil / moorum / gravel etc.) in foundation, trenches or drain in required width dressing of sides and ramming of bottom including strutting, timbering, shoring and getting out the excavated soil and disposal of surplus excavated earth as directed by the Project-in-charge.

**2.2 Back filling** with available excavated earth (excluding rock) in lawns, foundations etc., in layers not exceeding 20 cm in depth, consolidating each deposited layer by watering and ramming including all leads and lifts complete.

#### **2.3 SUB GRADE WORKS**

Preparation of subgrade by excavating earth to an avg. depth of 225 mm. Dressing to camber and consolidation with 8 to 10 tonne roller as required and disposal of surplus earth within the site.

#### **2.4 HARDCORE WORKS**

Providing and laying of WBM of 100mm thick layer with 63-45mm aggregate, spreading to template patching with smaller stone rolling, binding with selected earth and morrum, watering and consolidating with roller Of 8MT.

Providing and laying of WBM of 150mm thick layer with 90-63mm aggregate, spreading to template patching with smaller stone rolling, binding with selected earth and morrum, watering and consolidating with roller Of 8MT.

Providing and laying of soling of 160mm thick layer with 90-63mm aggregate, spreading to template patching with smaller stone rolling, binding with selected earth and morrum, watering and consolidating with roller Of 8MT.

Providing and laying fine Sand including watering, ramming, consolidating and dressing etc. as per the direction of Engineer-in-charge.

## 2.5 CONCRETE WORK (CAST - IN - SITU)

Providing & laying in position **plain cement concrete** of specified grade in raft, bases of column footings, brick wall footing, base of floor, as screed over areas to make up levels or to form slopes, laid to required levels and grade at all locations, consolidated finished fair and cured including side forms as required complete.

Concrete mix 1:4:8 (1 cement : 5 coarse sand: 10 graded stone aggregate 40 mm nominal size)

Providing and laying **damp-proof-course** 40 mm thick with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 12.5 mm nominal size mixed with water proofing compound in cement concrete @ 1 kg per 50 kg of cement.

## 2.6 RCC WORK (CAST - IN - SITU)

Providing and laying in position reinforced cement concrete of specified grade in walls (any thickness) including attached pilasters, buttresses, plinth and string courses, fillets, columns, pillars, piers, abutments, posts, struts, beams, suspended floors, roofs having slopes upto 15° , balconies, shelves, chajjas, lintels, bands, plain window sills, staircases and spiral staircases upto floor five level excluding the cost of centering, shuttering, finishing and reinforcement with 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size).

## 2.7 FORM WORK

Providing erecting shuttering of good quality/ approved sheets in RCC beams, columns, footings, walls etc. including Centering, strutting, propping and bracing, bolting, welding and keeping the same to the lines and levels indicated on the drawings and removing the same as per specifications, drawings including provisions for grooves, drip throats, chamfers, inserts, sleeves, conduits, junction box, recesses, projecting dowels etc. at all levels, heights, depths.

## **2.8 STEEL REINFORCEMENT**

Laying and fixing in position TMT 500d bar reinforcement for RCC insitu & precast work including cost of supplying straightening, cutting, bending and binding with 16 gauge MS annealed binding wire, cement mortar spacer blocks etc. complete as per drawings specifications and as directed by Engineer-in-Charge (For all heights & diameters), .

## **2.9 BRICKWORK**

Providing and Constructing Brick masonry work with common burnt clay F.P.S. (non modular) bricks of class designation 7.5 in foundation and plinth in Cement mortar 1:6 (1 cement : 6 coarse sand)

Providing and constructing Cement block work in foundation and plinth laid in cement mortar 1:6 (1 cement : 6 coarse sand) mix, joints finished, flush/ raked to 6mm depth including scaffolding, curing complete as per specification and drawing or as directed by Project Manager.

## **2.10 LIGHT WEIGHT FILLING**

Providing and laying of Autoclaved aerated concrete blocks as filler on top of slab to the specified height mentioned in drawings.

## **2.11 PLASTERING**

Providing and applying plaster 20mm thick in cement mortar 1:4 (1 cement: 4 coarse sand) in all internal areas of planters complete as per specification and drawing or as directed by Project Manager

## **2.12 WATERPROOF PLASTERING**

Providing and laying waterproofing treatment on Brickwall / RCC by applying cement slurry mixed with - First layer of slurry of cement and acrylic base approved polymer mixed in ratio 1:2 (1 polymer : 2 cement). This layer will be allowed to air cure for four hours. second layer of slurry of cement and acrylic base approved polymer mixed in ratio 1:2 (1 polymer : 2 cement). this layer will be allowed to air cure for four hours followed with water curing for 48 hours.

## **2.13 DRAIN BOARD**

Providing and laying of **HDPE Drain BOARD** 12-15 mm thk with geotextile membrane. Once the waterproofing treatment has been done and protected with screed. Install Prefabricated sheet

drain Gutta Drain V or equivalent having the following specification: Studs Height: 8 mm; Compressive Strength: 23 t/sqm; Flow Rate: 4.6 L/s/m. The Drain Cell to be factory fitted with 110 gsm Polypropylene geotextile or equivalent. The filter fabric is to be bonded to each dimple so as to prevent soil particles from entering the flow channels while allowing water to freely enter the drainage core from one side. The drain boards are to be unrolled on top of the substrate with overlaps of minimum 100mm and with upturns of minimum 200mm on the vertical edges.

## 2.14 Finishes

Supplying and laying **Grass Crete Pavers**, Green honeycomb panels with self anchoring pegs, made of high impact resistant HDPE. Each grass paver should be of 330mm x 330 mm and 35 mm in height consisting of four floral shaped structure of 125mm open cell and nine round cell opening of 45 mm dia. Each of the open cell are connected with a web like structure for strength and stability. Base of the panel is equipped with a slot opening for drainage and four round struts for anchoring purpose. The Grass Paver to have interlock system to lock each other. The Grass Paver should have compressive strength of minimum 100 tons/sqmt capable to take the load of the fire tender. The panel should have high level of porosity greater than 90%, porous for Grass, shrubs and low planters. Laying to be done on 50 mm sand bed over well compacted sub base/WBM as per manufacturer specifications and directions of Engineer in charge

Providing and fixing of 300x150 x 300 mm Concrete Kerb including setting in cement mortar 1:4 with coarse sand and pointing of joints with same mortars, etc. complete.

Providing and fixing of 900(L)x300(D)x255(H)mm Granite Flush Kerb including setting in cement mortar 1:4 with coarse sand and pointing of joints with same mortars, etc. complete.

Providing and fixing of 600(L)x300(D)x255(H)mm M30 Concrete Upstand Kerb 100mm including setting in cement mortar 1:4 with coarse sand and pointing of joints with same mortars, etc. complete.

Providing and fixing stainless steel edging of 6 mm thick fixed to the concrete hunching/Base work with the help of necessary screws where required; complete as per manufacturer /vendor's detail and as per detail drawings, approved sample all complete and as directed by the Architect/ Engineer-in- Charge.

Providing and laying of 18-20mm thick Shot blasted & leather finish Granite of approved shade in flooring as per Sample with groove filled with matching epoxy grout laid over cement mortar 30mm thick as per drawings.

Providing and fixing 40 mm thick (two stones to be used) Prepolished GRANITE of approved quality on COPING / SEATs with cement mortar 1:3 ( 1 cement : 3 coarse sand) with approved design and pattern, jointed with white cement slurry mixed with pigment to match the shade of the stone including making the moulding and edge polishing as per design and drawing.

Providing and fixing 20 mm thick Flamed GRANITE of approved quality on CLADDING with cement mortar 1:3 ( 1 cement : 3 coarse sand) with approved design and pattern, jointed with white cement slurry mixed with pigment to match the shade of the stone including necessary holdfasts, clamps and pins etc. as per requirement as per design and drawing.

Providing and laying Tactile tile (for vision impaired persons as per standards) of size 300x300x9.8mm having with water absorption less than 0.5% and conforming to IS: 15622 of approved make in all colours and shades in for outdoor floors such as footpath, court yard, multi modal location etc., laid on 20mm thick base of cement mortar 1:4 (1 cement : 4 coarse sand) in all shapes & patterns including grouting the joints with white cement mixed with matching pigments etc. complete.

Providing and laying Precast interlocking GREY concrete paving blocks of approved quality, shade, shape and colour as per design and to be laid over stone soling or PCC with fine sand as a sub-base or as per manufacture's specification complete: (60 mm thick.)

## **2.15 WATER FEATURES WORKS**

**The scope of work under this RFQ broadly covers, but not limited to following;**

1. Preparing shop drawings and obtaining approval from our consultant on detailed engineering, working on alternatives, value addition options.
2. Procuring and sourcing materials, supplying, installing system as approved by our consultants, installing, testing, commissioning and running the system under trial runs for specified duration and finally handing over fully functional system complied with design intent, after de-snagging.
3. Co-ordination of your installations work with that of other agencies, resolving the conflicts of clashing of services, and your services with civil/ finishing works.
4. The scope also includes training the facility maintenance team for operating the system, conducting the objective test at the end of training.
5. Making “As built Drawings”, obtaining approval on same from consultants, handing over operating, maintenance manuals, list of essential spares, original guarantees/ warranties and insurance covers etc, to owners.

**Salient features of the system are as follows;**

1. Water velocity of 1.5m/s is recommended for pipe sizes.
2. Final intended fountain effect is indicated against each type. Vendor is expected to propose suitable Nozzles, diffusers, nozzers, furnishing manufacturer's catalogues clearly indicating makes, model Nos., and performance details.
3. Puddle flanges in hot deep galvanized MS for inlet, outlet, drains, and makeup water are mandatory across the concrete / masonry basins.
4. PVC piping should be used everywhere except areas specified otherwise. In those selected areas GI pipe shall be used.



5. Some fountains have expansion joint running across them. The jointing materials should be primarily water tight and shall be able to take lateral movement. It shall be a flexible connection, which should be able to withstand 10kg/cm<sup>2</sup> working pressure.
6. Bidders are expected to design and select the appropriate pumps and filters, with respect to flow rates, maximum operating heads, and suction and discharge conditions. The selection criterion and pumps curves shall be enclosed along with the offers.
7. The circulating pumps of approved vendors.
8. All nozzle heads shall be Gun-metal or bronze unless otherwise specified.
9. Electrical control panels shall be in close proximity to the fountains as per drawing.
10. Water supply is by water pump from water tanks on basement, the tapping is left at one point at podium level as indicated in the drawings attached.
11. Pipes shall be laid inside the waterproofing & treatment with half round cement pipe covered on top for protection.

**Please note following while preparing and submitting your Offer;**

1. Circuits and valves to be decided by vendor as per detailed engineering design and development. The schematics and single line drawings shall be submitted along with the offer, now. The shop drawings shall be prepared and submitted based on these drawings after the award of contract.
2. On award of work, contractor shall furnish shop drawings covering detailed layouts, pipe routing, technical data sheets, single line diagram, schematics layouts, performance ratings, control diagrams, etc.
3. Connections to pumps, motors, etc. from sub panels or isolators and from main panels to sub panels/isolators shall be done by contractor. Main panel shall be energized by contractor.
4. Pipe routing shall need coordination with other agencies, approval from consultant prior to ordering of materials.
5. Layouts are issued with tender. The contractors' may use these for development of your proposal and submit it in hard and soft copy (CD) while submitting the offer.
6. Confirmation about adequacy of water head available at site for safe operating of the system proposed by vendor.

**Waterbody finishes**

Providing and laying 5mm thick Mosaic Glass Tiles as per approved Make/Sample, in floor and walls of Water Features with 20 mm thick epoxy mortar 1:4(1 cement: 4 coarse sand) mixed with water proofing compound as per manufacturer direction including jointing with epoxy grout to match the approved shade of tiles, grouting and rubbing wherever required complete as directed.

Providing and laying of 40mm thick Pre-polished **Granite of approved shade** in Coping as per Sample with groove filled with matching epoxy grout laid over cement mortar 30mm thick as per drawings.

Providing and laying of 25mm thick Flamed **Granite of approved shade** in cladding as per Sample with groove filled with matching epoxy grout laid over cement mortar 30mm thick as per drawings.

## **2.16 MISCELLANEOUS WORKS**

Steel forging, reducing to required shape, size and figure, drilling, tapping, counter sinking for screws, filling etc. and satisfactory workmanship required to fabricate, finish, erect and fix in position, all structural steel and iron in a good and perfect manner.

Providing all bolts and nuts including holding down and anchor bolts, round, squared or tapered washers, anchor plates, rivets, packing pieces, gusset plates, cleats, wedges, brackets, separators etc.

Providing all spikes, nails, service bolts, clamps, jigs etc.

Making all necessary templates, patterns moulds and platforms for layout etc.

All smithy work, unloading, getting in, hoisting, erecting and fixing in position at all heights, levels and locations, curve portion.

Rigidly inserting and setting in lead or other specified material and fixing into concrete and/ or building into brick work while the work proceeds and for all fixing, anchoring, plugging, screwing, bolting etc. including non shrink grout and sealants as may be required or directed.

Painting two top coat of red oxide / Zinc Chromate primer before hoisting and erecting in position.

The priming coat is required to be of high grade loosing approved quality of Red Oxide /Zinc Chromate primer to provide a coating having a good rust preventive property and shall adhere well to the metal surfaces, affording a good foundation for subsequent coats.

Bending to required shape of square bars, pipes, angles, plates etc as per drawing.  
Compliance with requirements of technical specification.

### **Railing**

Providing and fixing stainless steel railing made of Hollow tubes, channels, plates etc. including welding, grinding, buffing, polishing and making curvature (wherever required) and fitting the same with necessary stainless steel nuts and bolts complete i/c fixing the railing with necessary accessories & stainless steel dash fasteners , stainless steel bolts etc., of required size, on the top of the floor or the side of waist slab with suitable arrangement as per approval of Engineer-in-charge.

### **Geotextile & Weep holes pipe**

Providing and laying 200 gsm geotextile made of 100% virgin polypropylenon woven and mechanically strengthened by needle punching process and thermofusion. The geotextile should

have puncture resistance 2.57 KN. Tensile Strength 15.6 KN/m, Elongation 55%, Permeability 34x10<sup>-3</sup> m/s. The geotextile to be overlapped by 200mm at joints over the drainage layer complete.

Providing and constructing of Weep Holes by fixing of Geotextile wrapped perforated 63mm/ 6Kgf Dia pipe as per drawings and details.

Supplying and fixing of bollards are made from **Stainless Steel 304** and treated with an anti-graffiti coating.

Function: Asset Protection, Height: 32 in, Body Diameter: 4 in, Base Diameter: 4 in Weight: 17lbs

Material: 304 Stainless

Supplying and fixing of **S.S. Dustbins** with swing covers 2' high, 1'6" dia at locations shown on drawings.

Supplying and fixing of **S.S. Benches** of sizes as shown on drawings.

## **2.17 IRRIGATION WORKS**

### **A. The scope of work broadly covers, but not limited to following;**

- ☐ Preparing shop drawings and obtaining approval from our consultant on detailed engineering, working on alternatives, value addition options.
- ☐ Procuring and sourcing materials, supplying, installing system as approved installing, testing, commissioning and running the system under trial runs for specified duration and finally handing over fully functional system complied with design intent, after de-snagging.
- ☐ Co-ordination of installations work with that of other agencies, resolving the conflicts of clashing of services.
- ☐ The scope also includes training the facility maintenance team for operating the system, conducting the objective test at the end of training.
- ☐ Making “As built Drawings”, obtaining approval on same from consultants, handing over operating, maintenance manuals, list of essential spares, original guarantees/ warranties and insurance covers etc., to owners.

### **B. Salient features of the system are as follows;**

Vendor is expected to propose suitable pipes, drippers, sprinklers, valves etc. furnishing manufacturer's catalogues clearly indicating makes, model Nos., and performance details.

- ☐ UPVC piping should be used everywhere except areas specified otherwise. In those selected areas GI pipe shall be used.

- ☐ Pipes will be laid inside the brick coba/ light weight fill with half round cement pipe covered on top for protection.

**C. Please note following while preparing and submitting your Offer;**

- ☐ Circuits and valves to be decided by vendor as per detailed engineering design and development. The schematics and single line drawings shall be submitted along with the offer, now. The shop drawings shall be prepared and submitted based on these drawings after the award of contract.

On award of work, contractor shall furnish shop drawings covering detailed layouts, pipe routing, technical data sheets, single line diagram, schematics layouts, performance ratings, control diagrams, etc.

- ☐ Connections to pumps, motors, etc. from sub panels or isolators and from main panels to sub panels/isolators shall be done by contractor. Main panel shall also be energized by contractor.
- ☐ Pipe routing shall need coordination with other agencies, approval from consultant prior to ordering of materials.
- ☐ There shall be a ring main pipe running all along the boundary wall as approved by the consultant.
- ☐ The irrigation plan shall be schematic. Adjustments to spray head, etc. layout pattern shall be made in the field according to final layout of turf and ground cover/ shrub areas and location of trees while maintaining head and drip line spacing.
- ☐ No spray heads shall be located within the fire access lanes. Heads shall be located along edge of fire access lane to provide coverage of turf block areas.

All planting areas, including turf and turf block areas, shall maintain full irrigation coverage.

- ☐ Irrigation as-built record drawings shall be prepared in accordance with specifications showing accurate location of all irrigation components.
- ☐ Confirmation about adequacy of water head available at site for safe operating of the system proposed by vendor.

## **2.18 LIGHTING**

### **Landscape Lighting Fixtures specifications;**

**Street light** Supply of Road star road lighting luminaire is dark-sky compliant using unique, sealed optics with vibration resistant design, offering better light control and uniformity with upto 8 times spacing between poles and maintenance free operation.

High energy savings

Type Roadstar Light source LED Color 4000K Lamp wattage (LED) range 40W-180W System power range 45W-204W,

Nominal voltage 220V-240V, 50Hz,

Driver Integral type,  
CRI 70 Mounting (OD) 60mm,

Protection IP 66, Class I (7.0 m Height pole)

**Post top lantern** Supply of led post top lantern lighting luminaire. Having good light distribution, limited upward light component that avoids light pollution, this luminaire is an affordable landscape lighting solution. Features

High energy savings

Specifications Type BGP151 Light source LED,

Lumen output 1900lm (WW), 2000lm (NW),

Light color Warm White (3000K),

Power consumption 30W, Driver Integral type

Nominal voltage 220-240V, 50 Hz

Optics Closed diffuser CRI 70

Mounting (OD) 60mm,

Weight 7.5Kg.

Protection IP 65, Class I (4.0 m Hight pole)

### **Flood light**

Supply of LED based Architectural Flood light, housing made up of Compact die-cast aluminium with powder-coated finish and tampered lens. The fixture should have a minimum system efficacy of 83 lumen/Watt and a minimum system lumen output of 5656 lumens and maximum system wattage of 68 Watts. The fixture shall have a CRI of minimum 80, CCT of 3000K and 20/40 degree beam angle. The fixture shall be designed for a system life of 50,000 hours @70% lumen maintenance. Ingress Protection of IP66 (lamp and gear Compartment) and Mechanical Impact

Resistance Rating of IK 09. The fixture driver should have an operating voltage range of 140-270 V, PF >0.9 and THD<20%. The fixture should comply with the parameters as per IS10322. LM 79 and LM80 reports need to be submitted from a NABL/UL accredited lab to verify above parameters. Vaya Flood MP, 3000K

**TECHNICAL SPECIFICATIONS**

**GREEN BUILDING PRACTICE**

**SECTION – 9**

## **1.0 CONDITIONS OF CONTRACT SPECIFIC TO GREEN BUILDING PRACTICES**

The contractor shall strictly adhere to the following conditions as part of his contractual obligations as the project is targeted to get GRIHA certification as specified:

### **1.1 SITE**

The contractor shall ensure that adequate measures are taken for the prevention of erosion of the top soil during the construction phase. The contractor shall provide and implement the Erosion and Sedimentation Control Plan (ESCP) and get it approved by the Engineer-In-Charge as part of the larger Construction Management Plan (CMP). The contractor shall obtain the Erosion and Sedimentation Control Plan (ESCP) Guidelines as approved by the Engineer-In-Charge and then prepare "working plan" for the following month's activities as a CAD drawing showing the construction management, staging & ESCP. At no time soil should be allowed to erode away from the site and sediments should be trapped where necessary.

The contractor shall ensure that all the top soil excavated during construction works is neatly stacked and is not mixed with other excavated earth. The contractors shall take the clearance of the Engineer-In-Charge before any excavation. Top soil should be stripped to a depth of approximately 15 cm/20 cm (centimeters) from the areas to be disturbed, for areas i.e. buildings, roads, paved areas, external services and area required for construction activities etc. It shall be stockpiled within the campus area only to a maximum height of 40 cm in designated areas, covered or stabilized with temporary seeding for erosion prevention. The excavation, loading, unloading, stacking and cartage shall be paid separately. This stockpiled soil in the end shall be reapplied to site during plantation of the vegetation. The excavation, loading, unloading and filling including cartage shall again be paid separately Top soil shall be separated from subsoil, debris and stones larger than 50 mm (millimeter) diameter.

The contractor shall carry out the recommendations of the soil test report for improving the soil under the guidance of the Engineer-In- Charge who would also advise on the timing of application of fertilizers and warn about excessive nutrient levels.

The contractor shall carry out post-construction placement of topsoil or other suitable plant material over disturbed lands to provide suitable soil medium for vegetative growth. Prior to spreading the topsoil, the sub-grade shall be loosened to a depth of 50mm to permit bonding. Topsoil shall be spread uniformly at a minimum compacted depth of 50 mm on grade 1:3 or steeper slopes, a minimum depth of 100 mm on shallower slopes. A depth of 300 mm is preferred on relatively flatter land. The Contractor should follow the construction plan as approved by Engineer-In-Charge to minimize the site disturbance such as soil pollution due to spilling. Use staging and spill prevention and control plan to restrict the spilling of the contaminating material on site. Protect top soil from erosion by collection storage and reapplication of top soil, constructing sediment basin, contour trenching, mulching etc. The barricading by sheets of the construction area shall be done as per direction of Engineer-In Charge to the required height and perimeter.



The contractor shall not change the natural gradient of the ground unless specifically instructed by the Engineer-In-Charge. This shall cover all natural features like water bodies, drainage gullies, slopes, mounds, depressions, rocky outcrops, etc. Existing drainage patterns through or into any preservation area shall not be modified unless specifically directed by the Engineer -In-Charge. The contractor shall not carry out any work which results in the blockage of natural drainage.

The contractor shall ensure that existing grades of soil shall be maintained around existing vegetation and lowering or raising the levels around the vegetation is not allowed unless specifically directed by the Engineer-In-Charge.

Contractor shall reduce pollution and land development impacts from automobiles use during construction.

Overloading of trucks is unlawful and creates and erosion and sedimentation problems, especially when loose materials like stone dust, excavated earth, sand etc. are moved. Proper covering must take place. No overloading shall be permitted.

## **1.2 CONSTRUCTION PHASE AND WORKER FACILITIES**

The contractor shall specify and limit construction activity in pre-planned/designated areas and shall start construction work after securing the approval for the same from the Engineer-In-Charge. This shall include areas of construction, storage of materials, and material and personnel movement. Preserve and Protect Landscape during Construction. The contractor shall ensure that no trees, existing or otherwise, shall be harmed and damage to roots should be prevented during trenching, placing backfill, driving or parking heavy equipment, dumping of trash, oil, paint, and other materials detrimental to plant health. These activities should be restricted to the areas outside of the canopy of the tree, or, from a safe distance from the tree/plant by means of barricading. Trees will not be used for support; their trunks shall not be damaged by cutting and carving or by nailing posters, advertisements or other material. Lighting of fires or carrying out heat or gas emitting construction activity within the ground, covered by canopy of the tree is not to be permitted.

The contractor shall take steps to protect trees or saplings identified for preservation within the construction site have to be protected using tree guards as per Engineer-In-Charge. The contractor shall conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity. Contractor should limit all construction activity within the specified area as per the Construction Management Plan (CMP) approved by the Engineer-In-Charge.

The contractor shall avoid cut and fill in the root zones, through delineating and fencing the drip line (the spread limit of a canopy projected on the ground) of all the trees or group of trees. Separate the zones of movement of heavy equipment, parking, or excessive foot traffic from the fenced plant protection zones.

Maintenance activities shall be performed as needed to ensure that the vegetation remains healthy. The preserved vegetated area shall be inspected by the Engineer-In-Charge at regular intervals so that they remain undisturbed.

The date of inspection, type of maintenance or restorative action followed shall be recorded in the logbook. Contractor shall be required to develop and implement a waste management plan, quantifying material diversion goals. He shall establish goals for diversion from disposal in landfills and incinerators and adopt a construction waste management plan to achieve these goals. A project-wide policy of "Nothing leaves the Site" should be followed. In such a case when strictly followed, care would automatically be taken in ordering and timing of materials such that excess doesn't become "waste". The Contractor's ingenuity is especially called towards meeting GRIHA requirement. Consider recycling cardboard, metal, brick, acoustical tile, concrete, plastic, clean wood, glass, gypsum wallboard, carpet and insulation. Designate a specific area(s) on the construction site for segregated or collection of recyclable material, and track recycling efforts throughout the construction process. Identify construction haulers and recyclers to handle the designated materials. Note that diversion may include donation of materials to charitable organizations and salvage of materials onsite.

Contractor shall collect all construction waste generated on site. Segregate these wastes based on their utility and examine means of sending such waste to manufacturing units which use them as raw material or other site which require it for specific purpose. Typical construction debris could be broken bricks, steel bars, broken tiles, spilled concrete and mortar etc.

The contractor shall comply with the safety procedures, norms and guidelines (as applicable) as outlined in the document Part 7. Constructional practices and safety, 2005, National Building code of India, Bureau of Indian Standards which has safety measures for different construction activities.

The contractor shall provide clean drinking water for all workers

The contractor shall provide the minimum level of sanitation and safety facilities for the workers at site. The contractor shall ensure cleanliness of workplace with regard to the disposal of waste and effluent; provide clean drinking water and latrines and urinals as per applicable standard. Adequate toilet facilities shall be provided for the workman within easy access of their place of work. The total no. to be provided shall not be less than 1 per 30 employs in any one shift. Toilet facilities shall be provided from the start of building operations, connection to a sewer shall be made as soon as practicable. Every toilet shall be so constructed that the occupant is sheltered from view and protected from the weather and falling objects. Toilet facilities shall be maintained in a sanitary condition. A sufficient quantity of disinfectant shall be provided. Natural or artificial illumination shall be provided.

The contractor shall ensure that air pollution due to dust/generators is kept to a minimum, preventing any adverse effects on the workers and other people in and around the site. The contractor shall ensure proper screening, covering stockpiles, covering brick and loads of dusty

materials, wheel washing facility, gravel pit, and water spraying. Contractor shall ensure the following activities to prevent air pollution during construction:

Clear vegetation only from areas where work will start right away.

Vegetate / mulch areas where vehicles do not ply.

Apply gravel / landscaping rock to the areas where mulching / paving is impractical.

Identify roads on-site that would be used for vehicular traffic. Upgrade vehicular roads (if these are unpaved) by increasing the surface strength by improving particle size, shape and mineral types that make up the surface & base. Add surface gravel to reduce source of dust emission. Limit amount of fine particles (smaller than 0.075mm) to 10 - 20%

Water spray, through a simple hose for small projects, to keep dust under control. Fine mists should be used to control fine particulate. However, this should be done with care so as not to waste water. Heavy watering can also create mud, which when tracked onto paved public roadways, must be promptly removed. Also, there must be an adequate supply of clean water nearby to ensure that spray nozzles don't get plugged. Water spraying can be done on:

Any dusty materials before transferring, loading and unloading Area where demolition work is being carried out

Any un-paved main haul road

Areas where excavation or earth moving activities are to be carried out

The contractor shall ensure that the speed of vehicles within the site is limited to 10km/hr.

All material storages should be adequately covered and contained so that they are not exposed to situations where winds on site could lead to dust / particulate emissions.

Spills of dirt or dusty materials will be cleaned up promptly so the spilled material does not become a source of fugitive dust and also to prevent of seepage of pollutant laden water into the ground aquifers. When cleaning up the spill, ensure that the clean-up process does not generate additional dust. Similarly, spilled concrete slurries or liquid wastes should be contained / cleaned up immediately before they can infiltrate into the soil / ground or runoff in nearby areas

Provide hoardings of not less than 3m high along the site boundary, next to a road or other public area

Provide dust screens, sheeting or netting to scaffold along the perimeter of the building

Cover stockpiles of dusty material with impervious sheeting

Cover dusty load on vehicles by impervious sheeting before they leave the site

- 1.3 Contractor shall be required to provide an easily accessible area that serves the entire building and is dedicated to the separation, collection and storage of materials for recycling including (at a minimum) paper, corrugated cardboard, glass, plastics, and metals. He shall coordinate the size and functionality of the recycling areas with the anticipated collections services for glass, plastic, office paper, newspaper, cardboard and organic wastes to maximize the effectiveness of the dedicated areas. Consider employing cardboard balers, aluminum can crushers, recycling chutes, and collection bins at individual workstations to further enhance the recycling program
- 1.4 The contractor shall ensure that no construction leach ate (Ex: cement slurry), is allowed to percolate into the ground. Adequate precautions are to be taken to safeguard against this including, reduction of wasteful curing processes, collection, basic filtering and reuse. The contractor shall follow requisite measures for collecting drainage water run-off from construction areas and material storage sites and diverting water flow away from such polluted areas. Temporary drainage channels, perimeter dike/swale, etc. shall be constructed to carry the pollutant-laden water directly to the treatment device or facility (municipal sewer line).
- 1.5 Staging (dividing a construction area into two or more areas to minimize the area of soil that will be exposed at any given time) should be done to separate undisturbed land from land disturbed by construction activity and material storage.
- 1.6 Comply with the safety procedures, norms and guidelines (as applicable) as outlined in the document Part 7 Constructional practices and safety, 2005, National Building code of India, Bureau of Indian Standards. A copy of all pertinent regulations and notices concerning accidents, injury and first-aid shall be prominently exhibited at the work site. Depending upon the scope & nature of work, a person qualified in first-aid shall be available at work site to render and direct first-aid to casualties. A telephone may be provided to first- aid assistant with telephone numbers of the hospitals displayed. Complete reports of all accidents and action taken thereon shall be forwarded to the competent authorities.

Adopt additional best practices, prescribed norms as in Doc No. CED 46(6086), July 2003: Draft

National Building Code of India: Part 7 Constructional practices and safety, issued by Bureau of Indian Standards

- 1.7 The storage of material shall be as per standard good practices as specified in Part 7, Section 2 - Storage, Stacking and Handling practices, NBC 2005 and shall be to the satisfaction of the Engineer-In-Charge to ensure minimum wastage and to prevent any misuse, damage, inconvenience or accident. Watch and ward of the Contractor's materials shall be his own responsibility. There should be a proper planning of the layout for stacking and storage of different materials, components and equipments with proper access and proper maneuverability of the vehicles carrying the materials.

While planning the layout, the requirements of various materials, components and equipments at different stages of construction shall be considered. The Owner shall not take any responsibility on any account.

- 1.8** The contractor shall ensure the following activities for construction workers safety, among other measures:

Guarding all parts of dangerous machinery.

Precautionary signs for working on machinery

Maintaining hoists and lifts, lifting machines, chains, ropes, and other lifting tackles in good condition.

Durable and reusable formwork systems to replace timber formwork and ensure that formwork where used is properly maintained.

Ensuring that walking surfaces or boards at height are of sound construction and are provided with safety rails or belts.

Provide protective equipment; helmets etc.

Provide measures to prevent fires. Fire extinguishers and buckets of sand to be provided in the fire-prone area and elsewhere.

Provide sufficient and suitable light for working during night time.

- 1.9** The contractor shall provide for adequate number of garbage bins around the construction site and the workers facilities and will be responsible for the proper utilization of these bins for any solid waste generated during the construction. The contractor shall ensure that the site and the workers facilities are kept litter free. Separate bins should be provided for plastic, glass, metal, biological and paper waste and labelled in both Hindi and English.
- 1.10** The contractor shall prepare and submit 'Spill prevention and control plans' before the start of construction, clearly stating measures to stop the source of the spill, to contain the spill, to dispose the contaminated material and hazardous wastes, and stating designation of personnel trained to prevent and control spills. Hazardous wastes include pesticides, paints, cleaners, and petroleum products.
- 1.11** Contractor shall collect the relevant material certificates for materials with high recycled (both postindustrial and post-consumer) content.

- 1.12** Contractor shall collect the relevant material certificates for rapidly renewable materials such as bamboo, wool, cotton insulation, agri-fiber, linoleum, wheat board, strawboard and cork.
- 1.13** Contractor shall adopt an IAQ (Indoor Air Quality) management plan to protect the HVAC system during construction, control pollutant sources, and interrupt pathways for contamination. He shall sequence installation of materials to avoid contamination of absorptive materials such as insulation, carpeting, ceiling tile, and gypsum wallboard. He shall also protect stored on-site or installed absorptive materials from moisture damage. Testing charges for ascertaining air quality or noise pollution shall be paid by the department.
- 1.14** The contractor shall ensure that a flush out of all internal spaces is conducted prior to handover. This shall comprise an opening of all doors and windows for 14 days to vent out any toxic fumes due to paints, varnishes, polishes, etc.
- 1.15** Contractor shall make efforts to reduce the quantity of indoor air contaminants that are odorous or potentially irritating harmful to the comfort and well-being of installer and building occupants.

Contractor shall ensure that the VOC (Volatile Organic Compounds) content of paints, coatings and primers used must not exceed the VOC content limits mentioned below: Paints

Non-flat- 150 g/L

Flat (Mat) - 50 g/L

Anti corrosive/ anti rust - 250 g/L

Coatings / Clear wood finishes

Varnish - 350 g/L

Lacquer - 550 g/L

Floor coatings -100 g/L

Stains - 250 g/L

Sealers

Waterproofing sealer - 250 g/L

Sanding sealer - 275 g/L

Other sealers - 200 g/L

The VOC (Volatile Organic Compounds) content of adhesives and sealants used must be less than

VOC content limits mentioned:

Architectural Applications VOC Limit(g/l less water)

Indoor Carpet adhesives - 50

Pad Adhesives - 50

Wood Flooring Adhesive -100

Floor Adhesives - 60

Sub Floor Adhesives - 50

Ceramic Tile Adhesives - 65

VCT and Asphalt Tile adhesives - 50

Dry Wall and Panel Adhesives - 50  
Structural Glazing Adhesives - 100  
Multipurpose Construction Adhesives - 70

Substrate Specific Application VOC Limit (g/l less water)Metal to Metal - 30  
Plastic Foams - 50  
Porous material (except wood) - 50  
Wood - 30  
Fiber Glass – 80

**1.16** Wherever required, Contractor shall meet and carry out documentation of all activities on site, supplementation of information, and submittals in accordance with GRIHA program standards and guidelines. Towards meeting the aforementioned building environmental rating standard(s) expert assistance shall be provided to him up on request.

**1.17** Contractor shall provide quantities, manufacturers data, O&M manuals, and Certificates required from manufacturer in accordance with GRIHA program requirement for all equipments and materials.

**1.18** Water Use during Construction

Contractor should spray curing water on concrete structure and shall not allow free flow of water. After liberal curing on the first day, all the concrete structures should be painted with curing chemical to save water which shall be paid separately. Areas on which the curing compound is to be used shall be decided by Engineer -In-Charge (as on some areas water may also be used for curing). Concrete structures should be kept covered with thick cloth/gunny bags and water should be sprayed on them. Contractor shall do water ponding on all sunken slabs using cement and sand mortar.

**1.19** The Contractor shall remove from site all rubbish and debris generated by the Works and keep Works clean and tidy throughout the Contract Period. All the serviceable and non-serviceable (malba) material shall be segregated and stored separately. The malba obtained during construction shall be collected in well-formed heaps at properly selected places, keeping in a view safe condition for workmen in the area. Materials which are likely to cause dust nuisance or undue environmental pollution in any other way, shall be removed from the site at the earliest in the campus elsewhere or within the campus and till then they shall be suitable covered. Glass & steel should be dumped or buried separately to prevent injury. The work of removal of debris should be carried out during day. In case of poor visibility artificial light may be provided.

Debris shall be disposed in the campus within a lead of 2 kms. by digging a well and properly covering the same with soil.

**1.20 MATERIALS & FIXTURES FOR THE PROJECT**

- 1.20.1 All materials sourced specifically for construction at this project, shall be strictly sourced from a distance of 800 km radius from the project site. Contractor shall collect the relevant material certificates to prove the same :-

Any material that is to be sourced from outside the prescribed radius shall be done after securing the necessary approval from the Engineer-In-Charge.

All cement used at site for reinforced concrete, precast members, mortar, plaster, building blocks, etc shall be PPC (Portland Pozzolana Cement). The PPC must meet the requirements of IS 1489: 1991.

As a measure to reduce wastage and water consumption during construction, the contractor shall source or set up the infrastructure for a batch mix concrete.

The contractor has to comply as per MoEF issued notification 8.0.763(E) dated 14th Sept. 1999 containing directive for greater fly ash utilization, where it stipulates. The contractor shall ensure that all paints, polishes, adhesives and sealants used both internally and externally, on any surface, shall be Low VOC products. The contractor shall get prior approval from Engineer-In-Charge before the application of any such material.

All plumbing and sanitary fixtures installed shall be as per the prescription of the Engineer-In-Charge and shall adhere to the minimum LPM and LPF mentioned.

The contractor shall employ 100% zero ODP (ozone depletion potential) insulation; HCFC (hydro-chlorofluorocarbon)/ and CFC (chlorofluorocarbon) free HVAC and refrigeration equipments and/halon-free fire suppression and fire extinguishing systems.

The contractor shall ensure that all composite wood products/agro-fibre products used for cabinet work, etc do not contain any added urea formaldehyde resin.

## **1.21 RESOURCES CONSUMED DURING CONSTRUCTION**

The contractor shall ensure that the least amount of water and electricity is wasted during construction. The Engineer-In-Charge can bring to the attention any such wastage and the contractor will have to ensure that such bad practices are corrected.

The contractor shall install necessary meters and measuring devices to record the consumption of water, electricity and diesel on a monthly basis for the entire tenure of the project.

The contractor shall ensure that all run-off water from the site, during construction is collected and reused to the maximum.

The contractor shall use treated recycled water of appropriate quality standards for construction, if available.



No lights shall be turned on during the period between 6:00 AM to 6:00 PM, without the permission of the Engineer-In-Charge.

The contractor is encouraged to use bio-diesel in place of petroleum diesel for the running of generators during construction.

## **1.22 CONSTRUCTION WASTE**

Contractor shall ensure that wastage of construction material is kept to a maximum of 3%.

All construction debris generated during construction shall be carefully segregated and stored in a demarcated waste yard. Clear, identifiable areas shall be provided for each waste type. Employ measures to segregate the waste on site into inert, chemical, or hazardous wastes.

All construction debris shall be used for road preparation, back filling, etc, as per the instructions of Engineer-In-Charge, with necessary activities of sorting, crushing, etc. and surplus shall be disposed of in a well after digging a well for this purpose and suitably covered with soil within the 2 kms. lead in the campus. No construction debris shall be taken away from the site, without the prior approval of the Engineer-In-Charge.

The contractor shall recycle the unused chemical/hazardous wastes such as oil, paint, batteries, and asbestos.

If and when construction debris is taken out of the site, after prior permissions from the Engineer-In-Charge, then the contractor shall ensure the safe disposal of all wastes and will only dispose of any such construction waste in approved dumping sites.

Inert waste to be disposed-off by Municipal Corporation/ local bodies at landfill sites.

The facility for cleaning the tyres of trucks/ dumpers carting the material shall be provided at the entry points and sedimentation trap shall be made.

## **1.23 Documentation**

The contractor shall, during the entire tenure of the construction phase, submit the following records to the Engineer-In-Charge on a monthly basis:

Water consumption in litres

Electricity consumption in 'KWH' units

Diesel consumption in litres

Quantum of waste generated at site and the segregated waste types divided into inert, chemical and hazardous wastes,

Digital photo documentation to demonstrate compliance of safety guidelines as specified here and in the Appendix on Safety Conditions.

The contractor shall, during the entire tenure of the construction phase, submit the following records to the Engineer-In-Charge on a weekly basis:

Quantities of material brought into the site, including the material issued to the contractor by the client,

Quantities of construction debris (if at all) taken out of the site,

Digital photographs of the works at site, the workers facilities, the waste and other material storage yards, pre-fabrication and block making works, etc as guided by the Engineer-In-Charge

The contractor shall submit one document after construction of the buildings, a brief description along with photographic records to show that other areas have not been disrupted during construction. The document should also include brief explanation and photographic records to show erosion and sedimentation control measures adopted. (Document CAD drawing showing site plan details of existing vegetation, existing buildings, existing slopes and site drainage pattern, staging and spill prevention measures, erosion and sedimentation control measures and measures adopted for or top soil preservation during construction

The contractor shall submit to the Engineer-In-Charge after construction of the buildings, detailed as-built quantification of the following:

Total materials used,

Total top soil stacked and total reused

Total earth excavated,

Total waste generated,

Total waste reused,

Total water used,

Total electricity, and

Total diesel consumed.

The contractor shall submit to the Engineer-In-Charge, As built drawings after construction of the buildings as detailed.

The contractor shall submit to the Engineer-In-Charge, before the start of construction, a site plan along with a narrative to demarcate areas on site from which top soil has to be gathered, designate area where it will be stored, measures adopted for top soil preservation and indicate areas where it will be reapplied after construction is complete.

The contractor shall submit to the Project Manager, a detailed narrative (not more than 250 words) on provision for safe drinking water and sanitation facility for construction workers and site personnel.

Provide supporting document from the manufacturer of the cement specifying the fly-ash content in PPC used in reinforced concrete/ in other works.

Provide supporting document from the manufacturer of the pre-cast building blocks specifying the fly ash content of the blocks used in an infill wall system.

The contractor shall, at the end of construction of the buildings, submit to the Engineer-In-Charge , submit following information, for all material brought to site for construction purposes, including manufacturer's certifications, verifying information, and test data, where Specifications sections require data relating to environmental issues including but not limited to:

Source of products: Supplier details and location of the supplier.

Project Recyclability: Submit information to assist Owner and Contractor in recycling materials involved in shipping, handling, and delivery, and for temporary materials necessary for installation of products.

Recycled Content: Submit information regarding product post industrial recycled and post consumer recycled content. Use the "Recycled Content Certification Form", to be provided by the Commissioning Authority appointed for the Project.

Product Recyclability: Submit information regarding product and product's component's recyclability including potential sources accepting recyclable materials,

Provide certification for all wood products provided by a Forest Stewardship Council (FSC- or equivalent organization) accredited certifier.

Provide final certification of well-managed forest of origin to provide final documentation of certified sustainably harvested status: Acceptable wood "certified sustainably harvested" certifications shall include:

Wood suppliers' certificate issued by one of the Forest Stewardship Council accredited certifying agencies;

Suppliers' invoice detailing the quantities of certified wood products for project;

Letter from one of a certifying agency corroborating that the products on the wood supplier's invoice originate from certified well-managed forests.

Clean tech: Provide pollution clearance certificates from all manufacturers of materials

Indoor Air quality and Environmental Issues: Submit emission test data, sourced from the manufacturers, produced by acceptable testing laboratory listed in Quality Assurance Article for materials as required in each specific Specification section.

Certifications from manufacturers of Low VOC paints, adhesives, sealant and polishes used at this particular project site.

Certification from manufacturers of composite wood products/agro fibre products on the absence of added urea formaldehyde resin in the products supplied to them to this particular site.

Submit environmental and pollution clearance certificates for all diesel generators installed as part of this project.

Provide total support to the Engineer-In-Charge in completing all Green Building

Rating related formalities, including signing of forms, providing signed letters in the contractor's letterhead.

## **1.24 EQUIPMENT**

To ensure energy efficiency during and post construction all pumps, motors and engines used during construction or installed, shall be subject to approval and as per the specifications.

All lighting installed by the contractor around the site and at the labour quarters during construction shall be CFL bulbs of the appropriate illumination levels. This condition is a must, unless specifically prescribed. The contractor is expected to go through all other conditions of the GRIHA rating stipulations. Failure to adhere to any of the above mentioned items, without necessary clearances from the Engineer-In-Charge, shall be deemed as a violation of contract and the contractor shall be held liable for penalty as determined by the Engineer-In-Charge.

**TECHNICAL SPECIFICATION**

**ELECTRICAL SERVICES**

**Section 10**

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**SUB HEAD – 1****ELECTRICAL GENERAL PROVISIONS****Work Description**

The scope of works for all electrical works and system comprises of design, engineering, supply, delivery, installation, testing and commissioning, handover, training, maintenance and warranty all as described or reasonably implied in the Contract. The Contractor is obliged to provide fully functioning works and systems in conformance with the requirements of the Contract and approved design and development documents prepared by the contractor.

In the event certain items are not fully described or indicated in the Contract, but deemed essential by the contractor for the performance of the works and systems then the provision of such items shall form part of the Contractors scope of works.

The drawings and documents from Engineer-in-charge shall be used as guidance for the contractor in producing his detail design and shop drawings for carrying out works at site.

The Contractor shall be responsible to co-ordinate the equipment and services and shall produce properly coordinated shop drawings to demonstrate the installation comply with the performance requirement with shop drawings, calculations and details. The Engineer-in-charge shall monitor the process of shop drawings and document preparation.

Shop drawings shall take into account actual measurement and setting out dimensions/levels obtained and determined by the Contractor on site, actual equipment / material used, actual routing of services, co-ordination with all installation, and site conditions/constraints.

Please consider latest all relevant code/ standard for each equipment in their respective head of Technical specification.

The electrical Installation work shall be carried out in accordance with Indian Standard Code of Practice. It shall also be in conformity with the current Indian Electricity rules and regulations and requirements of the Local Electricity Supply Authority and Fire Insurance regulations, so far as these become applicable to the installation. Electrical work in general shall be carried out as per following CPWD General Specifications amended upto date:-

Part-I - Internal Work - 2013.

Part-IV - Substation Work- 2013.

Part-VII - DG Set Work - 2013.

Wherever these specifications calls for a higher standard of material and or workmanship than those required by any of the above mentions regulations and specification then the specification here under shall take precedence over the said regulations and standards.

The details of scope of work subhead wise are given in the subsequent phrase.



The Contractor should note that the specifications furnished general nature only and it is the responsibility of the Contractor to design, supply, install and commission the equipment and services required for the satisfactory performance of the installation. All the items of equipment required for the safe and satisfactory operation of the installation shall be supplied and installed by the Contractor Scope of Work:

The electrical services scope of works for the re-development includes the following:

1. Incoming HV supply feeder from SEB intake point
2. HV meter room, HV Switchgear, Transformers and LV Switchgear, Main Power Distribution
3. 100% Standby Power Generating System
4. UPS for emergency lighting with 30 minutes battery back-up.
5. Lighting.
6. Lighting for car parks and electrical, mechanical rooms
7. Lightning Protection System
8. Earthing and T-N-S grounding system
9. Solar Power System
10. External Lighting Installation
11. Life safety and emergency evacuation system
12. Fire detection & Alarm system.
13. Public Address system
14. Integrated Building Management System
15. Metering.
16. Elevators & Escalators
17. Integrated Passenger Information Display & Announcement System
18. Low Voltage Services – CCTV, Data Networking/LAN/WIFI Points, EPABX, Access Control
19. Stack Parking & Parking Management System
20. Security Systems
21. Conduiting works for all LV systems as shown in the drawings.

#### **Common Services:**

Liaison with Client & Local Authority to obtain and coordinate provision of incoming electricity supply of 11 KV.

Complete central earthing systems for all electrical equipment and systems.

#### **Internal Services:**

Complete LT distribution system including main LT switchboard, automatic power factor correction devices, sub-boards and distribution boards, UPS and associated distribution main and sub-main cabling and associated accessories.

Complete lighting and power installation including all final circuiting work and associated accessories.

Normal and emergency lighting supply and installation and associated accessories.

Complete earthing system.

Complete lightning protection system and associated accessories.

Complete telephone cabling system and associated accessories.

Complete Data Networking Cabling System and all associated accessories.

Complete wiring work to external/landscape and public area architectural/special lighting system.

Complete internal cable system and outlets for Telephone and MATV system and associate works.

Complete wiring and installation for complete Security systems

Complete wiring and installation for CCTV systems

Complete wiring, installation and integration of IBMS system

Miscellaneous works like providing and fixing of rubber mats, fire buckets, first aid box, fire extinguishers, etc.

All associated interfacing power supply work to other mechanical installations.

Fire Alarm & Voice evacuation & talk back System

Voltage drop, transformer losses, power factor and other parameter shall be as per ASHRAE 90, ECBC, NBC and GRIHA-3 star requirement. Light Power Density shall be furnished through energy simulation carried out for GRIHA rating.

All MEP equipment shall be controlled and monitored through BMS like Chiller, Cooling Towers, DG Sets, HSD tanks, Plumbing and Fire Fighting Equipments, level indicators etc. as detailed under IBMS technical specifications.

All associated interfacing works with other M&E installations.

Other works as shown on the Drawings and described elsewhere in the Contract documents.

All equipment shall be of the class most suitable for working under the conditions specified and shall withstand the atmospheric conditions without deterioration.

Contractor shall co-ordinate with all other agencies working at site for interconnection and safety aspects.

Contractor will follow strictly makes approved for Electrical work. No other discipline makes will be applicable for Electrical work

Also the Contractor shall furnish combined guarantee minimum for 1 year from the date of successful commissioning from the manufacturer. In case there is any defect, the free replacement of any part or in whole will be made immediately.

Electrical panels of other services like HVAC, PHE and FF shall be included in the scope of contractor.

Any item make not mentioned. The Contractor gets approval from Engineer-in-charge before procurement

**Fee, Permits & Tests:**

The contractor shall obtain all sanctions and permits required for the above said works from all the relevant authorities. On completion of the work, the Contractor shall obtain N.O.C from concerned authorities including, Chief Electrical Inspectorate of State. The original of the same shall be delivered to the Engineer-in-charge.

The Engineer-in-charge shall have full power regarding the equipments/ materials get tested by authorized/ recognized independent agency at the contractor's expense in order to prove their soundness and adequacy. The contractor will rectify the defects/ suggestions pointed out by independent agency through Engineer-in-charge at contractor's expense.

The installation shall comply in all respects with the requirements of Indian Electricity Act 1910, Indian Electricity Rules (IER) 1956 and other related Laws and Regulations (for F.F. etc.) as amended up to date, there under and special requirements, if any, of the State Electricity Boards etc. The contractor shall be liable to furnish the list of authorized licensed persons/ employed/ deputed to carry out the works/ perform the assigned duties to fulfill the requirement of Rule No.3 of IER 1956 as amended up to date.

**Codes & Standards:**

The design, manufacture, inspection, testing and performance shall comply with all the currently applicable statutes, safety codes, relevant Bureau of Indian Standards (BIS), British Standards (BS), International Electro Technical Commission (IEC) publication, NEMA & VDE Standards amended up to date.

The design, engineering, manufacturing and the installation shall be in accordance with established codes, sound engineering, practices and specifications. Further, the same shall conform to the statutory regulations applicable in the country. Contractor shall obtain all approvals from statutory authorities, e.g. electrical inspector, SEB or any other agency as applicable before commissioning of electrical system if required.

Some of the relevant Indian and British Standards are listed below.

Indian Electricity Act.

Indian Electricity Rules.

Factory Act.

Energy Conservation Building Code (ECBC)-2017

1-CEA-2010

NBC-2016

NEC-2010

BS-7671

State regulation

Any other standard may be followed provided it is equivalent or more stringent than the standards specified above.

In case of any deviation/conflict with the codes & standards, the following order of precedence shall govern

Recommended Design guidelines of consultant

International standards & requirements.

Local codes of practice

Approved design development documents

**Design:**

The Contractor shall be fully responsible for the complete design of all works for the Contract, including all temporary works.

It is the responsibility of the Contractor to ensure that his design does not compromise the design intents of the consultant's approved design development documents, all authorities compliances and approvals.

The design and workmanship shall be in accordance with the best engineering practices, to ensure satisfactory performance and service life. The equipment offered by the contractor shall be complete in all respects.

Any materials or accessories, which may not have been specifically mentioned, but which are usual and necessary for the completion of the system and satisfactory & trouble free operation and maintenance of the equipment shall be provided. This shall also include spares for commissioning of the equipment.

This specification defines the basic guidelines to develop a suitable electrical system as necessary for the Complex. All data required in this regard shall be taken in to consideration to develop a detailed engineering for the system. Site conditions as applicable are mentioned elsewhere.

Contractor shall be responsible for:

- Detailed co-ordination with other services, shop drawings for various electrical layouts such as Power layout, Lighting layout, Relay coordination for LV, MV system on ETAP. Electrical Detailed single line Diagram, All Technical Calculation to support design of electric system, Lighting Lux Level Calculation on DIALUX, equipment layout, cabling layouts, lightning protection layouts, earthing layouts including equipment installation and cable termination details etc. prior to start of work.
- Preparation of bill of materials for electrical works.
- Protection co-ordination drawings/ tables for complete power system.

- Shop inspection and testing procedures.
- Field-testing and commissioning procedures.
- Preparation of as built drawings.

Contractor shall also be responsible for:

Any other work/activity which is not listed above however is necessary for completeness of electrical system.

**Date of Commencement and Completion Period:**

The contractor shall be allowed admittance to the site on the date of commencement as described in the General Conditions and he shall there upon and forthwith begin the works and shall regularly proceed with and complete the same on or before the date of completion subject, nevertheless to the provisions for the extension of time. The time being the essence of the contract, the Contractor will adhere to the time, progress chart and project schedule and will give proportional output/progress in proportional time.

**Schedule and Manner of Operations:**

Time being the essence of this Contract, the Contractor will be expected to furnish all labor and materials in sufficient quantities and at appropriate times, expedite and schedule the work as required and so manage the operation that the work will be completed within the time stated in the Contract.

**Design Conditions:**

Design ambient temperature for outdoor equipments 50 Deg C & 40 Deg C for indoor equipments. Summer 50 Deg C & Winter 0 Deg C

**Coordination of Work**

Contract documents establish scope, materials and quality but are not detailed installation instruction.

Coordinate work with related trades and furnish, in writing, any information necessary to permit the work of related trades to be installed satisfactorily and with the least possible conflict or delay.

The drawings show the general arrangement of equipment and appurtenances. Follow these drawings as closely as the actual construction and the work of other divisions will permit. Provide off-sets, fittings, and accessories which may be required but not shown on the drawings. Investigate the site, and review drawings of other divisions to determine conditions affecting the work, and provide such work and accessories as may be required to accommodate such conditions.

The locations of thermostats, switches, panels and other equipment indicated on the drawings are approximately correct. Exercise particular caution with reference to the location of panels, thermostats, switches, etc., and have the precise and definite locations accepted by the Engineer before proceeding with the installation.

The drawings show only the general run of services and approximate location of equipment, outlets, panels, etc. Any significant changes in location of equipment, outlets, panels, etc., necessary in order to meet field conditions shall be brought to the determine attention of the Engineer-in-charge for review before such alterations are made. Modifications shall be made accordingly.

Carefully check space requirements with other division works to ensure that equipment can be installed in the space allotted.

Wherever work interconnects with work amongst different installation, coordinate with other trades to ensure that they have the information necessary so that the Contractor may properly install the necessary connections and equipment. Identify items requiring access in order that the Ceiling Trade will know where to install access doors and panels.

Furnish and set sleeves for passage of risers through structural masonry and concrete walls and floors and elsewhere as required for the proper protection of each riser passing through building surfaces.

Provide fire stopping around all pipes, conduits, ducts, sleeves, etc, which pass through fire compartments.

Provide required supports and hangers for equipment suitably so as not to exceed allowable loading of structures.

Wherever the work is of sufficient complexity, prepare additional detail drawings to scale to coordinate the work with the work of other trades. Detailed work shall be clearly identified on the drawings as to the area to which it applies. Submit these drawings to the Engineer for review. At completion include a set of these drawings with each set of record drawings.

Coordinate with the local utility companies/authorities for their requirements for service connections and provide all necessary provisions, grounding, materials, equipment, labor, testing, and appurtenances.

Before commencing works, examine adjoining works on which this work is in any way affected and report conditions which prevent performance of the works. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.

The Contractor is responsible to any modifications required due to service not properly coordinated.

### **Electrical Power Supply Interfaces**

The Contractor shall provide power supply points/isolators at certain designated locations within the development for all mechanical and electrical installations. It is the responsibility of the Contractor to coordinate and make connections to these power supply points/isolators and to provide all the necessary 'down-stream' power supply distribution board/network to the mechanical system's control panels, equipment, sensors, field devices, etc.

### **Interfacing With All Services and Systems**

The Contractor shall provide all necessary provisions for interfacing amongst installation, services, and equipment. All necessary sensors, current/voltage transformers, voltage-free contacts, relays, auxiliary contacts, terminals, transducers etc. for interfacing works shall be provided by the Contractor.

All control/monitoring wiring from sensors, equipment, and components for the interfacing shall be terminated at a separate interfacing compartment located at the respective equipment/system's switchboard or control panel. The interfacing compartment shall be completed with all necessary connectors, terminals, and with proper identifications to allow interfacing works to be easily carried out. The compartment shall clearly indicate "Extra Low Voltage Cable Only. No Power Cable Connection". Where there is no equipment/system switchboard or control panel involved, the Contractor shall provide separate interfacing panels with provisions same as the interfacing compartment as described above. The locations of the switchboard/control panels and the interfacing panels shall be properly coordinated.

For every control panel and each module of the switchboard, at least five (5) spare terminals shall be provided for future interfacing works.

Wiring and cables for interfacing with the fire alarm system and other fire protection and life safety systems shall be fire rated to comply with Civil Defense's requirements.

All the interface provisions shall be DC operated and rated not more than 50 mA.

The Contractor shall provide and make all power cable connections from mechanical equipment, local control panels, and distribution boards to the electrical isolators or power points (including cable termination) provided. Location of power supply isolators and power points shall be properly coordinated.

In addition to the interfacing requirements shown on the Drawings, interfacing provisions as described below shall also be provided and included in the Contract.

### **Electrical Installation**

The Electrical Installation shall provide the following:

Isolators and power points (fused spur units) for all mechanical equipment and systems. Where shown on the Drawings, the Electrical installation shall include direct power cable connections to the mechanical system's main motor control centers.

Earthing terminal in the Fire Command Centre and all other plant rooms for supplementary equip-potential bonding of mechanical equipment and systems.

### **Examination of Site**

Prior to the submitting of bids, visit the project site and become familiar with all conditions affecting the proposed installation and make provisions.

The Contract Documents do not make representations regarding the character or extent of the sub-soils, water levels, existing structural, mechanical and electrical installations, above or below ground, or other sub-surface conditions which may be encountered during the work, based on examination of the site or other information. Failure to examine the drawings or other information does not relieve the Contractor of responsibility for satisfactorily completion of the work.

### **Excavation and Backfill**

Wherever required provide trenches details, duly approved by the Engineer-in-charge with all relevant section etc. as per IS codes, minimum before 1 month of laying the pipes, etc. Co ordinate with during the excavation, and ensure that the excavation and backfilling is being properly done as per requirement.

Where-ever it is asked by the Engineer-in-charge for providing trenches in Contractor's scope. It is deemed that the cost of the pipe is inclusive of trench digging and backfilling. The following points needs to be taken care of while making the trenches.

The trench shall be of widths necessary for the proper execution of the work. Grade bottom of the trenches accurately to provide uniform bearing and support the work on undisturbed soil at every point along its entire length. Except where rock is encountered, do not excavate below the depths indicated. Where rock excavations are required, excavate rock to a minimum over depth of four inches below the trench depths indicated on the drawings or required. Backfill over depths in the rock excavation and unauthorized over depths with loose, granular, moist earth, thoroughly machine tamped to a compaction level of at least 95% to standard proctor density or 75% relative density or as specified by the Engineer. Wherever unstable soil that is incapable of properly supporting the work is encountered in the bottom of the trench, remove soil to a depth required and backfill the trench to the proper grade with coarse sand, fine gravel or other suitable material.

Excavate trenches for utilities that will provide the following minimum depths of cover from existing grade or from indicated finished grade as required by local authorities.

Trenches should not be placed within 3 meters of foundation or soil surfaces which must be resist horizontal forces.

Do not backfill until all required tests have been performed and installation observed by the Engineer.

Comply with the requirements of other sections of the specifications.

Backfill shall consist of non-expansive soil with limited porosity. Deposit in 15 cm layers and thoroughly and carefully tamp until the work has a cover of not less than 30 cm. Backfill and tamp remainder of trench at 30 cm intervals until complete. Uniformly grade the finished surface.

### **Cutting and Patching**

All kinds of cutting and repairing of brick Walls or Partitions, etc. for the proper routing of pipe, cutting and repairing of RCC wall, or ceiling shall be in the scope of the contractor.

Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finish plaster, woodwork, metalwork, etc., using skilled trade people of the trades required at no additional cost to the Contract.

Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations.

### **Sealing of Penetrations**



**Air Tight Seals**

All penetrations through the building fabric subject to suction or pressurization shall be sealed airtight.

**Holes in Roof**

Roof penetrations for passage of conduits or circular PVC and PVC Cables shall be sealed watertight using a flexible polypropylene conical sleeve manufacturer to seal the cable to the roof structure, regardless of the roof profile.

All sharp metal edges, which may come in contact with the cable, shall be suitably bushed.

**Fire Rated Penetrations**

Where services penetrate any fire rated barrier, the Contractor shall seal the penetration with the use of an appropriate material to ensure the integrity of the fire barrier.

The Contractor shall seal the cable enclosures through fire rated barriers to ensure the integrity and rating of the fire barrier.

**Acoustic Penetrations**

Where services penetrate acoustic barriers, sealant shall be supplied and installed to maintain the acoustic separation at least equal to the barrier penetration.

**Mounting Heights**

Verify exact locations and mounting heights with the Engineer before installation.

**Supports**

Support work in accordance with the best industry practice. Provide supports, hangers, auxiliary structural members and supplemental hardware required for support of the work.

Provide supporting frames or racks extending from floor slab to ceiling slab for work indicated as being supported from walls where the walls are incapable of supporting the weight. In particular, provide such frames or racks in electric closets and equipment room.

Provide supporting frames or racks for equipment which is installed in a free standing position.

Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members, rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workman like arrangement of all equipment mounted on them.

Adequate support of equipment (including outlet, pull and junction boxes and fittings) shall not depend on ducts, pipe, electric conduits, raceways, or cables for support.

Equipment shall not rest on or depend for support on suspended ceiling media (tiles, lath, plaster, as well as splinters, runners, bars and the like in the plane of the ceiling). Provide independent support of equipment. Do not attach to supports provided for ductwork, piping or work of other trades.

Provide required supports and hangers for equipment so that loading will not exceed allowable loading of structure. Equipment and supports shall not come in contact with work of other trades.

Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall suitably weld or clamped to building steel. Provide threaded rods or bolts to attach to bridging members. For items which are shown as being ceiling mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.

Wall mounted equipment may be directly secured to wall by means of steel bolts. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars.

### **Identification**

Identify equipment with permanently attached black phenolic nameplates with 13 mm high white engraved lettering. Identification shall include equipment name or load served as appropriate. Nameplates shall be attached with cadmium plated screws; peel and stick tape or glue on type nameplates is unacceptable. Services runs shall be properly identified as per the requirements in the Contract. See individual section for additional identification requirements.

### **Prohibited Labels and Identifications**

In all public areas, tenant areas, and similar locations within the project, the inclusion or installation of any equipment or assembly which bears on any surface any name, trademark, or other insignia which is intended to identify the manufacturer, the vendor or other source(s) from which such object has been obtained is prohibited.

Required test lab certification labels shall neither be removed nor shall identification specifically required under the various technical sections of the Specifications be removed.

### **Equipment Pads and Anchor Bolts**

Provide all details with proper sections for the equipment pads and anchor. The equipment pads casting and making provision for anchor fastening shall be as per the final UNALTERED drawing duly approved by the Engineer-in-charge, shall be in the scope of contractor.

All equipment pads for all vibrating equipments shall have cork vibration pads sandwiched between the finish surface and the bottom surface of required thickness suggested by the contractor to ensure that the minimum vibration can travel below.

Provide galvanized anchor bolts for all equipment placed on concrete equipment pads, inertia blocks, or on concrete slabs. Provide bolts of the size and number recommended by the manufacturer of the equipment and locate by means of suitable templates. Equipment installed on vibration isolators shall be secured to the isolator. Secure the isolator to the floor, pad, or support as recommended by the vibration isolation manufacturer.

Where equipment is mounted on gypsum board partitions, the mounting screws shall pass through the gypsum board and securely attach to the partition studs. As an attached to 15 cm square, galvanized metal

back plates which are attached to the gypsum board with an approved non-flammable adhesive. Toggle bolts installed in gypsum board partitions are not acceptable.

**Miscellaneous:**

A site order book will be maintained at site, which will be in the custody of the Engineer-in-charge, or his representative and all instructions given to the contractor will be recorded in the site order book and the same has to be signed by the contractor to comply with the instructions given therein.

After completion of the work the whole installation shall be tested by the contractor. The tests shall comply the following I.E.E. Regulations and shall be submitted along with the final bill:

The result of the insulation test shall comply with the I.E.E. Regulations 1101 to 1108A and 1008B as may be applicable.

Test shall be carried out to ascertain that all the non-linked SP switches have been connected to the phase conductor.

The continuity test of the earthing system shall comply with I.E.E. Regulations 1108 to 1109 to the latest addition.

If the result of the above tests does not comply with the I.E.E. Regulations, the contractor shall be bound to rectify the faults so that the required results are obtained.

The contractor shall be responsible to provide all the necessary test certificates of testing instruments, such as megger insulation tester, earth tester multi-meter, AVO meter etc for carrying out the above tests.

The work will not be considered as complete and taken over by the Engineer-in-charge till all the components of the work after being completed at site in all respects have been inspected/ tested by the Engineer-in-charge to his entire satisfaction and a completion certificate issued by the Engineer-in-charge to this effect.

Shop drawing for electrical work e.g. equipment, cable earthing and conduit layout for all systems shall be prepared by the Contractor and got approved before starting of the work.

At the completion of the work and before issuance of certificate of virtual completion, the contractor shall submit 6 sets of drawing and two tracing of each drawing to Engineer-in-charge of each layout drawings drawn as approved.

**Contractor's Superintendence:**

The Contractor shall provide all necessary superintendence during the execution of the works and as long as there is necessity. The Contractor or his competent and authorized agent or representative approved of in writing by the Engineer-in-charge (which approval may at any time be withdrawn) is to be constantly on the works and shall give his whole time to the superintendence of the same. Such authorized agent or

representative shall receive on behalf of the Contractor, directions and instructions from the Engineer-in-charge or his representative.

The Contractor shall provide detailed organization of the execution team deployed for the works with names and CV's, of all key staff before the commencement of work and get it approved of in writing by the Engineer-in-charge. Contact telephone or mobile numbers for emergency and/or twenty-four (24) hour call shall also be included.

If in any case of withdrawal of any worker/ technician/ Engineer from the execution team, the replacement of the same shall be done with equivalent qualification, and shall be approved in writing by the Engineer-in-charge.

## **PRODUCT, TESTING & COMMISSIONING**

### **Design Criteria**

#### **LT Power Distribution System:**

Voltage	: 415 V
Frequency	: 50 Hz
Neutral	: Grounded

Short Circuit Fault withstand capacity: 10kA to 65kA for 1Sec., as per calculations

#### **Control supply for Electrical System:**

The various supply voltage to be used in the control panels for the main equipment shall be as under:

Spring charge motor	:	230V, AC or 110V DC (Universal Motor)
Closing/ Trip Coil	:	110V, DC
Alarm/ Indication/ Relays	:	110V, DC
Heaters	:	230V, AC

#### **Painting of Panels:**

Powder coating of approved shade as per Specification. (Refer clause of painting)

#### **Cable Details:**

LT Control Cables: Copper conductor XLPE insulated armoured /FRLS-PVC inner and outer sheath, 1.1 KV grade.

LT Power Cables: Aluminium conductor XLPE insulated armoured /FRLS-PVC inner and out sheath , 1.1 KV grade.

#### **Drawings**

The Tender drawings are enclosed along with this specification. These drawings are meant to give general idea to the contractor regarding the nature of work covered by these specifications. Any information/data shown/not shown in these drawings shall not relieve the contractor of his responsibility to carry out the work as per the specifications. Additional information required by the bidder for successfully completing the work shall be obtained by him.

### **Shop Drawings**

The contractor shall prepare detailed coordinated electrical shop drawing indicating Panel layout, with other relevant services. The shop drawings shall indicate all setting out details and physical dimensions of all components with wiring and cable details including system operating write up in the system i.e. Control and Relay Panel and fixing details for the above mentioned work. All work shall be carried out on the approval of these drawings. However, approval of these drawings do not relieve the Contractor of his responsibility for providing maintenance free and full proof system including any missing component/accessories to meet with the intent of the specifications. Contractor will submit 2 (two) prints for preliminary approval and finally 6 (six) prints for distribution.

### **Manufacturer's Instructions**

Where manufacturers have furnished specific instructions, relating to the material/equipments to be used on this job, covering points not specifically mentioned in this document, manufacturer's instructions should be followed.

### **Completion Documents and Drawings**

Three copies of operation manuals/catalogues of all standard equipment are to be furnished by the Contractor immediately after commissioning of plant.

Three copies of write up on preventive maintenance, trouble shooting and operating instructions of the system along with as-built drawings are to be supplied by the Contractor at the time of commissioning.

On completion of the work in all respects, the Contractor shall supply five portfolios (300x450 mm), each containing complete set of drawings on approved scale, clearly indicating complete layouts, location; wiring and sequencing of automatic controls, location of all concealed wiring and other services. Each portfolio shall also contain consolidated control diagrams and technical literature on all controls. The Contractor shall frame under glass, in the Panel rooms, one set of these consolidated control diagrams.

### **Materials and Equipment**

All the materials and equipments shall be of the approved make and design. Unless otherwise called from Engineer-in-charge, only the best quality materials and equipment shall be used.

### **Space Heaters:**

Suitable number of adequately rated heaters thermostatically controlled with On-Off switch and fuse shall be provided to prevent condensation in any panel compartment. The heaters shall be installed in the lower portion of the compartment and electrical connections shall be made from below the heaters to minimize

deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

**Fungi static Varnish:**

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts, which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

**Ventilation Opening:**

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

**Degree of Protection:**

The enclosures of the control cabinet, junction boxes and marshalling boxes, panels etc to be installed shall provide degree of protection as detailed here under.

- |                      |   |                          |
|----------------------|---|--------------------------|
| 1. Installed Outdoor | : | IP-55 with weather proof |
| 2. Installed indoor  | : | IP-42                    |

The degree of protection shall be in accordance with IS:13947 (Part-I) IEC-947 (Part-I). Type test report for degree of protection test, on each type of the box shall be submitted for approval.

**Rating plates, Name plates and Labels:**

LT panel and auxiliary items installed in the building is to permanently attach to it in a conspicuous position. A rating plate of non-corrosive material with engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of loading conditions of equipment in question has been designed to operate and such diagram plates as may require by the Engineer-in-charge. The rating plate of each equipment shall be in accordance with IEC requirement.

All such nameplates, instruction plates, rating plates shall be bilingual with Hindi inscription first followed by English. Alternatively, two separate plates on with Hindi and another with English inscriptions may be provided.

**Quality Assurance Program:**

To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Contractor's works or at the Engineer-in-charge's site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance program to control such activities at all points necessary. Such program shall be outlined by the Contractor and shall be finally accepted by the Engineer-in-charge after discussions before the award of Contract. A quality

assurance program of the Contractor shall generally cover the following: His organization structure for the management and implementation of the proposed quality assurance program.

Documentation control system.

Qualification data for bidder's key personnel.

The procedure for purchases of materials, parts components and selection of services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.

System for shop manufacturing and site erection controls including process controls and fabrication and assembly control.

Control of non-conforming items and system for corrective actions.

Inspection and test procedure both for manufacture and field activities.

Control of calibration and testing of measuring instruments and field activities.

System for indication and appraisal of inspection status.

System for authorizing release of manufactured product to the Engineer-in-charge.

System for maintenance of records.

System for handling storage and delivery.

The Engineer-in-charge or his duly authorized representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor / his Vendor's quality management and control activities.

### **Quality Assurance Documents**

The Contractor shall be required to submit the following Quality Assurance Documents within three weeks after dispatch of the equipment.

All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication and reports including radiography interpretation reports. Welder and welding operator qualification certificates. Welder's identification list, listing welders and welding operator's qualification procedure and welding identification symbols. Raw material test reports on components as specified by the specification and / or agreed to in the quality plan. Stress relief time temperature charts/oil impregnation time temperature charts. Factory test results for testing required as per applicable codes/mutually agreed quality plan/standards referred in the technical specification. The quality plan with verification of various customer inspection points (CIP) as mutually and methods used to verify the inspection and testing points in the quality plan were performed satisfactory.

### **Inspection, Testing and Inspection Certificates**

The Engineer-in-charge or duly authorized representative shall have at all reasonable times free access to the Contractor's premises or works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection, if part of the works is being manufactured or assembled at other premises or works, The Contractor shall obtain permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. Inspection may be made at any stage of manufacture, dispatch or at site at the option of the Engineer-in-charge and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

All equipment being supplied shall conform to type tests and shall be subject to routine tests in accordance with requirements stipulated under respective sections. Bidder shall submit the type tests reports for approval. The Contractor shall intimate the Engineer-in-charge the detailed programme about the tests at least three (3) weeks in advance in case of domestic supplies. If for any item type test were pending payment would be made on successful completion of type/routine test(s) actually carried out as per Engineer-in-charge instructions.

The Contractor shall give the Engineer-in-charge thirty (30) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account. The Engineer-in-charge unless witnessing of the tests is virtually waived will attend such tests within thirty (30) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed with the test which shall be deemed to have been made in the presence of Engineer-in-charge.

The Engineer-in-charge within fifteen (15) days from the date of inspection as defined shall inform in writing to the Contractor of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and make the necessary modifications accordingly.

When the factory tests have been completed at the Contractor's works, the Engineer-in-charge shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Engineer-in-charge the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Engineer-in-charge. Failure of the issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificate shall not bind the Engineer-in-charge to accept the equipment should, it, on further tests after erection, is found not to comply with the Specification. The equipment shall be dispatched to site only after approval of test reports and issuance of material inspection clearance certificate by the Engineer-in-charge. For tests whether at the premises or at the works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labor, materials, electricity, fuel, water, stores, apparatus and instruments as may be required by Engineer-in-charge or this authorized representative to carry out effectively such tests of the equipment in accordance with the Specification.

The inspection by Engineer-in-charge and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance program forming a part of the Contract.

The Engineer-in-charge will have the right of having at his own expenses any other tests(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests to satisfy that the material comply with the specifications.



The Engineer-in-charge reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipments for these tests shall be provided by the Contractor.

## **Tests**

### **Charging (Pre-commissioning tests):**

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Engineer-in-charge and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The pre-commissioning tests to be performed as per relevant I.S. / vendor/ bidder submittal and as included in the Contractor's quality assurance program.

### **Commissioning Tests:**

The available instrumentation and control equipment will be used during such tests and the Contractor will calibrate all such measuring equipment and devices as far as practicable. However, immeasurable parameters shall be taken into account in a reasonable manner by the Contractor for the requirement of these tests. The tests will be conducted at the specified load points and as near the specified cycle condition as practicable. The Contractor will apply proper corrections in calculation, to take into account conditions which do not correspond to the specified conditions.

All instruments, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost. Pre-commissioning test shall be carried out as per relevant IS and/or as specified in the relevant clause. The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning of the equipment. However necessary fee shall be reimburse by Engineer-in-charge on production of requisite documents.

## **Packaging**

All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of availability of Railway wagon/truck/trailer sizes in India should be taken account of the Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Engineer-in-charge takes no responsibility of the availability of any special packaging/transporting arrangement.

## **Protection**

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

## **Finishing of Metal Surfaces**

All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts and bolts and spring washers shall be electro galvanize. All steel conductors used for earthing/grounding (above ground level) shall be galvanized according to IS: 2629.

**Painting:**

All sheet steel work shall be degreased, pickled, and phosphated in accordance with the IS-6005 “Code of practice for Phosphate iron and sheet”. All surfaces, which will not be easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swab shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

After Phosphate process thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stowing type zinc chromate primer. The first coat may be “flashing dried” while the second coat shall be stoved.

Powder coating/electrostatic painting of approved shade shall be applied. The exterior color of the paint shall be as per quantity of finishing paint shall be supplied IS-5 or as approved by Engineer-in-charge. A small for minor touching up required at site after installation of the equipments, if required.

In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures like electrostatic painting etc. the procedure shall be submitted along with the Bids for Engineer-in-charge’s review and approval.

**Handling, Storage and Installation**

In accordance with the specific installation instructions as shown on manufacturer’s drawings or as directed by the Engineer-in-charge or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level plumb, square and properly aligned and oriented.

Contractor shall follow the site procedure for transporting of materials, unloading, and safe storage. The equipments after collection from store shall be erected, tested and commissioned as per contract specification, manufacturer guidelines and Engineer-in-charge instruction.

In case of any doubt/misunderstanding as to the correct interpretation of manufacturer’s drawings or instructions, necessary clarifications shall be obtained from the Engineer-in-charge. Contractor shall be held responsible for any damage to the equipment consequent for not following manufacturer’s drawings/instructions correctly.

Where assemblies are supplied in more than the one section, Contractor shall make all necessary connections between sections. All components shall be protected against damage during unloading,

transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.

The Contractor shall submit to the Engineer-in-charge every week, a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharf age and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

The Contractor shall be fully responsible for the equipment/material until the same is handed-over to the Engineer-in-charge in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by Engineer-in-charge, as well as protection of the same against theft, element of nature, corrosion, damages etc.

The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment, which require indoor storage.

The words 'erection' and 'installation' used in the specification are synonymous.

Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.

The minimum phase to earth, phase to phase and section clearance along with other technical parameters for the various voltage levels shall be maintained as per relevant IS.

### **Protective Guards**

Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards with necessary spares and accessories shall be designed for easy installation and removal for maintenance purpose.

The Contractor shall also conform to the general regulations governing personnel on the site and must keep to the working space allocated for their use.

The Contractor shall be responsible for any kind of mishap, etc. happened with personnel. The Engineer-in-charge shall not take the responsibility for any of such kind.

### **Tools and Tackles**

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dismantling and maintenance of the equipments.

## SUB HEAD – 2

### CONDUIT SYSTEM, CABLE TRAY, CABLE LADDER AND TRUNKING INSTALLATION

#### Work Description

This section describes the supply and installation of wiring facilities systems include conduits, cable trays, cable ladder and Trunking system, c/w associated fittings and accessories.

All cables running above the suspended false ceiling, columns, or on surface shall be supported by proper clamps, on cable tray or cable ladder system. No free hanging of cable is allowed.

The cable routes shown in the drawings shall be used as a guide only. The cable routes may be physically examined and coordinated with other services before undertaking the installation work in hand.

Uncoordinated and inaccessible routes after other services are installed, shall be relocated at the expense of the Contractor.

All conduits, trunking, cable trays and cable ladders shall be earthed in accordance to IS: 3043.

#### Standards

The complete wiring facilities system shall be manufactured, supplied, installed and tested in accordance with the latest revision of the Indian standards and the appropriate BS / IEC include:

- |  |   |
|--|---|
| 1. Steel Conduit and Fitting Accessories | IS:9537 (Part-II)/ BS4568 & BS731       |
| 2. PVC Conduit and Fitting Accessories   | IS-9537/1983 (Part-III)/BS6099 & BS4607 |
| 3. Cable Tray                            | BS 729                                  |
| 4. Cable Ladder                          | BS 729                                  |
| 5 Cable Trunking                         | BS 4678                                 |

The complete wiring facility system shall conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in the approved specification and drawings.

#### Submissions

All technical submissions shall be approved by the contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of Engineer-in-charge for its review and approval.

#### Routing of installation

Sample of proprietary factory-made accessories, elbows, risers, reducers, tees, crosses, etc.

## **PRODUCTS**

### **Steel Conduit and Accessories**

#### **Steel Conduit:**

All conduits shall be of heavy gauge solid drawn ERW welded manufactured out of 16 (1.6mm) gauge MS Sheet up to 32mm dia and 14 (2 mm) gauge for sizes above 32mm.

Both inner and outer surfaces shall be smooth without burrs, dents and kinks.

Conduits shall be black stove enameled inside and outside. The cross section of conduit shall be uniform throughout.

The welding shall be uniform such that welded joints do not yield when subjected to flattening test. Welded joint shall not break when threaded or bent at an angle.

Conduit shall conform to specifications of IS: 9537 (Part-II) and the capacity of conduits shall be in accordance with the standards

The minimum size of the conduit shall be 19/20mm diameter.

Care shall be taken to ensure that all conduits are adequately protected while stored at site prior to erection and no damaged conduit is used.

#### **Fittings**

Samples of conduit fittings shall be submitted for approval prior to use on work.

Fittings shall be those intended for use with screwed conduits and shall comply with IS 9537. However, bends, elbows and tees shall not be installed.

Boxes and cover plates installed outdoors shall have fixing lugs exterior to the box so that fixing screws do not enter the box interior.

Adaptors used with flexible conduits shall conform to IS: 9537.

#### **Circular Boxes**

Circular boxes shall be of malleable cast iron, galvanized and of standard pattern with spout(s). When used for connecting lengths of conduits, circular boxes shall be provided with cover plates of similar make that are complete with brass fixing screws.

#### **Rectangular Boxes**

Rectangular boxes (adaptable boxes) shall be of mild steel not less than 2.4 mm gauge and galvanized.

When used as junction boxes, lids of the same gauge with brass fixing screws shall be used.

#### **Boxes for Accessories**

Boxes for accessories shall be suitable for surface mounting or recessed mounting according to the requirements. Surface mounted boxes and accessories shall be metal clad pattern. Recessed boxes and accessories shall be complete with insulated molded type cover plates conforming to IS: 5133 Part I-1969.

### **Covers**

All covers for boxes, etc shall be made of galvanized steel of 1.2 mm thickness.

### **PVC Conduit and Accessories**

#### **PVC Conduit**

All conduits shall be high impact rigid 2mm thickness PVC heavy duty type and shall comply with I.E.E. regulations for non-metallic conduit as per IS-9537/1983 (Part-III).

All sections of conduit and relevant boxes shall be properly cleaned and glued by using epoxy resin glue and the proper connecting pieces.

Inspection type conduit fittings such as inspection boxes, drawn boxes, fan boxes and outlet boxes shall be of M.S. or otherwise mentioned.

Conduit shall be terminated with adopter/PVC glands as required.

#### **PVC Conduit Accessories**

Accessories used for conduit wiring shall be of an approved type conforming to IS: 3837-1966.

All accessories used shall be of standard white or black color, identical to conduit used.

Plain conduits should be jointed by slip type of couplers with manufacturer's standard sealing cement.

All conduit entries to outlet boxes, trunking and switchgear are to be made with adaptors female thread and male bushes screwed.

PVC-switch and socket boxes with round knockouts are to be used. The colors of these boxes and the conduits shall be the same.

Standard PVC circular junction boxes are to be used with conduits for intersection, Tee-junction, angle-junction and terminal. For the drawing-in of cables, standard circular through boxes shall be used.

Samples of accessories shall be submitted for approval prior to installation.

All jointing of PVC conduits shall be by means of adhesive jointing. Adequate expansion joints shall be allowed to take up the expansion of PVC conduits.

### **Conduit Installation**

#### **Layout**

The conduit layout and conduit routes shall be submitted for approval. Allowance for adjustments due to site conditions shall be made at no extra cost.

Conduit routes shall be chosen for easy, straight runs with minimum bends and crossings. Generally they shall follow the structure of building, running at right angles or in parallel to floors and ceilings. Conduits shall be kept within 300 mm of floors and ceilings when running parallel to them.

Outlet boxes for housing accessories shall be used as draw boxes. The total number of draw boxes shall be kept to a minimum and shall be provided so that conduit runs do not exceed 12 m or have more than two right angle bends.

All conduits shall be kept clear of gas and water pipes. In particular, conduits shall be at least 150 mm away from gas pipes. Where proximity to these pipes is unavoidable, they shall be effectively segregated e.g. using rubber or other insulating material to prevent appreciable voltage differences at possible points of contact. Segregation from extra low voltage circuits and telecommunication circuits shall also apply unless these are wired to the same voltage requirements as lighting and power circuits.

Conduits from different distribution boards shall not be connected to the same junction box. Each run of conduit shall be assembled complete with draw-in-wires.

### **Joints and Terminations**

Electrical and mechanical continuity shall be maintained throughout all conduit joints and terminations. Conduit threads shall be thoroughly cleaned and tightly screwed. The conduit system shall be watertight after installation.

Conduits shall be connected using couples or via boxes. With a coupler, the ends of the conduit shall butt close together and the running coupler is screwed tightly on and tightened by a locknut.

Conduits terminating into boxes provided with spouts shall be threaded so that there are no exposed threads. For boxes with no spouts, the termination shall be made using a brass bush and a coupler. The conduit is pushed through the knockout or drilled entry and the bush is screwed tightly onto its end. The coupler is screwed to butt firmly against the exterior wall of the box.

Where conduits are not jointed or terminated in boxes, they shall be terminated in a screwed brass bush.

In all joints and terminations, conduit threads shall not be exposed. Where this cannot be avoided as in a running coupler, the exposed threads shall be coated with red lead paint to seal against the ingress of water.

### **Bends**

Conduits shall only be bent cold with an approved type of bending block or bending machine, without altering the dimensions of their sections.

All conduit bends shall be such as to permit compliance to the requirements for bends in cables to as stated in the BS 7671.

Bends shall be made with as large a radius as the position of the conduit within the building permits. Where the bend is more than 90 degree, circular or rectangular junction boxes are to be used for connecting conduits.

### Wiring and Cabling

The conduit system must be installed free of obstructions and sharp corners before any cables are drawn in. Conduits shall be thoroughly swabbed to remove moisture and dirt immediately prior to the drawing in of cables.

Cables shall be drawn without crossing each other and shall not be pulled against the walls of the draw boxes. Slack cables shall left in all draw boxes.

Cables shall be continuous throughout conduit lengths and no joints are permitted. There shall be no kink in cables, neither any cut, abrasion or chink in the cable insulation.

The same conduit shall carry the lead and return conductors bunched together. However, the same conduit shall not house cables from different distribution boards.

Cables for power and lighting circuits and extra low voltage systems shall not be drawn into the same conduit. Lighting and power circuits shall run in separate conduits except, where an adopter box is employed as final distribution point, a number of final circuits are grouped together in larger conduits between the distribution board and the adopter box provided that all final circuits in one conduit are of the same phase. In the case of three phase circuits, all three phases including neutral, if any, shall be drawn into the same conduit.

Conduits shall not constitute the earth continuity path for the electrical circuit. A separate circuit protective conductor shall be installed within the conduit. The whole conduit system shall be effectively earthed.

Flexible conduits shall have a separate earthing conductor installed within the tubing and connected at conduit ends. Flexible conduits in general shall not be used for more than 3m length.

Maximum number of PVC insulated 1100V grade/copper conductor cable conforming to IS:694-1990,

Nominal Cross- Sectional area of Conductor in Sq.mm	20mm		25mm		32mm		38mm		51mm		64mm	
	S	B	S	B	S	B	S	B	S	B	S	B
1.0	2	3	4	5	6	7	8	9	10	11	12	13
1.5	5	4	10	8	18	12	-	-	-	-	-	-
2.5	5	3	8	6	12	10	-	-	-	-	-	-
4.0	3	2	6	5	10	8	-	-	-	-	-	-
6.0	2	-	5	4	8	7	-	-	-	-	-	-



10	2	-	4	3	6	5	8	6	-	-	-	-
16	-	-	2	2	3	3	5	5	10	7	12	8
25	-	-	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	-	-	3	2	6	5	8	6
50	-	-	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	-	-	4	3	5	4

**Notes:**

The above table shows the maximum capacity of drawing in of cables in conduits

The columns Head 'S' apply to runs of conduits which have distance not exceeding 4.25 m between draw in boxes and which do not deflect from the straight run by an angle of more than 15 degrees. The columns heads 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.

Conduit sizes are the nominal external diameters.

**Access and Drainage**

The conduit system shall be re-wireable, that is, draw boxes must be accessible for the purpose. Where boxes are concealed, their covers shall be flushed with the finished surface.

The need for accessibility notwithstanding, the conduit system shall be protected against the ingress of water and impurities. When installed, conduits shall be kept dry and free of debris with approved pipe plugs or caps. Such plugging is especially essential prior to pouring concrete for concealed installation. As for boxes, they shall be covered by steel plates prior to concreting.

When installed outdoor, and in situations liable to condensation of moisture, conduits shall be arranged to be self-draining, so that water may drain to low points which are fitted with a drain plug. Conduits laid under concrete floors shall have watertight floor-traps of approved detail for access of these drainage points.

Conduits run on surfaces other than structural steel members shall be secured using galvanized space bar saddles and brass fixing screws. Spacing of saddles shall not exceed 1.2 m for conduit sizes up to and including 25 mm and 1.8 m for sizes 32 mm and above.

Conduits run on structural steel shall be secured using girder clips or an approved clamp. These conduits and those run in the vicinity of structural steel shall be bonded to the steelwork using an efficient and permanent metallic connection. The conduits shall not in any way be under mechanical stress.

All conduit boxes except loop-in patterns shall be fixed direct to the building structure in addition to the support provided by the conduits.

Conduits terminating into surface boxes shall be secured by a minimum of 3 saddles at not less than 32 mm, 150 mm and 300 mm respectively from the box.

Conduits shall be painted with an approved paint to blend with visual environment. A zinc rich undercoat shall be provided before painting the final coat.

### **Cable Tray**

Cable tray shall be hot dipped galvanized process and thickness of coating as per IS 277. All cable trays shall be installed in a straight run parallel to walls where possible.

Cable trays shall be supported by electro-galvanized 'U' channel with galvanized threaded rod for indoor suspended tray and hot-dipped galvanized for area subject to weather.

All hangers shall be installed at 1 meter interval and shall be applied primer and painted to match with the surrounding building finish approved by the Engineer-in-charge.

The cable trays those are exposed to the weather, a hot-dip galvanized cover of 1.5 mm gauge steel, flush fixing type with gasket, shall be installed on top of the tray.

Depending on the size of cable trays spare space of 25% shall be maintained for future expansion. Copper earth link bar shall be fixed at every joint of the cable tray run.

### **Cable Ladder**

All cable ladders and accessories installed indoors shall be heavy-duty epoxy coated electro-galvanized mild steel type. All cable ladders installed outdoors shall be heavy-duty hot dipped galvanized hot rolled mild steel. Thickness of the mild steel shall not be less than 2 mm.

All nuts, bolts and washers for clips and brackets shall be zinc plated. Each cable ladder shall be in standard manufacturer's length and supplied complete with coupling sets consisting of fishplates, spine bolts, and nuts and locking washers.

The complete cable ladder installation shall be provided with all necessary proprietary factory-made elbows, risers, reducers, tees, crosses, drop-outs, etc. and any site fabricated items will not be permitted.

Separate flexible earth continuity connectors of at least 16mm<sup>2</sup> copper jumpers shall be installed between the ladder sections.

All cables ladders shall be supported from the ceiling concrete slab, steel structures or sidewalls using a frame system, with overhead hangers, support channels, hanger rods or angle brackets, beam clamps and ceiling brackets.

Fixings and supports shall be installed at regular intervals not exceeding 1000 mm and 150 mm from all bends, tees, inter-sections and risers.

When cable ladder is refined to install across structure expansion joints, the ladder shall be in two sections between supports installed on either side of the expansion joint.

The ladder sections shall than be jointed with expansion joint fishplates, bolts, nuts and washers install in elongated holes permitting a length wise movement of 25 mm from the initial fastening position.

For cable ladder that are exposed to the weather, hot-dip galvanized cover of 1.5 mm gauge steel, flush fixing type with gasket, shall be installed on top of the ladder.

Copper earth link bar shall be fixed at every joint of the cable ladder run.

### **Cable Trunking**

Cable trunking shall be manufactured from 1.6 mm minimum electro-galvanized mild sheet steel to BS4678 finished in oven-baked electro statically coated epoxy powder coating with color.

All trunking shall have removable lids extending over their entire lengths. Lids shall be fixed at interval not exceeding 1 meter by means of brass steel screws which and protected against corrosion by a finish of zinc coating or equivalent to zinc coating.

Factory-made bends, joints, elbow, riser, tee, reducer and accessories with same material shall be provided throughout the installation for trunking.

Trunking space factor shall be in compliance with latest IS standards. Copper earth link bar shall be fixed at every joint of the cable trunking run.

Note: All items mentioned in this section shall be manufactured to comply with the specifications of National Electrical Code (NEC) and National Electrical Manufacturer's Association (NEMA).

## **SUB HEAD – 3**

### **WIRES AND CABLES**

#### **Work Description**

The design, manufacturing, testing and supply of single core PVC insulated 1.1 KV grade stranded wires shall comply with following standards with update amendments under the specifications.

IS-3961: Current rating for cables.

IS-5831: PVC insulation and sheath of electric cables.

IS-694: PVC insulated cables for working voltage up to and including 1100 volts.

IEC-54 (I): PVC insulated cable.

Copper conductor FRLS PVC insulated wires shall be used in conduit as per requirement of work.

Aluminum conductors for power cables and copper conductors for control cables shall be used.

The wires shall be color coded - (red, yellow, blue) for Phases, black for Neutral and green for Earth.

Progressive automatic in line indelible, legible and sequential marking of grade, voltage, capacity and length in meters shall be embossed at every meter on the outer sheath of cable.

The design, manufacture, testing and supply of the cable under these specifications shall comply with following standards latest edition of:

IS: 8130: Conductors for insulated electric cables and flexible cords.

IS: 5831: HRPVC / HR PVC insulation and LSZH sheath of electric cables.

IS: 3975: Mild steel wires, strips and tapes for armoring cables.

IS: 3961: Current rating of cables.

The routing and minimum rated current carrying capacity of the LV power cables shall be indicated on the Drawing. The Contractor shall consider the manufacturer data and engineering for cable sizing and to ensure that it meets the conditions of grouping, ambient temperature etc.

All LT cables for normal power/control circuits within buildings shall be XLPE insulated and FRLSPVC inner and outer sheathed Aluminum conductor and control cables shall be XLPE insulated and FRLS PVC inner and outer sheathed copper conductor respectively.

Cables in service duct, open trench, direct-laid underground in soil shall be by means of armoured cables.

Non-armoured cables shall only be laid in conduits with mechanical protection.

All life safety Panels and equipment shall be feed through fire survival cable as per NBC -2016.

### Standards

All cables shall be manufactured and constructed in accordance of the following standards with the latest revision:

1.	IS: 694	:	HRPVC/XLPE insulated (heavy duty) electric cables for working voltage up to and including 1100 volts.
2.	IS: 424-1475(F-3)	:	Power cable-flammability test.
3.	IS: 7098(I)	:	Specification for cross-linked polyethylene insulated LSZHPVC sheathed cable for working voltage up to 1.1 KV.
4.	IS: 1554	:	Specification for PVC insulated (heavy duty) electric cables for working voltages up to and including 1100 volts.

5.	ASTM-D: 2863	:	Standard method for measuring the minimum oxygen concentration to support candle-like combustion of plastics (Oxygen Index).
6.	ASTM-D: 2843	:	Standard test method for measuring the density of smoke from the burning or decomposition.
7.	IEEE: 383	:	Standard for type of tests Class-IE, Electric cables, field splices and connections for power generation station.
8.	ASTME: 662/ IEC: 754(x)	:	Standard test method for specific optical density of smoke generated by solid materials
9.	IS: 10418	:	Cable drums.
10	IS-10810	:	Testing method of cable.
11.	IS-6121	:	Cable glands.
12.	IS-9537	:	Rigid steel conduit.

The manufacturing of the cable shall also conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in the approved Specification and Drawings of contractor. Only more stringent specification shall be followed.

### Submission

All technical submissions shall be got approved by the contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of Engineer-in-charge for its review and approval.

As a minimum requirement, the submission shall include the following:

Equipment submission with manufacturer's data

### Sample submission

Shop Drawings of the cable route showing the co-ordinated routing of cables, arrangement on cable trays, methods of fixing of cable trays and cables, etc. All conduits including concealed conduit routing drawings shall also be included

Cable test reports and IS Certification

Cable schedule indicate the following data include:

Cable code and type and installation method

Cable feed from and serve to

Cable route length and voltage drop

Cable capacity and

Upstream protection breaker rating

The cable schedule shall be prepared in accordance to the cable manufacturer's data.

## **MEDIUM VOLTAGE CABLES**

### **TYPE:**

Medium voltage cables shall be aluminium or copper conductor, XLPE insulated, FRLSPVC inner and outer sheathed steel wire armoured or steel strip armoured construction. Aluminium conductors up to 10sq.mm may be solid, circular in cross section, and sizes above 10sq.mm shall be stranded. Sector shaped stranded conductors shall be used for sizes above 16 sq.mm. The cable shall conform to IS 1554 (Part I) for PVC & IS 7098 (Part-I) for XLPE Cables.

### **RATING**

The cable shall be rated for a voltage of 1100 Volts.

### **CONSTRUCTION**

The conductors for power cables shall be made high conductivity aluminium & Copper / control cable from annealed high conductivity copper (complying with IS 8130- 1984). The conductors shall be insulated with high quality PVC base compound. A command covering (bedding) shall be applied over the laid up cores by extrusion or wrapping of a filling material containing unvulcanized rubber or thermoplastic material, armouring shall be applied over the inner sheath, over the armouring a tough outer sheath of FRLS PVC sheathing shall be extruded. The outer sheath shall bear the manufacturers name and trade mark at regular interval as per IS. Inner and Outersheath of cables should be FRLS.

### **CORE IDENTIFICATION:**

Core shall be provided with the following colour scheme of PVC insulation.

- i. 1 Core : Red/ Yellow/Blue
- ii. 2 Core : Red and Black
- iii. 3 Core : Red, Yellow, and Blue

- iv. 3.5/4 core : Red, Yellow, Blue and black.

**CURRENT RATINGS:**

The current rating shall be based on the following conditions. XLPE

- |      |                               |   |            |
|------|-------------------------------|---|------------|
| i.   | Maximum conductor temperature | : | 90°C       |
| ii.  | Ambient air temperature       | : | 40°C/50°C  |
| iii. | Ground temperature            | : | 35°C /40°C |
| iv.  | Depth of laying               | : | 75cm       |

**SHORT CIRCUIT RATING:**

Short circuit ratings for the cables shall be as specified in IS: 1554 Part -I. for PVC & IS 7098 (Part-I) for XLPE Cables.

**SELECTION OF CABLES:**

Cables have been selected considering the conditions of the maximum connected load, ambient temperature, grouping of cables & the allowable voltage drop. However, the Contractor shall recheck the sizes before the cables are fixed and connected to the service.

**Mineral Insulated copper Conductor Cable**

The cable shall be MICC (Mineral Insulated copper Conductor) cable confirming to British standard (BS:5839, BS: 6387, BS 8434-2 & BS: 60702) (Latest Edition)

The cable shall have opening voltage grade of 500V / 750V and the outer welded sheath be of copper.

The cable shall withstand temperature minimum 950 degree C for 3 hours Fire rated as per BS: 6387

The cable shall be LSZH (Low Smoke Zero Halogen) CWZ type, LPCB approved. As per BS 8434-2, all three tests of C, W & Z category should be performed on one single sample of cable and in no way these 3 tests should be done on 3 different samples.

The cables shall be connected to the various devices with proper termination kits/glands. Appropriate glands shall be provided where the cable enters the junction box.

Cables are to be supplied along with all accessories, crimped termination etc. Cable is to be laid by the Trained & Experienced personnel only.

The cable when running in outdoor area shall not be taken overhead. It shall be laid underground according to IS 1255-1983 (Latest Edition)

The manufacturer shall have their own adequate no. trained personnel, based in India, who are specialized for termination and installation of MICC cables, which is specialty of this cable.

**XLPE HT Cables (Upto 11KV)**

The cross linked polyethylene (XLPE) cable shall be aluminium conductor FRLS PVC outer and inner sheath steel strip armoured over inner sheath construction. XLPE cable shall conform to testing in accordance with IS: 7098 (Part-I) 1977 and (Part-II) 1973. The screening shall be done on individual cover. The armouring applied over the common covering shall be flat steel wires.

The termination and jointing techniques for XLPE cables shall be by using heat shrinkable or push on cable jointing kits.

While laying underground cables in ducts care should be taken so that any underground structures such as water pipes, sewerage lines etc. are not damaged. Any telephone or other cable coming in the way shall be properly protected as per instructions of the Engineer-in-charge. The HT cable shall be laid at least 1200mm for cable up to 11 KV (E) below the ground level in a trench 450mm wide.

After laying and jointing work is completed High Pot test shall be performed in presence of Engineer-in-charge and test results submitted for approval in order to ensure that they have not been damaged during or after the laying of cables. In case, the test results are unsatisfactory, the cost of all repairs and replacement and all extra work of removal and relaying will be made good by the contractor without any extra cost.

Note: All other procedure will be followed as per L.T. cables.

**Inspection**

All cables shall be inspected on receipt of the same at site and checked for any damage during transit.

**Joints in Cables**

Cable drum length and sizes of cable lengths required may be checked carefully before cutting the cables from drum. The Contractor shall take care that the cables received at site are distributed to various locations in single length as far as possible to ensure maximum utilization. Where the joints are unavoidable, the same is to be done with approval from the Engineer-in-charge. The joints shall be done by qualified jointer strictly in accordance with manufacturer's instruction / drawings in presence of Engineer-in-charge.

**Joint Boxes for Cables**

The cable joint boxes shall be of appropriate size suitable for type of cable of particular voltage rating.

**Cable Joints**

All cable joints materials shall be of standard make and suitable to requirement. On jointing of cables in the joint box the cable compound shall be filled in accordance with manufacturer's instructions and in approved manner. All straight through joints shall be done in epoxy mould boxes with epoxy resins. Straight through joints shall not be permitted unless the length of run is in excess of cable drum.

End terminations of cables more than 1.1 KV grade shall be done with epoxy mould boxed and epoxy resin. Cable glands shall be 1.1KV grade double compression type and made to tin plated heavy-duty brass casting and machine finished. Glands shall be of robust construction capable of clamping cable and cable armour, firmly without injury of cable.



All washers and hardware shall be made of brass tinned. Rubber components used in the glands shall be made of neoprene of tested quality.

Cable lugs shall be tinned copper / aluminium solder less crimping type conforming to IS: 8309 suitable for aluminium or copper conductor.

Crimping of terminals shall be done by using Corrosion inhibitory compound, with crimping tool.

Fire resistant paint has to be applied 1 Meter on either side of cable joint.

The Contractor shall liaise fully with all other sub - contractors to achieve an efficient and properly coordinated installation where equipment has to be re-positioned due to lack of site liaison.

### **Erection of Cables**

Notwithstanding the cable routes indicated on the Drawings the Contractor shall be entirely responsible for the supply of correct lengths of the cables to be installed and for all allowances for connecting and terminating the cables to the switchgears and transformers respectively

The Contractor shall submit proposed cable routes including details of supports for the cables for approval before installation. The cable shall not be run in places other than corridor, passageway, electrical riser or other designated areas subject to the Engineer's approval. The cost of support shall be deemed to have included in the Contract.

### **Cable Pulling**

Winching of cables through ducts / pipes shall only be carried out with the approval of the Engineer-in-charge in which event a pulley eye shall be attached to the conductors. Cable shall be run in neat and orderly manner to allow space for future cabling and maintenance. Under any circumstances the cable shall not run diagonally across a room, cable basement, corridor, etc.

A cable sheath stocking may be employed on cables where no undue stress in the sheath is likely to occur.

Care shall be taken to ensure that the draw strain is applied to the armouring and protected during drawing against damage.

### **Cable Laying**

The cable drum shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming links. At all changes in directions in horizontal & vertical places, the cable shall be bent with a radius of bend not less than 8 times the diameter of cable.

The cable of 1.1KV grade shall be laid not less than 750mm below ground level in a 375 mm wide trench (throughout). Where more than one cable is to be laid in the same trench, the width of the trench shall be increased such that the inter axial spacing between the cables except where otherwise specified is at least 150mm minimum or as per site requirements or as approved by the Engineer-in-charge. Where single core cables are used in multiphase systems, the cables shall be installed in trefoil where possible.

In case the cables are laid in vertical formation due to unavoidable circumstance the depth per tier shall be increased by 200 mm (minimum). Cable shall be laid in reasonably straight line, where a change in direction takes place a suitable curvature shall be i.e. either 20 times the diameter of the cable or the radius of the bend shall not be less than twice the diameter of the cable drum or whichever less is. Minimum 3 meter long loop shall be provided at both sides of every straight through joint & 3 meters at each end of cable or as directed at site.

Greater care shall be exercised in handling the cable in order to avoid forming 'Kinks'. The cable drum shall in-verbally convey on wheels and the cable unrolled in right direction as indicated on the drum by the manufacturer. The cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains.

Cables laid in trenches in single tier formation, 10 cms all-around sand cushioning is provided below and above the cable before a protective cover is laid. For every additional vertical tier. The 30 cm of sand cushion is provided over the initial tier. The cable shall be protected by 2nd class brick of size not less than 230 x 115 x 75mm, stone tiles / RCC curved channel be placed on top of the sand breadth wise for the full length of the cable and where more than one cable is to be laid in the same trench the brick shall cover all cables and project at least 8 cms over the outer sides of the end cables.

Filling of trenches shall be done after sand cushioning and tiles or bricks lying and inspection is carried out by the Engineer-in-charge (Refer drawing). Back fill for trenches shall be filled in layer not exceeding 150 mm. Each layer shall be properly rammed & consolidated before laying the next layer.

PVC pipe shall be provided on all road crossing. The size of the pipe shall be above the size of the cable. Minimum 100mm dia. pipes are to be provided. The pipe shall be laid in ground with special arrangement and shall be cement jointed and concreting of 1:5:10 shall be provided as per relevant IS with latest amendment. Nothing extra shall be paid on this account. Cable route markers at interval of 30 meters and at the point of direction change shall be provided to indicate cable path. Aluminum strip cable tag of 20mm wide with engraved tag no. shall be provided at both ends of cable.

Where the cables are laid in ducts (pucca trenches) inside the building, they will be laid on MS rack / cable trays grouted on trenches walls. Cables passing through floors shall be protected from mechanical damage by steel channel to a height of one meter above the floor. Sleeve shall be provided in the wall for crossing of cables.

Where the cables are laid in open (in building) along walls, ceiling or above false-ceiling, cable rack (ladder type) or cable tray shall be provided. The size of the cable tray or rack shall depend on the number of cables to pass over that rack. Cable tray/rack shall be properly supported through wall/ceiling according to the site conditions.

Cable laid on tray & riser shall be neatly dressed & clamped at an interval of 1000 mm & 750mm for horizontal & vertical cable run respectively either side at each bend of cable. All power cables shall be clamped individually & control cables shall be clamped in groups of three or four cables. Clamps for multi core cables shall be fabricated of 25x3 GI flats. Single core power cable shall be laid in trefoil formation & clamped with trefoil clamps made of PVC/fiber glass.

Cable openings in wall/floor shall be sealed by the Contractor suitably by Hessian tape & Bitumen compound or by any other proven material to prevent ingress of water.

After the cables are laid, shall be tested as per IS and the results submitted to Architects/Engineer and in case the results found unsatisfactory, all the repairing/ replacing of cables will be done by the Contractor free of charge.

### **Internal Wiring**

All the wiring installation shall be as per IS: 732 with latest amendment. FRLS PVC insulated copper conductor cables and shall be used for sub-circuit runs from the distribution boards to the points and pulled into conduits. Colour Code for wiring shall be followed.

Looping system of wiring shall be used, wires shall not be jointed. Where joints are unavoidable, they shall be made through approved mechanical connectors with prior permission of the Engineer-in-charge. No reduction of strands is permitted at terminations. No wire smaller than 1.5 sq.mm shall be used. Wherever wiring is run through trunkings or raceways, the wires emerging from individual distributions shall be bunched together with cable straps at required regular intervals. Identification ferrules indicating the circuit and DB number shall be used for sub main sub-circuit wiring. The ferrules shall be provided at both end of each sub main and sub-circuit.

Where single phase circuits are supplied from a three phase and a neutral distribution board, no conduit shall contain the wiring fed from more than one phase. In any one room in the premises where all or part of the electrical load consists of lights, fans and/or other single phase current consuming devices, all shall be connected to the same phase of the supply. Circuits fed from distinct sources of supply or from different distribution boards or through switches or MCBs shall not be bunched in one conduit. In large areas and other situations where the load is divided between two or three phase, no two single phase switches connected to different phase shall be mounted within two meters of each other.

All splicing shall be done by means of terminal blocks or connectors and no twisting connection between conductors shall be allowed.

Industrial sockets shall be of polycarbonate and deeply recessed contact tubes. Visible scraping type earth terminal shall be provided. Socket shall have self-adjustable spring loaded protective cap. Socket shall have MCB/ELCB/RCCB as specified in the schedule of work.

### **Fire Seal System**

All the floor/wall opening provided for cable crossing shall be sealed by fire seal system.

The fire proof sealing system shall fully comply with the requirements of relevant IS/BS: 476 Part-B. The fire proof seal system shall have minimum one hour fire resistance rating.

The fire proof seal system shall be physically, chemically, thermally stable and shall be mechanically secured to the masonry concrete members. The system shall be completely gas and smoke tight, anti-rodent and anti-termite.

The material used in fire proof seal system shall be non-toxic and harmless to the working personnel.

Type of fire proof seal system shall be foaming type or flamemastic type compound or approved equivalent.

After laying and jointing work is completed, high voltage test should be applied to all cables to ensure that they have not been damaged during or after the laying operation and that there is not fault in the jointing.

Cables for use on low and medium voltage system (1.1KV grade cables) should withstand for 15 minutes a pressure of 3000V, DC applied between conductors and also between each conductor and sheaths. In the absence of pressure testing facilities it is sufficient to test for one minute with a 1000V insulation tester. In case the test results are unsatisfactory the cost of repairs and replacements and extra work of removal & laying will be made good by the Contractor.

Minimum clearance between the LV, MV, ELV and other metallic pipe as per IS-1255 Clause-6.3.3

### **Factory Tests**

Each type of cable specified shall be fully type tested according to IEC 502 and the appropriate British Standards. The types and sizes of cables required are shown on the Drawings.

Should the Engineer require it, the Contractor shall submit reports issued by a national or international testing authority on type test that have been successfully performed on the cable for his approval.

The type test shall include the following test:

Partial discharge test;

Bending test, plus partial discharge test;

Tan  $\delta$  measurement as a function of the voltage and capacitance measurement;

Tan  $\delta$  measurement as a function of the temperature;

Heating cycle test plus partial discharge test;

Impulse withstand test, followed by a power frequency voltage test;

Medium-voltage alternating current test;

Type test (non-electrical) as stipulated in IEC 502, Table VI.

Cable routine test shall be conducted at factory in accordance with IEC 502 for the following tests:

Measurement of the electrical resistance of conductors

Partial discharge test, 4-hour HT test

### **Site Acceptance Test**

The Contractor shall supply all necessary testing equipments for site testing. When required, these testing equipments shall be calibrated at the expense of the Contractor at a recognized national laboratory.

The Contractor shall engage an Authorised Medium Voltage Testing Engineer who is recognized by SEB to perform all site tests.

In addition to SEB's requirements and those recommended by the manufacturer, the following tests shall be carried out:

Continuity test

Earth test

Polarity test

Insulation resistance test

DC high voltage test. The test voltage shall be in accordance with SEB's requirements and Engineer's approval.

**SUB HEAD – 4****WIRING DEVICES****GENERAL****Work Description**

The drawings for the lighting and power points indicate approximate position of all lighting fittings, switches, power outlet points, isolating switch points etc. The actual position of all fittings, switches, the wiring details and cable routes shall be coordinated with other trades at site and submitted for the approval of the Engineer-in-charge. All time and cost required for adjusting the layout or complete installation to suit site requirement is included.

To determine the exact positioning of lighting and power points due consideration shall be given, for selection of the most accessible routes for wiring, convenience of switching and operational requirement of the installation. Wiring devices shall be modular.

No extra cost will be paid should the final positions be relocated within the same room.

For the purpose of specification and related drawing, each lighting & power point circuit shall be coded with a prefix to indicate the corresponding distribution board number.

The electrical equipment/system may develop sudden changes due to low frequency or direct electric current components such as fluorescent lamps, contactors, etc. shall be fitted with radio and television interference suppression components suitable to meet the levels specified in BS:

“Limits of Radio Interference”.

This section included the specification of the following:

Distribution boards

Miniature circuit breakers

Earth leakage circuit breakers

6A Switch Socket Outlet

16A Switch Socket Outlets

Shaver Outlets

Isolating Switches

Conduit Boxes

Contactors

Dimmers Switch

Time Switch

Cooler Control Units

Water Heater Switches

Bell Push Switches

### **Standards**

The complete wiring installation shall be engineered according to manufacturer data and constructed in accordance with the latest revision of the IS and the appropriate BS/IEC

In the adoption of standards and requirements, the Contractor shall take the following precedence:

Engineer's decision

Local codes of practice

Drawings

Specification

International standards and requirements

### **Submission**

All technical submissions shall be approved by the contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of Engineer-in-charge for its review and approval.

The submission shall include the following as a minimum requirement,

- Equipment catalogues submission with manufacturer's data
- Sample submission include all wiring accessories
- Shop Drawings of the lighting and power positions, circuit numbers, cable routings, switching arrangement, mounting height, etc. The positions and mounting heights shall be coordinated with other services. Fixing details of all wiring accessories shall also be included. Drawings showing the installation details, Labeling system.
- Builder's works requirement.

### **PRODUCT**

#### **Lighting Point Installation**

The various types of light fittings to be supplied and installed are described in the Schedule of Lighting Fittings on Drawing

Surface mounted light fitting shall terminate at junction box having entries appropriate to the run of conduit. This shall be complete with porcelain / PVC connector suitable for the size and number of connections and wiring points to be connected with the specified fitting. Wiring to the light fittings within the false ceiling space shall be by means of heat resistant (butyl or silicon rubber insulated to BS 6500) cables i.e. between the junction box and the lamp holder/terminal blocks, in flexible conduits.

At every light fitting an approved type earth terminal shall be provided for connection of the circuit protective conductor of the final circuit.

Ferrous metal work shall be of minimum of 1mm thickness and treated against corrosion by galvanising after welding or lead primer or other approved process. Metal work shall be painted with one priming coat, one under-coat and two final coats with stove-enamelled matt white paint unless otherwise specified.

Cables used for internal wiring of the lighting fittings shall be with appropriate type and size, number with conductor of size not less than 1.5 sq mm single core. The insulation of the cables shall withstand the maximum temperature throughout the life of the fitting. It will be subject to normal use without deterioration which could affect the safety of the fitting.

Cables within the lighting fittings shall be neatly bundled by nylon self-locking cable ties. Wiring shall be properly routed and secured away from control gear etc. wherever possible.

All cable terminations within the light fittings shall be suitably shrouded.

All light fittings shall be supported with appropriate fixing accessories such as clips, supporting brackets, suspension sets, nuts, washers, screws etc. for their proper installation on different types of ceiling panels. Suspension sets shall be of adjustable type suitable to carry the weight of the lighting fittings unless otherwise stated or indicated on drawings. The suspension sets shall be generally of 900mm length. Exact lengths required shall be provided to suit the site requirement.

All lamps in operational condition with proper control gear shall be provided together with the light fittings as required and specified.

### **Switches**

Lighting switches unless otherwise specified, shall be modular, single pole, quick make and break, silent action type with solid silver alloy contacts and totally enclosed for flush or surface mounting as required.

Lighting switches shall be suitable for indoor or outdoor service according to location housed in standardized purpose manufactured galvanized steel boxes completed with conduit knockouts made up into single or multi-gang units employing a grid switch system of fully interchangeable components at standardized fixing centers of matching switches of different types and ratings but of identical dimensions, push buttons, neon indicator lamps, blanking units, grids, steel boxes and plates all capable of integration into standard composite assemblies complete as required.

Grids shall be adjustable for variation in depth of plaster and for squaring errors and of the same type for surface or flush mounting.



Switches in mechanical plant rooms and electrical sub-stations and switch rooms shall be of the metal clad type approved by the Engineer-in-charge mounted in flush or surface conduit boxes as specified.

Switches located on brick or concrete walls shall be mounted in horizontal arrangement in plaster depth steel boxes or in galvanized steel boxes using box suspension straps and cover plates. Countersunk screws shall be provided for fixing to the conduit boxes.

Switches for external use shall be of weatherproof construction with IP-65 rating unless otherwise specified.

Samples of all switches, conduit boxes and plaster depth boxes shall be submitted to the Engineer for approval prior to installation.

Switches shall be rated for 6Amps (minimum light switch rating 6Amps), 16Amps or 20Amps (as determined by circuit load). Inductive lighting circuit shall be assessed at twice the steady state connected load current. One or two ways switch as indicated on the drawings be fixed generally at a height of 1200mm from floor level in rooms. The switch shall possibly be located inside the room on the handle side of the door as close as practicable.

Earth continuity terminal shall be provided and connected to the circuit protective conductor at every lighting switch position.

Single pole switches shall be connected to break the phase wire of the supply. The neutral wire shall not be routed through switch boxes.

Switches which are mounted in the same location shall be of multi-gang type, of the maximum number of gangs available.

All switches used shall be of approved or prescribed items as required by local Authorities. Circuit from different phase and circuit from emergency power should have separate switch plate.

### **Isolation Switch**

Isolating switches shall be of the current ratings and number of poles (generally double pole for single phase and 4-pole three phases) as indicated on the Drawings.

Isolating switches shall be of the totally enclosed pattern, metal-clad or polycarbonate with positive quick-make and quick-break action.

Switches shall be capable of passing and interrupting their full rated current safely and without damage.

Ferrous materials shall be galvanized, switch handles shall be interlocked to prevent opening the cover with the switch "ON".

### **6AMP Switch Socket Outlets**

6Amp Switch shall be as per IS 3854:1997, single pole and Socket shall be as per IS 1293:2005, 6Amp 3round pin shuttered outlets, modular, flush mounting according to location.

Switches shall be of the quick-make and break type silent action totally enclosed with solid silver alloy contacts. Switched socket outlets for indoor use shall be housed in suitable galvanized steel boxes with conduit knockouts. Types and finishes of socket plates shall match those for the lighting switches.

Generally switch socket outlets shall be positioned 300mm above floor level except in plant rooms, kitchen, etc. where they shall be positioned 1400mm above floor level or 150mm above counters or benches as per requirement.

Switch socket outlet in all mechanical plant rooms, electrical switch rooms shall be of the metal clad type, with recessed or protected switch dolly, mounted in flush or surface conduit boxes as specified.

All switch socket outlets used shall be of an approved quality.

### **16 AMP Switch Socket Outlets**

16Amp Switch shall be as per IS 3854:1997, single pole and Socket shall be as per IS 1293:2005, 16Amp 5pin shuttered outlets, modular, flush mounting according to location.

### **Weatherproof Isolator**

Weatherproof enclosure shall be of the high impact, water resistant to IP-65. The isolator provided shall complete with lockable device. Isolators shall be 2-pole, 4-pole as specified.

### **Lighting Dimmers Switch**

Lighting dimmer switch shall be solid state, variable load and thyristor controlled type suitable for controlling LED or fluorescent lighting circuits operating at  $230V \pm 6\%$ , 50Hz single phase AC supply.

Dimmer switch shall be manufactured to eliminate TV and radio frequency interference in compliance with IS.

The ratings of the dimmer units shall be suitable for lighting circuit specified on Drawing.

### **Time Switches**

Time switches shall be self-contained unit suitable for mains operation. All units shall have self-starting synchronous motor with single-pole fuse in the motor circuit, 3-way terminal block and thirty-six (36) hours spring reserve complete with an automatic solar dial.

The solar dial shall be capable of switching ON The lighting at sunset and OFF at sunrise throughout the year by control of a secondary calendar dial with month and day settings. The automatic switching time shall be adjustable.

Time switches shall be encased in dust-tight metal casing having hinged front cover with clear Perspex window. The casing shall be effectively earthed.

A manual bypass switch shall be incorporated with the time switch to facilitate maintenance of the latter.

### **Miniature Circuit Breaker**

The MCB shall be suitable for manual closing, opening and automatic tripping under overload and short circuit. The MCB shall also be trip free type.

Single pole / three pole versions shall be furnished as required. The MCB shall be rated for 10KA fault level.

The MCB shall be suitable for housing in the lighting boards and is suitable for connection at the outgoing side by tinned cable lugs and for bus-bars connection on the incoming side.

The terminal of the MCB and their open and close conditions shall be clearly / indelibly marked. The MCB shall generally conform to IS: 8828.

### **Earth Leakage Circuit Breaker**

ELCB shall be 4 pole 415 volts 50Hz, 30-300mA sensitivity. These shall be of approved make. The rating of the ELCB shall be as required. These shall be suitable for manual closing and opening and for automatic tripping under earth fault circuit of 30-300 mA as specified.

The enclosure of the ELCB shall be moulded from high quality insulating material. The material shall be fire retardant, anti tracking, non-hygroscopic, impact resistant and shall withstand high temperature.

All parts of switching mechanism shall be non-greasing, self lubricating material so as to provide consistent and trouble free operation.

Operation of ELCB shall be independent of mounting position and trip free type.

### **Lighting/Small Power Distribution Boards**

Distribution boards shall be of standard make with MCBs as per approved make given. Distribution boards shall be of steel sheet construction double door all welded enclosure of IP42 protection and powder coated painted.

Ample clearance between the conductors of opposite pole and sheet steel body shall be maintained in order to obviate any chance of short circuit. Removable conduits entry plates shall be provided at top and bottom to facilitate drilling holes at site to suit individual requirements.

Additional / separate adopter box of suitable size shall be provided to accommodate wires, cables and No. of conduits etc. at no extra cost.

The MCB shall be mounted on high grade rigid insulating support and connected by electrolytic copper bus bars.

Each incoming MCB isolator shall be provided with solder-less cable sockets for crimping.

Phase separation barriers made out of arc resistant materials shall be provided between the phases. Bus bars shall be colour coded for phase identification.

Distribution boards shall be recessed in wall or mounted on surface of wall with necessary mounting arrangement.

The mounting height shall not exceed 1200mm from finished floor level. Distribution board shall be provided with proper circuit identification name plate and danger sticker/plate as per requirement.

All the distribution boards shall be provided with engraved name plates with 'lighting', 'power' or 'UPS' with DB Nos., as the case may be. Each DB shall be provided with circuit list giving details of each circuit. All the outgoing circuit wiring shall be provided with identification ferrules giving the circuit number & phase.

Each distribution board shall have separate neutral and earth connection bar mounted within the DB each having the same number of terminals as the total number of outgoing individual circuits from the distribution board. Conduit & cable armouring shall be bonded together & connected to the distribution board earth bar.

Where oversized cables are specified due to voltage drop problems, it shall be Contractors responsibility to ensure that satisfactory terminal arrangements are provided without an extra cost.

### **Telephone Outlets**

Telephone outlets where called for shall be single or twin flush mounted type suitable to receive the plug-in telephone cable lead to the approval of the Telecom. The finish of the telephone outlet plates at various areas shall be as specified for lighting switches.

### **Water Cooler Drinking Fountain Switches**

Flush-mounted double pole AC switch of 20Amps rating shall be provided for water cooler and marked "water cooler".

Associated connector units shall be provided next to the water cooler. The switches and the connector shall be IP-65 waterproof rating.

### **Bell Push Switches**

Bell push switches shall be flush-mounted having single-pole AC switch of 6Amps rating and marked with bell symbol.

### **Shaver Outlets**

Shaver outlets shall comprise a 20VA continuously rated double wound isolating transformer to provide an earth-free AC supply at mains frequency, complete with self-resetting thermal overload device fitted in the primary circuit an insulated voltage selector switch to provide either 115 or 230volt output, one ON-OFF switch and one universal socket outlet suitable for British, American, Continental and Australian razor plugs, all contained in recessed sheet steel box with insulated moulded front plate suitable for flush, mounting and suitably inscribed to give clear indication of the voltages available at the outlet and the service of the outlet.

### **Cooler Control Units**

Cooler Control Units shall be flush mounted double pole AC switch of rating 30Amps complete with pilot indicating lamps and with self-adhesive plastic identification label mounted on a removable chassis

contained within steel box finished aluminium stove enamel provided with conduit knockouts and earthing terminals. The cover plates shall be of the same finish as those specified for the lighting switches.

Associated connector units shall be provided adjacent to the cooler units. Wirings between the cooler control units and associated connector units shall be provided in concealed conduits.

### **Water Heater Switches**

Water heater switches shall be flush mounted having double pole AC switch rated at 20amps fitted with pilot lamp and marked “water heater”. The cover plates shall be of the same finish as those specified for the other switches. Associated connector units shall be provided next to the water heater units.

### **Power Supply for Lighting at Wet Condition**

Residual Current Circuit Breakers shall be provided individually for each circuits serving lighting subject to wet condition.

**SUB HEAD – 5****LT PANEL BOARDS****Scope**

The section covers the detailed requirements of medium voltage switch panel for 415 volts, 3 phases, 50 HZ, 4 wire systems. These shall be branded and or / assembled / fabricated of factory of repute. All switchgears shall be fully rated at an ambient of 50 deg C.

**Type of Panel**

The medium voltage switch board panel shall comprise of any of the following types of switchgears as specified:

Air circuit breakers draw out type.

MCCBs should be suitable for Icu = Ics ratings. MCCBs shall invariably be current limiting type. Features like Double Break, positive isolation functions shall be preferred.

This specification covers the ‘General Requirement’ for the design, manufacture, supply performance, inspection, testing and commissioning including supply of indoor type low voltage switch boards panels up to 1100V including necessary termination cabling and bus work required for satisfactory operation .

The Panel boards including distribution boards and control panels shall be built in accordance with IEC-61439 “Factory Built Assemblies for Low Voltage” or BS-5486 “Factory-built Assemblies of Switchgear and Control Gear for Voltage up to and including 1000V AC and 1200V DC.

Specific requirements shall be in accordance with single line diagram / specification.

The technical parameters of switchgear equipments, transformers etc. shall be referred.

**Standards**

All equipment material and components shall comply with the requirements of the latest editions of Indian Standards with updated amendments. Standards and Regulations applicable in the area where equipments are to be installed should be followed.

The equipment offered complying with other standards shall be submitted with copies of standard followed and full details indicating merits of adopted standard over to specified standards.

The Panel boards shall be engineered and constructed in accordance with the latest revision of the following Indian and British standards:

IS 13947	: A.C. Circuit Breakers
IS 3427	: Metal enclosed Switchgear & Control Gear
BS 162	: Safety Clearances

IS 2705	: Current Transformers
IS 3156	: Voltage Transformers
IS 3202	: Code of Practice for climate proofing of electrical equipment
IS 375	: Marking & Arrangement for Switchgear Bus Bars, main connections and auxiliary wiring.
IS 722	: A.C. Electric Meters
IS 1248	: Direct acting Electrical Indicating Instruments
IS 3231	: Electrical Relays for Power System Protection
IS 2544	: Epoxy Cast Resin Insulators
IS 5082	: Electrolytic Copper/ Aluminium
IS 5792	: High Voltage HRC fuses
BS 88	: Cartridge fuses for voltages up to and including 1000V AC and 1500V DC.
BS 89	: Direct acting electrical indicating analogue electrical measuring instruments and their accessories.
BS 142	: Electrical protective relays
BS 159	: Bus-bar and Bus-bar connection
BS 1433	: Copper for electrical purposes. Rods and bars.
BS EN 60898	: Circuit-breakers for over current protection for household and similar installations.
BS 3938	: Current transformers
BS EN 60947-2	: Low-voltage switchgear and control gear, Part-2 circuit-breakers for control and auxiliary circuits, for voltages up to and including 1000V AC and 1200V DC).
BS 5419	: Air-break switches, air-break dis-connectors and fuse combination units for voltages up to and including 1000V AC and 1200V DC.
BS 5420	: Degrees of protection of enclosures of switchgear Part-I and control gear for voltages up to and including 1000V AC and 1200V DC.

BS 5424	:	Control gear for voltages up to and including 1000V AC and 1200V DC-Part-1
BS 5486	:	Requirement for type tested and partially type tested assemblies.
BS 5685	:	Electricity meters-Part-I: Class-0.5, 1 and 2 single phase and poly phase, single- rate and multi-rate watt-hour meters.
BS 5992	:	Electrical relays
BS 6004	:	PVC insulated cables, (non-armoured), for electric power and lighting.
BS 6231	:	PVC insulated cables for switchgear and control gear wiring.
IS 3043/ BS7430	:	Earthing

BS / IEC or IS standards not specifically mentioned above but applicable to the installation shall also apply.

### **Submission**

All technical submissions shall be approved by the contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of Engineer-in-charge for its review and approval.

Detailed co-ordination with other services shop drawings for various electrical layouts such as equipment layout and earthing layout including equipment installation and cable termination details etc. prior to start of work.

Such drawings shall show the proposed method of construction of the cubicles, equipment, bus bar layout, method of supporting equipment and Bus bar electrical control wiring diagrams, equipment weight, colors, and surface treatment.

The drawings shall also incorporate full list of proposed materials. The construction shall not commence until the drawings are approved for construction.

Factory and site testing procedures and report formats shall also be included. Preparation of bill of materials for different Items as mentioned. Lighting / power panel schedule.

Interconnection drawing.

Protection coordination drawings/tables for complete power system. Shop inspection and testing procedures.

Field testing and commissioning procedures.

Preparation of as built drawings for the services rendered by the Contractor.



Any other work or activity not listed above but necessary for completion of electrical system shall form part of the specification.

## **PRODUCTS**

### **Panel Board**

All the Main Panels/Motor control centers Distribution boards, Sub-Main Distribution boards, to be suitable for operation on three phase/ single phase, 415 Volts, 50 Hz neutral solidly grounded at transformer and short circuit level not less than 65 KA/ 50KA / 35 KA or as specified elsewhere at 415 Volts.

The main LT Panels will be Totally Type tested and manufactured by OEM only. Channel Partners are not acceptable.

Panel construction to comply Form of Separation of 4b for Main Panels of Transformer Supply, Form 3b for Sub LT Panels and Floor Panels and Form-2a required for Wall Mounting Panels. The main LT Panels for Transformer supply shall be Totally Type Tested (TTA), all other panels may be Partially Type Tested (PTA).

The switch boards shall be floor mounted free standing cubicle type totally enclosed and extensible type. The switch board shall be dust and vermin proof offering degree of protection not less than IP-42 and suitable for climatic conditions specified.

The design shall include all provisions for safety of operation and maintenance personnel. The general construction shall conform to IS 8623/1993 for factory assembled switch board.

All factories built assemblies subject to rain or wet conditions or located outside electrical switch room shall be of weatherproof construction conformation to IP 65 and able to withstand high impact strength of 60KN/m<sup>2</sup> (min.) temperature resistant, flame retardant and corrosion resistant.

The switchgear cubicles shall be rigid and robust in design and construction fabricated out of CRCA sheet steel not less than 2mm thick. Where ever necessary, such sheet steel members shall be stiffened by angle iron frame work

General construction shall employ the principle of compartmentalization and segregation for each circuit. Unless otherwise approved, incomer and bus section panels or sections shall be separate and independent and shall not be mixed with sections required for feeders. Each section of rear accessible type panel shall have hinged access door at the rear.

Overall height of the panel shall not exceed 2.4 Meters. Operating levers, handles etc of highest unit shall not be higher than 1.7 Meters.

Multi-tier mounting of feeders is permissible. The general arrangement for multi-tier construction shall be such that the horizontal tiers formed present a pleasing and aesthetic look. General arrangements shall be approved before fabrication.

Cable entries for various feeders shall be either from Top or Bottom of the panel. Through cable allies may be located in between two circuit sections either in the rear or in front of the panels.

All cable entries shall be through gland plates. There shall be separate gland plate for each cable entry so that there will not be dislocation of already wired circuits when the new feeders are added. Cable entry place therefore shall be sectionalized. The construction shall include necessary cable supporters for clamping the cable in the cable alley or rear cable chamber.

Cubicle panels with more than 1000Amps bus shall be made of tested structural modular sections.

All panels shall be of same height, width and depth. Panels shall be bolted together to form continuous flush front switch board suitable for front of board operation. .

All doors, panels, removable covers shall be provided with non-deteriorating (neoprene) gaskets all around the perimeter.

Floor mounted cubicles shall be provided with a 75mm high channel base frame. The total height of the cubicle shall not exceed 2400mm keeping in view the operating height of top switch should not exceed 1750mm from FFL including base channel.

Panel shall have 20% spare outgoing feeders and 25% spare space with complete wiring as outgoing feeders for future use.

### **Bus-Bars & Bus-Bar Chamber**

#### **Rating**

Bus bars shall be made of wrought aluminium or aluminium alloy, confirming to relevant Indian standard, as specified.

#### **Current density**

Cross-section of the busbars and current density shall be as per manufacturer's design & recommendation.

#### **Cross Section of Bus Bar**

The cross section of the Neutral Bus bar shall be same as of the phase bus bar for the bus bars of capacities up to 200 A ; for higher capacities, the neutral bus bar must not be less than half the cross section of that of the phase bus bar.

#### **Insulation**

Each bus bar shall be suitably insulated with PVC sleeves / tapes in approved manner

#### **Bus Bar Supports**

Bus bar Support insulators shall be Class F insulators made of non –hygroscopic, noncombustible, track resistant and high strength FRP / SMC / DMC material, and shall be of suitable size and spacing to withstand the dynamic stresses due to short circuit currents. The spacing between two insulators should not exceed 250mm.

#### **Bus Bar Clearances**

The minimum clearance to be maintained for enclosed indoor air insulated bus bar for medium voltage application shall be as follows:

<b>Between</b>	<b>Min clearance</b>
Phase to Earth	19mm
Phase to Phase	25mm

**Note:** For strip connection from bus bar to switch gear, the above clearances do not apply.

Bus bar Joints shall be thoroughly cleaned and suitable oxidizing grease shall be applied before making the joint.

High tensile bolts, plain and spring washers shall be provided to ensure good contacts at the joints.

The overlap of the bus bar at the joints shall be not less than the area of cross section of bus bars.

Bus bars & bus bar connections shall be of uniform cross section shall be suitable for carrying rated current continuously and short circuit current for specified duration without overheating.

Normal operating temperature for bus bars shall be 85 Deg C. Short circuit rating of the bus bars shall be 20 to 65KA for 1sec as per calculations.

Direct access to accidental contact with bus bars and primary connections shall be avoided by providing shrouds. All apertures and slots shall be protected by barriers to prevent accidental short circuiting of bus bars. To provide a tight seal between cubicles, bushings or insulating panels shall be provided for bus bars crossing from one cubicle into another.

All bus bars shall be color coded as per IS: 375.

### **Current Transformers (CT'S)**

Accommodation shall be provided in the circuit breaker panel to mount one set of three number dual core ratio CT's for metering and protection purposes. Access to the CTs for cleaning, testing or changing shall be from front, back or top of the panel.

Current transformers ratings shall be dual core and dual ratio CTs of suitable burden (but not less than 15 VA) shall be preferred with 5 Amp secondary.

Secondary terminals of CT shall be brought out suitably to a terminal block which will be easily accessible for testing and terminal connections.

The protection CTs shall be of accuracy class 5 P 10 of IS 2705 – Part – III -1992.

The Metering CTs shall conform to the metering ratio and accuracy class 0.5 of IS 2705 – 1992.

Current transformers shall conform to latest edition to relevant standards. The Current transformers shall be epoxy resin cast with bar Primary or ring type.

The design and construction shall be sufficiently robust to withstand thermal and dynamic stresses due to the maximum short circuit current of the circuit.

CT core laminations shall be of high grade silicon steel.

Rating plate details and terminal markings shall be according to the latest edition of relevant Indian Standard specification.

Current transformers (core) shall be used for metering and protection.

### **Potential Transformers (PT'S)**

Potential Transformers shall conform to latest edition of relevant standards.

Potential transformers shall be dry, cast epoxy resin type. The PTs shall be of single phase construction.

The PT'S shall be capable of operating continuously at 110% of the rated voltage without any damage. When star - star connection is required in non-effectively or ungrounded system, the PT'S shall be suitable for continuous operation with a persistent phase to ground fault.

Maximum temperature rise of the transformer at rated burden and with rated primary voltage and frequency shall not exceed 40 Deg's above an ambient of 50 deg C

Voltage transformer of burden not less than 100 VA and of the proper ratio and of proper ratio as specified shall be provided at the incoming panel. The accuracy class for the VT shall be class 0.5 as per IS 3156 Part-I to III for incomer and class 1 for outgoing panels.

The transformer shall be of cast epoxy resin construction. It shall be fixed/ withdraw able type. HRC fuses/MCBs shall be provided on both HV & LV side. It shall be possible to replace PT fuses easily without having to de-energies the main bus bars. Prospective interrupting current rating of the fuses shall be same as the system fault level.

Voltage transformer ratio, output and class shall be as specified in the drawing & specifications for engineers approval with relevant standards.

### **Protective Relays**

All relays shall be numerical type with communication port. Relays type and numbers shall be in accordance with the protective scheme specified or as per drawings or requirement.

Relays shall be enclosed in rectangular shaped cases suitable for flush mounting dust tight covers projecting from the front cover panel. The case shall be dust tight, damp proof and tropicals.

Relays shall be accessible for setting from the front. Access to setting devices shall be possible only after removal of front cover.

Protective relays shall be draw-out type. Where it is not possible to provide protective relays of the draw out pattern fixed type relays with facilities for plugging in a portable test plug shall be provided. Necessary test plugs shall be furnished along with the relays.

Relays shall be provided with positive action self reset type with indicator. The indicators shall be visible from the front.

Relays conform to relevant standards in all respects.

Relays shall be provided with minimum two pairs of self or hand reset type contacts as specified. Auxiliary relays shall have the number of NO and NC contacts as specified in data sheet.

### **Incomer / Termination**

Incomer termination shall be suitable for receiving bus trunking / underground cables. Cable shall invariably be through terminal blocks (Polyamide or Superior) or brought out solid terminals.

The housing material shall have unbreakable and fire retardant characteristic. All the metal parts shall be made up of copper alloy including the screws. Mounting shall be DIN or G-Rail type. Screws shall be captive type. No protection cover is required and the block shall be touch proof.

### **Instrument / Indication Lamp**

All Voltmeters and Ammeters shall be flush mounted of size minimum 96mm conforming to class 1.5 of IS:1248 for accuracy. All voltmeters shall be protected with MCB.

Multi-function meter of CL 1.0 accuracy with RS 485 port shall be provided.

On all the incomers of HT panels, ON/OFF indication LED lamps shall be provided and shall be suitable for operation on AC supply. Phase indicating lamps shall be associated with necessary ON / OFF toggle switch.

LED type indicating lamps shall be provided everywhere except where low voltage filament type with series resistor called for.

Lamp covers shall be provided with interchangeable colored lenses of Perspex or equivalent unbreakable material. The lenses shall not discolor in course of time due to heat of the lamp.

Bulbs and lenses shall be interchangeable and replaceable from the front.

Following colors shall be used for the function indicated:

Red	- Circuit Breaker 'ON'
Green	- Circuit Breaker 'OFF'
White	- Continuous trip supply supervision
Amber	- Auto trip
Blue	- Spring charged
R, Y, B	- Potential indication

**Push Buttons**

All push buttons shall be push to actuate the contact type.

Start & Stop push buttons shall be colored green and red respectively. Reset push buttons shall be yellow in color and test push buttons shall be blue in color. All other push buttons shall be black in color.

Emergency stop push buttons shall be lockable in the operated position, i.e. push to operate and key to release type. Push buttons for emergency stop shall be recessed/shrouded type to avoid accidental operation.

**Control & Selector Switches**

Control and Selector switches shall be of rotary type, having enclosed contacts accessible only after removal of cover.

All control and selector switches for circuit breakers and instruments shall be mounted on the front of the panel. Control switches for space heater/s and control supplies shall be mounted inside the panel.

Circuit Breaker control switches shall be provided with pistol grip handles. Selector switches shall be provided with round, knurled handles. All handles shall be black in color. Properly designated escutcheon plates clearly marked to show the operating positions shall be provided on all switches.

Circuit breaker control switches shall normally have three position close - Normal - Trip with spring return to normal position. Switch operating mechanism shall prevent the switch from being operated twice successively in the same direction. Circuit breaker control switch shall have one NO-NC contact along with other contacts as required.

All other instruments and selector switches shall have stay put contacts.

Contacts of all control and selector switches shall be rated for 10Amps at 240V, AC or 20Amps at 220V DC (inductive break). Switch for space heater supply and control voltage supply shall normally be two pole rated for 25A, AC.

**Control Terminal Block**

Box - clamp type, 650V grade line up terminals of minimum 2.5 sqmm size shall be provided. Connection to terminals shall be from front.

Not more than one wire on each side shall be connected on any terminal. Where duplication of terminals block/s is necessary, suitable solid bonding links shall be incorporated.

Terminal blocks at different voltage shall be segregated into groups and distinctly labeled.

Current transformer secondary leads shall be brought to terminal blocks having facility for short circuiting and grounding the secondary.

Terminals shall be numbered for identification and grouped according to function. Engraved back on white PVC labels shall be provided on the terminal blocks describing the function of the circuit.

Separate terminal stems shall be provided for internal and external wiring.

Control terminal blocks shall be so located that control cables are fully segregated from power cables. Suitable insulated or earthed metal race ways shall be provided for control wiring. Separate unrolled removable gland plate shall be provided for the control cables at the bottom of each panel.

Minimum 10% of total number spare terminals shall be provided for future use.

### **Small Wiring**

All wiring for Controls, Indication, protection, alarm and indicating circuits of all equipment shall be of suitable FRLS/HFFR (Halogen free fire retardant) copper conductor cable.

All wiring shall be suitably protected with in switch board. Runs of wire shall be neatly bunched, suitably supported and clamped.

Means shall be provided for easy identification of the wires. Identification ferrules shall be used at both ends of the wires. Ferrules shall fit tight on the wires, without falling off when wire is removed. Ferrules shall be of white color with black lettering. Each wire shall be identified by letter to denote its function followed by a number to denote its identity at both ends.

Where wires are drawn through steel conduits, the work shall confirm to CPWD General Specification for Electrical works Part-I-Internal)-.2013 and IS: 732 as the case may be.

All control wiring meant for external connections are to be brought out of terminal board.

All wiring shall be color coded as follows:

Instrument Transformer AC circuit	- Red, Yellow & Blue wire associated by phases
AC Phase Wire	- White
AC Neutral	- Black
DC Circuits	- Grey
Earth connections	- Green

All unused auxiliary contacts of the circuit breaker and relays shall be wired up to terminal block

### **Safety/ Protection & Interlocks / Features**

Following interlocks and features shall be incorporated for equipment protection and personnel safety under mal-operation. No deviations on these interlocks and safety features are allowed. These interlocks and safety features shall be fail-safe positive and full-proof.

It shall not be possible to plug-in or isolate a closed circuit breaker. An attempt to do so shall trip the breaker. (In case of breakers with vertical isolation, this will apply to raising and lowering). There shall be a positive locking facility to prevent closing of circuit unless it is in Service or Test position.

Closing and opening operations shall be possible only in discrete, well defined Test and Service positions and not in any position midway. An extension adapter cable with plugs and sockets shall preferably be provided so that the closing and opening operation of the circuit breaker can be done in fully withdrawn position outside the cable.

Slow operation of circuit breakers shall be possible only in the circuit breaker in Test or Isolated position.

Isolating switches if provided shall be interlocked with respective circuit breakers to prevent them making or breaking the current.

1 No. bus earthing truck shall be supplied with each panel to earth the outgoing cable of the VCB breaker.

Automatic safety shutters for all openings which will lead to access to the live parts of the switchgear upon withdrawal or any operation the switchgear components/parts shall be provided, preferably with a padlocking facility.

Spring of motor operated spring charged mechanism shall not discharge until they are fully charged and charging means are fully disconnected.

Where interlocking key is employed tripping of closed circuit breaker shall not occur if any attempt is made to remove the trapped key from the mechanism.

Any other interlock considered to be provided which manufacturer may deem to be required for safety and specifically specified separately required for the system shall be included.

All terminals, connections which may be live and exposed for accidental contact shall be adequately shrouded.

Components within cubicles shall be properly labeled to facilitate testing.

### **Earthing**

2 Nos 20 x 3 mm GI strip for LT panel up to 400 Amp and 25 x 5 mm GI strip for LT panel of higher capacity shall be provided all around the panel connected to 2 Nos earth bus copper strips connected to incoming conductors.

All non-current carrying metal parts frames and equipment mounted in the switch board shall be bonded to earth bus.

Earthing of moving carriage of draw out equipment shall be achieved by scraping earthing device. The earthing device shall maintain positive earth continuity in all Service Test and Isolated positions.

It shall be possible to connect each circuit or set of three phase bus bars to earth either through earthing trucks or through the circuit breakers.

One earthing trolley suitable for earthing of cables & bus bars for all circuit breakers of the same type / rating shall be provided

### **Name Plates and Labels**



One Name plate giving designation of the MV switchboard shall be affixed prominently on top of the switch board. Details of designation will be specified.

Labels with following details shall be affixed on each feeder panel:

Feeder Number.

Equipment reference Number & Description

**Rating (HP/kW/kVA/Amp.)**

All components whether mounted inside or on the door shall be permanently and clearly labeled with reference number / letter or their function. Rating of fuse shall be part of fuse designation. Paper labels, stickers or labels fixed with adhesives are not acceptable. All labels shall be properly fixed by screws with provision to prevent distortion due to expansion.

All labels shall be non-corroding, preferably laminated plastic or rear engraved Perspex with white letters on black background.

Labels for feeder panel designation fixed on front side shall be fitted with chrome plated, self tapping, and counter sunk head screws. These labels shall be of identical size to permit interchange.

**Cubicle Lighting**

Each cubicle shall be provided with interior lighting by means of LED light fixture. An ON/OFF switch/door switch shall be provided. The lighting fixture shall be suitable for operation from 240V single phase, 50 Hz. A.C. supplies.

**Auxiliary Supply**

Auxiliary supply for control, indication, space heater etc. shall be made available at one point on the switch board. Vendor shall provide suitable auxiliary supply in the switch board.

**Fuses**

Fuses shall be HRC cartridge link type (Diaz- zed Fuses are not acceptable) and shall be provided with operation indicator which shall be visible without removal of fuses from service.

Fuses shall be pressure fitted type and shall preferably have ribs on the contact blades to ensure good line contact.

It shall be possible to handle fuses during off load conditions with full voltage available on the terminals. Wherever required fuse pullers shall be provide. The fuse bases shall be so located in the modules to permit insertion of fuse pullers and removal of fuse links without any problems.

Mounting of fuse fitting shall ensure adequate dissipation of heat generated and shall facilitate inspection and easy replacement of fuse.

**Contactors**

The contactors shall be air break type, equipped with three main contacts and minimum 2NO + 2NC auxiliary contacts. The main contacts of a particular contactor shall have AC 3 ratings for unidirectional motors & AC 4 for reversible motors.

The auxiliary contacts shall be rated for minimum 5 Amps at 240V AC and 1.3 Amps at 110V DC (Inductive load).

Unless specified otherwise, the coil of the contactor shall be suitable for operation on 240V, (+) 10% & (-) 15% 1-Ø, AC supply. The drop off voltage of shall be 15% to 65% of the rated coil voltage.

### **Single Phasing Preventer (SPP)**

Unless specified otherwise SPP's shall be provided in all motor starter modules with contactor rating of 200 Amps and above. The SPP shall be of the current operated type and shall operate on the principle of sensing negative sequence component of current.

In case of single phasing, the SPP shall operate after a time delay of 2 to 3Secs. The relay shall be of the hand reset type and visual indication of the relay operation shall be available.

The SPP shall be suitable for protection of the non-reversible and reversible motors. The relay operation shall be independent of the loading and RPM of the motor prior to the occurrence of single phasing.

## **EXECUTION**

### **Testing and Commissioning**

All panel boards shall be inspected & tested in the presence of Engineer-in-charge or his representative. Engineer-in-charge after inspection shall issue inspection certificate for materials as per specification and commissioning the panels.

Generally such tests in the factory and repeated at site are as follows:

All routine tests specified in relevant Indian / British Standards shall be carried out on all circuit breakers.

Test for protective relay operation by secondary injection method.

Operation of all meters.

Secondary wiring continuity test

Insulation test with 1000Volts megger before and after voltage test.

HV test on secondary wiring and components on which such test is permissible (2KV for one minute)

Simulating external circuits for remote operation of breaker, indicating lights and other operations, if any.

Measurement of power required for closing/trip coil of the breaker.

Pick up and drop out voltages for shunt trip and closing coils.

CT Polarity test.

Power frequency voltage withstand test.

Earth continuity test;

Check of clearance and creep age distances;

Tests to prove correct operation of controls, interlocks, tripping and closing circuits, indications, etc.;

Interfacing test with BMS control function

All other tests required by the Engineer-in-charge to verify compliance with the Specification.

All principal test records and test certificates shall be supplied in triplicate for all the tests conducted in accordance with the Specification to the Engineer-in-charge for approval before dispatch from the factory.

All materials, instruments and, labour, etc. required for conducting the tests shall be provided by the contactor at no extra cost.

### **Drawings and Information**

The Vendor shall furnish following drawings/documents in accordance with enclosed requirements:

General Arrangement drawing of the Switchboard, showing front view, plan, foundation plan, floor cut-outs/trenches for external cables and elevations, transport sections and weights.

Sectional drawings of the circuit breaker panels, showing general constructional features, mounting details of various devices, bus bars, current transformers, cable boxes, terminal boxes for control cables etc.

Schematic and control wiring diagram for circuit breaker and protection including indicating devices, metering instruments, alarms, space heaters etc.

Terminal plans showing terminal numbers, ferrules markings, device terminal numbers and function details etc.

Relay wiring diagrams.

Equipment List.

Vendor shall furnish required number of copies of above drawings for purchaser's review. Fabrication of switch boards shall start only after purchaser's clearance for the same. After final review, required number of copies and reproducible shall be furnished as final certified drawings.

The information furnished shall include the following:

Technical literature giving complete information of the equipment.

Erection, Operation and Maintenance Manual complete with all relevant information, drawings and literature for auxiliary equipment and accessories, characteristics curves for relays etc.

A comprehensive spare parts catalogue.

### **Tools**

One complete set of all special or non-standard tools required for installation, operation and maintenance of the switch board shall be provided. The manufacturer shall provide a list of such tools individually priced with his quotation.

### **Spares**

The manufacturer / tenderer shall be responsible for commissioning of the equipment supplied by them. During commissioning if any of the components fails the same shall be replaced with new spare part with in the quoted price. Contractor shall ensure availability of commissioning spares and tools at site. The details for all such spare parts and tools shall be submitted in the tender. On commissioning of the system unutilized spares and tools shall be retained by engineer-in-charge and nothing extra shall be paid on this account. The delay in commissioning of system for want of spares shall be termed as delay in completion of contract and shall be dealt as per related terms of contract.

The Contractor shall also furnish minimum recommended spare parts required for three years with their prices. Availability of spares shall be guaranteed for rated life of the equipment.

### **Transportation**

Panel boards are not allowed to be delivered to site until the electrical room or switch room is in clean and acceptable condition with lockable doors.

Panel boards, transported to site shall be fully covered with weatherproof covers and transportation eye bolts shall be provided for handling at site.

Panel boards, which are poorly packed and result in signs of corrosion, will be rejected.

All necessary measures to cover and protect the panel boards at site shall be provided. Such measures shall include a complete PVC blanket over the whole panel boards.

### **Rejection of Panel Boards**

Deviation from specification must be stated in writing at the quotation stage.

In absence of such statement, it will be assumed that the requirements of the specifications are met without expectation.

If any of the above tests fail to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site, the Engineer may reject the item or defective component thereof, whichever is considered necessary, and after adjustment or modification as directed by the Engineer, the Contractor shall submit that item for further inspection and/or test. In the event of the defective item being of such nature that the requirements of this specification cannot be fulfilled by adjustment or modification, such item is to be replaced by the Contractor at his own expense, to the entire satisfaction of the Engineer. Delivery of panel boards on site without significant cable connection (Say 80%) shall not entitle progress payment certified for material delivery on site.

## CAPACITORS & CAPACITOR CONTROL PANEL

Power factor correction capacitors shall conform in all respects to IS 2834-1964 IS-13340 and latest IEC specification. The capacitors shall be suitable for 3 phase 440 V at 50Hz frequency and shall be available in units of 25/50/100 KVAR size (heavy duty) with self heating property to form a bank of capacitors of desired capacity. All these units shall be connected in parallel by means of high conductivity electrolytic copper bus bars of adequate current carrying capacity having S.C rating of 50 KA for 1 sec. Each capacitor bank shall be for PVC insulated aluminum conductor armored cables. Two separate earthing terminals shall be provided for each bank for earth connection.

The capacitor bank shall be subject to routine tests as specified in relevant Indian Standard and the test certificate shall be furnished. The capacitor shall be suitable for indoor use up to 45 Deg.C over and above ambient temperature of 50degree C. The permissible overloads shall be as given below:

- a) Voltage overload shall be 10% for continuous operation and 15% for 6 hours in a 24 hours cycle.
- b) Current overload 15% for continuous operation and 50% for 6 hours in a 24 hours cycle.

The capacitor banks shall be floor mounting type indoor housing using minimum floor space. with protective guard or fencing.

Capacitors shall be of metallized polypropylene film (capacitor grade). Hermetically sealed in sturdy corrosion-proof sheet steel 2mm thick containers and impregnated with non-inflammable synthetic liquid and of low power loss version. Every element of each capacitor unit shall be provided with its own built in silvered fuse. The capacitor shall have suitable discharge device to reduce the residual voltage from crest value of the rated voltage to 50 V or less within one minute after capacitor is disconnected from the source of supply. The loss factor of capacitor shall not exceed 0.005 for capacitors with synthetic impregnant. The capacitors shall withstand voltage of 2500V AC supply for 1 minute.

The insulation resistance between capacitor terminals and containers when test voltage of 500V AC is applied shall not be less than 50 mega ohms.

- Capacitor bank and switching equipment shall be housed in a cubicle having degree of protection IP-51 and constructed with sheet steel of minimum 2mm thickness.
- Capacitors shall be unit type having non-PCB, non-flammable non-toxic dielectric.
- Necessary discharge register shall be provided externally to reduce the terminal voltage to less than 50V in 60 seconds after disconnection from supply.
- Testing shall be done as per applicable standards for shunt capacitors.

## CAPACITOR CONTROL PANEL

The capacitor control panel shall generally comprise of the following:

- a) Automatic power factor correction relay. (APFCR)
- b) Step controller with reversing motor.
- c) Time delay and no-volt relays.

- d) Protection MCCB with static O/C and S/C releases.
- e) Contactor for individual capacitors of suitable rating.
- f) Change over switch for either automatic or manual operation with push button control.
- g) CTs with ammeter and selector switch.
- h) Voltmeter with selector switch.
- j) Indicating lights RYB.

All the capacitors and contactors shall be interconnected with PVC insulated copper conductor wires of adequate size in a neat and acceptable manner. Three phases and neutral bus bar shall be provided in panel as required.

The above control gear, Digital Microprocessor based APFC relay, push button station etc. shall be housed in a sheet steel metal enclosure cubical type, freestanding front operated with lockable doors. The panel shall be fabricated from MS sheet steel 2mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet steel shall be seam-welded. The panel shall be totally enclosed dust tight, vermin proof and ventilation louvers with wire mesh inside. Gaskets between all adjacent units and beneath all covers shall be used to render the joints effectively.

All sheet steel material used in the construction of capacitor control panel should be painted as per the painting clause with approved shade.

#### **Gas Flooding System in Electrical Panels (Main LT Panel, DG Synchronization and capacitor Panels and as per NBC-2016 provisions)**

#### **ELECTRICAL PANEL PROTECTION SYSTEM**

The system will be provided in Main LT Panel , DG Synchronization and capacitor Panels and as per NBC-2016 provisions.

Electrical Panel Protection System: This includes Supply, Installation, Testing and Commissioning of FK-5-1-12 (Dodecafluoro-2-Methylpentan-3-one) / Novec-1230 or equivalent gas Suppression system in accordance with the Contract Documents.

#### **Scope of Work:**

- a. Supply, Installation, Testing and Commissioning of clean Agent (Novec 1230/ FK5-1-12 or equivalent) Fire Suppression system designed to provide a uniform concentration within the electrical panels in accordance with NFPA2001 and requirements of the contract documents).
- b. Provide all engineering design and materials for a complete agent suppression system including FK-5-1-12 storage cylinders with steel bracket, extinguishing agent, detection tube, cylinder valve and associated accessories including but not limit to; adaptors, pressure switch, tube fittings etc, required for complete operation of system.
- c. All necessary safety requirements such as warning signs, discharge alarm shall be part of system.
- d. The necessary nomenclature such as pressurization level, agent volume, gross/net weight of cylinder shall be clearly marked on cylinder.

- e. Prior to supply of material at site. Contractor must submit following documents for approval of Engineer-in-charge.
- f. Drawing in A-4 size, clearly showing the panel, routing of tube inside the panel, location and fixing arrangement of cylinder & system components.
- g. All doors and holes in the enclosed/equipment's should be closed or sealed to maintain the tightness of enclosure.

#### System Description:

- a) The detection tube shall be fixed with cylinder valve at top of cylinder. The tube shall be pressurized with dry nitrogen. In case of reach of pre-determined temperature (100-120oC), the tube shall rupture gas shall be released from tube over the protected area.
- b) The pressure switch shall be provided for necessary indication of discharge of gas.
- c) The Extinguishing Agent shall be stored in cylinder as liquefied compressed gas, super pressurized with dry nitrogen at 15 Bar.
- d) The cylinder shall be equipped with brass valve, pressure gauge (to monitor agent pressure) and isolation valve for maintenance purposes. The cylinder bracket shall be of steel construction with quick release clamp.
- e) The detection tube shall be installed throughout the compartments of panel. The location and spacing of tube shall be above the hazard, to be protected.
- f) In case of fire, the tube shall rupture at a point. The rupture of tube shall result in formation of discharge point and release the agent in uniform pattern.
- g) With system activation, a signal should be generated via Audio Visual Alarm installed at convenient location as per Engineer-in-Charge.

#### System Components:

The bidder shall provide an under taking from Principle Manufacturer of CE marked product they intent to install, that manufacturer will fully support the bidder for this specific project.

- a) Cylinder of steel construction with standard red epoxy paint finish. Cylinders shall be accompanied by original manufacturers test certificate confirming the contents of the cylinder.
- b) The cylinders shall be from reputed Manufacturers only. Cylinders shall be super pressurized with dry nitrogen to an operating pressure and temperature as per manufacturer recommendations.
- c) Each cylinder shall have pressure gauge and low pressure switch to provide visual and electrical supervision of the cylinder pressure. The low pressure switch shall be wired to the Audio Visual Alarm to provide audible and visual trouble alarm in the event of drop of pressure. The pressure gauge shall be color coded to provide an easy, visual indication of cylinder pressure.

- d) Furnish a welded steel bracket with each cylinder assembly for holding the cylinders in a saddle with a front bracket piece that secures the cylinders.
- e) Cylinder shall be provided with a certificate provided by the company who charge with the FK-5-1-12 gas mixture. The certificate shall be secured around the cylinder with chain fastener.
- f) The Detection Tube, LPCB/UL/CE approved to be Red Colour and pressurized at 15 Bar. The Detection Tube to rupture between (100-120oC).
- g) The Pressure Switch should be CE Marked having NO/NC contact.
- h) The cylinder should be manufactured as per BIS 15683 specifications.
- i) The control panel shall have provision for integration with Fire Alarm / BMS.

#### Extinguishing Agent

FK-5-1-12 (Dedecafluoro-2-Methylpentan-3 One – CF<sub>2</sub>CF<sub>2</sub>C (O) CF (CF<sub>3</sub>)<sub>2</sub>

- (a) The agent shall not contain any Hydrofluorocarbons (HFC).
- (b) The ozone depletion potential should be zero.
- (c) The Global warming potential should be equal to or less than 1.
- (d) The Extinguishing Agent should be UL Listed/ FM approved.
- (e) The extinguishing agent should be filled in an UL Listed or FM approved filling station.

#### Installation

- a) The system shall be installed on basis of approved drawing.
- b) The installation / final connections shall carry out in direct supervision of representative of Manufacturer/authorized distributors.
- c) The installation contractor should be a proven source with minimum 5 years of installation of Trace Tube Systems in India.
- d) Cylinder shall be located so that they are not subjected to mechanical, chemical or other damage.
- e) All system components shall be capable of withstanding heat of fire and severe weather conditions.
- f) Detection Tube to be properly secured inside the panel by Clips/Tie etc.
- g) The Detection Tube outside the panel should be protected in flexible conduit.
- h) Inspection certificate should be pasted on cylinder clearly marking next due date of inspection.



**SUB HEAD – 6****MULTI FUNCTION METER****General Provisions:**

All setup parameters required by the Multifunction Meter with communication port shall be stored in non-volatile memory and retained in the event of a control power interruption.

The Multifunction Meter may be applied in three-phase, three- or four-wire systems as well as single phase

The Multifunction Meter shall be capable of being applied without modification at nominal frequencies of 45 to 65 Hz.

**Measured Values:**

The Multifunction Meter shall provide the following, true RMS metered quantities:

Real-Time Readings

Current (Per-Phase)

Voltage (L–L, L–N)

Real Power (Total)

Reactive Power (Total)

Apparent Power (Total)

Power Factor (Total)

Frequency

**Energy Readings**

**Signed Accumulated Energy (Real kWh\*, Signed Reactive kVarh\*, Apparent kVAh) (Absolute)**

**Demand Readings**

Demand Current Calculations (Per-Phase):

Present

Peak

Demand Real Power Calculations (Total):

Present

Peak

Demand Reactive Power Calculations (Total):

Present

Peak

Demand Apparent Power Calculations (Total):

Present

Peak

KWh and kVArh are signed net consumption values.

### **Demand**

All power demand calculations shall use any one of the following calculation methods, selectable by the user:

Block interval, with optional sub-intervals. The window length shall be set by the user from 1-60 minutes in 1 minute intervals. The user shall be able to set the sub-interval length from 1-60 minutes in 1-minute intervals. The following Block methods are available:

Sliding Block that calculates demand every 15 seconds with intervals less than 15 minutes and every 60 seconds with an interval between 15 and 60 minutes.

Fixed Block that calculates demand at the end of the interval.

### **Sampling**

The current and voltage signals shall be digitally sampled at a rate high enough to provide true r.m.s. accuracy to the 15th harmonic.

The Multifunction Meter shall provide continuous sampling at a minimum of up to 32 samples/cycle, simultaneously on all voltage and current channels in the meter.

### **Current Inputs**

The Multifunction Meter shall accept current inputs from standard instrument current transformers with 5 amp secondary output and shall have a metering range of 0-6 amps with the following withstand currents: 10 amp continuous, 50 amp 10 sec per hour, 120 amp 1 sec per hour.

Current transformer primaries through 327 kA shall be supported.

### **Voltage Inputs**

The Multifunction Meter shall allow connection to circuits up to 480 volts AC without the use of potential transformers. The Multifunction Meter shall also accept voltage inputs from standard instrument potential transformers. The Multifunction Meter shall support PT primaries through 1.6 MV.

The nominal full scale input of the Multifunction Meter shall be 277 Volts AC L-N, 480 Volts AC L-L. The meter shall accept a metering over-range of 20%. The input impedance shall be greater than 2 Mohm (L-L) or 1 Mohm (L-N).

**Accuracy**

The Multifunction Meter shall comply with ANSI C12.16 and IEC-62053-21, Class 1

Functions performance class according to IEC 61557-12 (with CT ratio=1:1 and PT ratio=1:1) are, Class 0.2 for Voltage L-L from 30 Vac–480 Vac. Class 0.2 for Phase Current from  $25\%I_n < I < I_{max}$  Class 1.0 for Total Active Power from  $1\% I_n < I < I_{max}$  and 0.5 Ind to 0.8 Cap. Class 1.0 for Total Active Energy from 0 - 9999999.9 kWh. Class-1.0 for Power Factor Vector from 0.5 Ind to 0.8 Cap. And Class 0.02 for Frequency from 45Hz - 65 Hz. (PM700)

No annual calibration shall be required to maintain this accuracy when the Multifunction Meter operates under specifications.

**Input/ Output**

The Multifunction Meter shall supply 2 pulse outputs as standard.

The Multifunction Meter shall be capable of operating a solid state output to provide output pulses for a user definable increment of reported energy. Minimum relay life shall be in excess of one billion operations. The standard pulse output shall operate up to 240 volt AC, 300 volt DC, 96mA max, and provide 2.41 kVolt rms isolation

**Control power:**

The Multifunction Meter shall operate properly over a wide range of control power including 110-415VAC, +/-10% or 125-250VDC, +/-20%.

**Communications:**

The Multifunction Meter shall communicate via RS-485 Modbus protocol with a 2-wire connection at speeds up to 19.2 kBaud.

It shall be possible to field upgrade the firmware in the Multifunction Meter to enhance functionality. These firmware upgrades shall be done through the communication connection and shall allow upgrades of individual meters or groups. No disassembly or changing of integrated circuit chips shall be required and it will not be necessary to de-energize the circuit or the equipment to perform the upgrade.

**Display**

The Multifunction Meter display shall be back lit LCD for easy viewing, display shall also be anti-glare and scratch resistant

The Display shall be capable of allowing the user to view four values on one screen at the same time. A summary screen shall also be available to allow the user to view a snapshot of the system.

The display shall include two different modes of visualization, IEEE and IEC for all quantities.

The Display shall show 3 phase bar graphs

The Multifunction Meter display shall provide local access to the following metered quantities:

Current, per phase rms

Voltage, phase-to-phase, phase-to-neutral

Real power, 3-phase total

Reactive power, 3-phase total

Apparent power, 3-phase total

Signed Power factor, 3-phase total

Frequency

Demand current, per phase

Demand real power, three phase total

Demand apparent power, three phase total

Signed Accumulated Energy, (kWh, kVAh, and kVARh)

Reset of the following electrical parameters shall also be allowed from the Multifunction Meter display:

Peak demand current

Peak demand power (kW, kVA, kVA)

Energy (MWh) and reactive energy (MVARh)

Setup for system requirements shall be allowed from the Multifunction Meter display. Setup provisions shall include:

CT rating

PT rating (Single Phase, 2-Wire)

System type [three-phase, 3-wire] [three-phase, 4-wire] [2 wire]

Watt-hours per pulse (PM200P Only)

Communication parameters such as address and baud rate

### **Upgrades**

It shall be possible to field upgrade the firmware in the Multifunction Meter to enhance functionality. These firmware upgrades shall be done through the communication connection and shall allow upgrades of individual meters or groups. No disassembly, changing of integrated circuit chips or kits shall be required and it will not be necessary to de-energize the circuit or the equipment to perform the upgrade.

**Installation**

To ensure safety of goods and people, the installation category of the Multifunction Meter shall be III. The communication circuit shall be of SELV type (security extra low voltage) and shall provide a class II insulation level between distribution system connection and communication port.

The Multifunction Meter shall be rated for an operating temperature range of 0°C to +60°C.

Depth of the Multifunction Meter behind panel with communication port shall be equal or less than 50mm.

**Standard**

The multifunction meter shall comply with the following standards.

IEC 62053-22 – Active Energy Class 1

IEC 61557-12

IEC 61010-1 – Safety

**SUB HEAD – 7****CIRCUIT BREAKER****GENERAL****Scope**

Circuit breaker i.e. Air-circuit breaker (ACB), Moulded Case Circuit Breakers (MCCB), Miniature Circuit Breakers (MCB) and Residual Current Circuit Breakers (RCCB/RCD) shall be provided according to the specification.

All breakers shall be capable to withstand the electrical, mechanical and thermal stress of the prospective fault level experience. The prospective fault levels of the various breakers shall be verified according to result in short circuit / co-ordination study specified in specification.

The drawings, specification complement each other and which is shown or called for one shall be interpreted as being called for on both. Material, if any, which may not have been specified but fairly required to make a complete assembly of switch gear as shown on the drawing, specifications shall be construed as being required and no extra charges shall be payable on this account.

**Standards**

All equipment, material and components shall comply with the requirements of the latest editions of Indian Standards with updated amendments. Standards and Regulations applicable in the area where equipment is to be installed shall also be followed.

The equipment offered complying with other standards, these standards shall be equal to or superior to those specified and full details of the differences shall be furnished along with the tender.

The Panel boards shall be engineered and constructed in accordance with the latest revision of the following Indian and British standards:

1.	IS:13947: 1993	Air circuit breaker/molded case circuit breaker
2.	IS: 3156: 1964	Voltage Transformers
3.	IS 2705	Current Transformer for metering and protection with classification burden and insulation.
4.	IS: 9224	Low voltage fuse and protection.
5.	IS: 3231	Specification for electrical relays for power system protection.
6.	IS:8623	Specification for factory-built assemblies of switchgear and control gear for voltage upto and including 1000V, AC / 1200V, DC.

7.	IS: 4237	General requirements for switch gear and control gear for voltage not exceeding gear.
8.	IS: 2147	Degree of protection provided enclosures for low voltage switch gear and control gear
9.	IS: 1018	Switchgear and control gear selection / installation & maintenance.
10.	IS: 1248	Direct acting electrical indicating instruments.
11.	IS: 375	Arrangement for switchgear, bus bars, main connections, auxiliary wiring and marking.
12.	IS: 2959	AC contactors for voltage not exceeding 1000V.
13.	IS: 5578	Guide for marking of insulated conductors.
14.	IS: 11050	Guide for forming system of marking and identification of conductors & apparatus terminal.
15.	IS: 1248	Direct acting indicating analogue electrical measuring instruments and testing accessories
16.	IS: 6005	Code of practice for phosphating of iron & steel.
17.	BS EN 60898	IEC Circuit breakers for over current protection for household and similar installations 898
18.	BS EN 60947-2	Low-voltage switchgear and control gear, Part -2 circuit breakers IEC 947-2
19.	BS 5419	Air-break switches, air-break disconnectors and fuse combination units for voltage up to and including 1000V AC and 1200 V DC.
20.	BS 5486	Low-voltage switchgear and control gear Part-I, assemblies. Part-II requirement for type tested and partially type tested assemblies
21.	BS 4293	Residual Current Circuit Breaker

BS/IEC or other National standards not mentioned above but are applicable to this installation shall also apply.

### Submission

All technical submissions shall be approved by the contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of Engineer-in-charge for its review and approval.

A component list and catalogues.

Preparation of bill of materials for different Items as mentioned.

Factory and site testing procedures and report formats shall also be included. Protection co-ordination drawings/tables for complete power system.

Shop inspection and testing procedures. Field testing and commissioning procedures.

General Arrangement drawing of the switchboard, showing front view, plan, foundation plan, floor cutouts/trenches for external cables and elevations, transport sections and weights.

Sectional drawings of the circuit breaker panels, showing general constructional features, mounting details of various devices, bus bars, current transformers, cable boxes and terminal boxes for control cables etc.

Schematic and control wiring diagram for circuit breaker and protection including indicating devices, metering instruments, alarms and space heaters etc.

Terminal plans showing terminal numbers, ferrules markings, device terminal numbers and function etc.

Relay wiring diagrams. Equipment List.

The information furnished shall include the following:

- a. Technical literature giving complete information of the equipment.
- b. Erection, Operation and Maintenance Manual complete with all relevant information, drawings and literature for auxiliary equipment and accessories, characteristics curves for relays etc.

A comprehensive spare parts catalogue.

For completion of electrical system any other work/activities which are not listed above and considered necessary.

## **PRODUCTS**

### **Air Circuit Breakers**

The ACBs shall comply to IS/IEC: 60947 Part I & II and shall be suitable for operation on 415 Volts, 50 Hz 3 Phase system.

The breaker shall comply with Isolation function requirements of IEC 60947 Part II and shall be clearly marked as “Suitable for Isolation / Disconnection” to ensure safety of operating personnel.

The ACB shall provide Class –II insulation between front panel and internal power circuit as per IEC 60947 Part II to avoid accidental contact with live parts during inspection & maintenance.

The ACB shall be 3/4 pole with modular construction, draw out, manually/electrical operated and shall be capable of providing short circuit, overload and earth fault protection with time delay through micro



processor based control unit sensing the true RMS value to ensure accurate measurement meeting the EMI/EMC requirement as per standard.

The circuit breakers shall be for continuous rating and service short Circuit Breaking capacity shall be as specified on the single line diagram and shall be equal to the short circuit withstand values for 75 A / 50 KA.

For ALL ACBs  $I_{cs} = I_{cu} = I_{cw}$  (1 sec)

Circuit breakers shall be designed to 'close' and 'trip' without opening the circuit breaker compartment door. The operating handle and the mechanical trip push button shall be at the front of the breakers panel and integral with the breaker. The ACB shall be provided with a door interlock.

The breaker all Incomer and outgoing feeders shall be provided with variable microprocessor based releases for over load (L), short circuit (S), instantaneous (I) and earth fault protection (G). This should be compatible to operate with PC and shall conform to specifications.

All Air Circuit Breaker release should have RS485 Port for BMS connectivity on MODBUS RTU/BACNET and breaker control thru PC.

All incoming and outgoing air circuit breakers (ACBs) shall be of electrically operated draw-out type (EDO) encased in metal clad housings as per requirement.

The manufacturing of the breaker shall be such so that adequate safety clearance is provided around the breakers, in order to optimize the switchboard space requirement.

ACB shall be of moulded housing flush front and provided with mechanical "ON"-"OFF"-"TRIP" indications.

It should be possible to know the control voltage ratings for all electrical accessories from front facia.

The ACBs manufacturing shall comprise of adequate ratings main and arcing contacts housed in reinforced polyester casings, offering double insulation from the front face and ensuring no possibility of "Flashover" between phases. The main contacts shall have double-actions in each pole and all contacts are silver-plated and replaceable.

All current carrying parts shall be silver plated and suitable arcing contacts with proper arc chutes shall be provided to protect the main contacts. Arc-chutes shall be suitable for lifting out for inspection of main and arcing contacts and it should be possible to remove Arc Chutes without using any tools.

The cradle shall be so designed and constructed as to permit smooth withdrawal and insertion of the breaker into it. The ACB shall have distinct and separate Service Position, Test Position and Isolated Position w.r.t. cradle.

ACB should have facilities for carrying out maintenance without physically removing the breaker from panels.

The draw out version of ACBs shall have three indicated positions as follows:

1. Service : The breaker is fully racked-in with all the main & auxiliaries engaged.
2. Test : The breaker is racked out and with mains disconnected but all auxiliaries is connected.
3. Isolate : The breaker is fully withdrawn and all circuits disconnected.

A clear means of Positive Contact Indication (PCI) shall be provided by a mechanical flag marked “ON” or “OFF” to indicate the circuit breaker’s contact positions. The stored energy mechanism shall also have clear indications marked “Charge” or “Discharge” to reflect its status.

Safety shutters shall be provided to all draw out type breakers in order to inhibit inadvertent access (Degree of Protection IP-20) to the “Live” clusters when the breakers are in the “Test” or “Disconnected” positions. It must be possible to padlock the safety shutters in the SHUT position.

The circuit breakers shall be equipped with electrical motor operating mechanisms for automatic charging of the stored energy spring mechanism without hindering the operation of breaker manually in case required. Closing operations can be initiated either from the local push button on the front face of the circuit breaker or by remote control. The closing coils shall be rated at 230VAC. After closing, the stored energy spring mechanism shall immediately be recharged automatically by the motor, so as to be ready for next closing operation when the breaker trips. The recharging time of this spring should not be more than 7 second.

The operating mechanism carriage and hinged panel shall be so interlocked that it is not possible to withdraw the circuit breaker while it is in the closed position. Closing of circuit breaker in between service and disconnected position is also not possible and vice versa.

Provision shall be made so that it is possible to operate the circuit breaker mechanism when it is in the disconnected position.

The main circuit breakers for the incoming supply and the bus-tie (couple) breaker shall be mechanically and electrically interlocked such that only two of the three circuit breakers can be closed at any one time. The mechanical interlock shall be achieved by means of pins / castle keys and electrical interlock under voltage release / shunt release. The system shall be so arranged that the withdrawal of any one circuit breaker shall in no way effect the operation of the others.

Pad locking facilities shall be provided for each breaker so that breaker operation can be locked in a particular position if so indicated.

The tests to verify the characteristics of circuit breaker shall include type tests, routine tests and special tests. ACB manufacturer shall submit copy of combined sequence test report of the type test certified from authorized approved Government authority. Routine test shall be witnessed as per IS -13947-2.

### **Protections:**

ACB release should be self powered and should have following protections and measurement functions.

Sense true RMS values of current to avoid nuisance tripping during starting of heavy loads

Separate fault indication by LEDs for each type of fault like Overload, Short Circuit, Instantaneous and Earth fault without using any auxiliary supply or battery resulting in faster fault diagnosis and reduced system down time.

The release shall have thermal memory feature for protection of the equipment or the circuit conductors in the event of repeated overloads.

Protection release should offer intelligent discrimination between circuit breakers to enable Zone Selective Interlocking to reduce thermal and dynamic stresses on the system during fault clearing

Release should have LCD display for current metering.

### **Moulded Case Circuit Breakers (MCCB)**

The MCCB shall conform to IS13947-2:1995 and IS/IEC 60947-2 and should comply with environmental directives i.e RoHS & WEEE. The MCCB should be preferably used for loads below 800 Amps.

MCCB should be current limiting type with trip time of less than 10 millisec under short circuit conditions.

The MCCB should be either 3 or 4 poles as specified.

MCCB shall comprise of Quick Make -break switching mechanism, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses.

The MCCB'S for substation panels should have double break, positive isolation current limiting, load line reversibility and Horizontal cum vertical mounting features.

MCCB used as incomer should have earthed fault. Earth leakage modules are not acceptable.

Note: The breaking capacity of the MCCB supplied shall be followed as per requirement.

The MCCB'S for substation panels should have double break, positive isolation current limiting, load line reversibility and Horizontal cum vertical mounting features

The rated service breaking capacity should be equal to rated ultimate breaking capacities ( $I_{cs}=I_{cu}$ ) at 415V AC. The rated operational voltage shall be minimum 433V AC. Rated insulation voltage ( $U_i$ ): 750V AC and rated Impulse voltage 8 kV.

MCCB should have Spreader links & Phase barriers as standard feature. Superior quality of engineering grade plastics confirming to glow wire Tests as Per IEC 60695-2-1 should be used for insulation purpose.

The handle position shall give positive indication of 'ON', 'OFF' or 'Tripped' thus qualifying to disconnection as per the IS/IEC indicating the true position of all the contacts.

Multi-pole MCCB shall have common-trip bar so that in fault condition on any one pole of the MCCB all poles shall trip simultaneously.

Automatic change over MCCB's shall be of the motorized type, fully withdraw able, with both mechanical and electrical interlock. The transfer operation shall be controlled by an adjustable time delay of 0.1 to 30 sec. The actual transfer time of the MCCB's shall not exceed 2 sec. The motor mechanism shall utilize universal motor with electromagnetic clutch and shall be equipped with full handles to allow manual operation of the MCCB. All automatic change over MCCB's shall have minimum mechanical life of 10,000 operations.

### **Miniature Circuit Breakers (MCB)**

MCB'S shall comply with IEC 898:1995. It shall C Curve characteristic ( $I^2t$ ). They shall be of the current limiting type having sealed ambient temperature independent thermal magnetic tripping mechanism providing overload and short circuit protection. All MCB'S shall be of 35mm D/N symmetrical rail mounted type.

The breaking capacity of MCB'S shall be at least equal to the prospective fault level at the point installation, unless back-up by current limiting upstream breaker of the same make.

The MCB operating mechanism shall be mechanically trip free from the operating handle so as to prevent the contacts from being held closed against short circuit and overload conditions. It shall be of the automatic resetting type.

The individual operating mechanism of each pole of a multi-pole MCB shall be directly linked within the MCB casing and not with the operating handles.

The operating handle shall be of the toggle type with possibility for mounting of padlocking facility.

Each pole shall be provided with bi-metallic thermal element for overload protection and magnetic element for short circuit protection.

It shall be possible to fit on site auxiliaries like shunt-trip coil, under-voltage release, ON/OFF switch or alarm switch.

### **Residual Current Circuit Breakers (RCCB)**

RCCB shall comply with BS 4293 and shall be of the current operated type. The RCCB'S shall be manufactured to trip within 0.1 second for 30 mA for lights, 100 mA for power and 300 mA for lifts, fire etc.

The RCCB'S shall be of 2-pole construction for single phase and 4-pole construction for 3 phases. All RCCB'S shall be complete with test buttons.

All RCCB'S shall be batch tested and bear the appropriate test label of approval meeting SEB requirement.

All RCCB'S shall be of high sensibility type as appropriate and as specified in the drawing. They shall be of surge proof manufacture to prevent nuisance tripping due to transient over voltage. UPS, Computers, printers shall of enhanced immunity with 30 mA to prevent nuisance tripping.

## **EXECUTION**

### Testing and Commissioning

All Switch gears shall be inspected & tested in the presence of Engineer-in-charge or his representative and certified 'safe for commissioning, operation and equipment comply with the requirements of the Specification' by the installation Engineer.

All routine tests specified in relevant Indian/British Standards shall be carried out on all circuit breakers.

Test for protective relay operation by primary or secondary injection method.

Operation of all meters.

Secondary wiring continuity test

Insulation test with 1000 Volts megger before and after voltage test.

HV test on secondary wiring and components on which such test is permissible (2kV for one minute) Simulating external circuits for remote operation of breaker, remote indicating lights and other remote operations if any.

Measurement of power required for closing / trip coil of the breaker.

Pick up and drop out voltage for shunt trip and closing coils.

CT Polarity test.

Tests to prove correct operation of controls, interlocks, tripping and closing circuits, indications etc.

Interfacing test with BMS control function.

All other tests required by the Engineer to verify compliance with the Specification.

Vendor shall provide all facilities such as power supply, testing instruments and apparatus required for carrying out the test.

Required copies of test certificates for all the tests carried out along with copies of type test certificates and certificates from sub-vendor for the components procured from them are to be submitted before dispatch of switch boards.

### Tools

One complete set of all special or non-standard tools required for installation, operation and maintenance of the switch board shall be provided. The manufacturer shall provide a list of such tools with his quotation.

### Spares

The manufacturer/ tenderer shall also supply a complete list of commissioning spares and tools. The same shall be included in the bid price. No extra payment shall be made on account of non-availability of spares during commissioning.

**Quality Assurance**

Quality Assurance shall follow the requirements of Engineer-in-charge as applicable.

Quality Assurance involvement will commence at enquiry and follow through to completion and acceptance thus ensuring total conformity to purchaser's requirements.

**Deviations**

Deviation if any, from specification must be stated in writing at the pre-bid stage.

In absence of such a statement, it will be assumed that the requirements of the specifications are met without exception.

If any of the above tests fail to comply with the requirements of the Specification in any respect whatsoever at any stage of manufacture, test, and erection or on completion at site, the Engineer-in-charge reserves the right to reject the item or defective component. Such items after replacement or repairs shall be offered for inspection / or test. All such items shall be used only after approval of Engineer-in-charge.

**SUB HEAD – 8****EARTHING SYSTEM****Work Description**

This section covers design, and setting of the complete earthing network for individual earthing systems, circuit protective conductors and bonding conductors and, supply, installation, testing, commissioning of earthing system.

A complete earthing network comprising cables, copper tapes, electrodes and earth bonding of all relevant necessary non-current carrying metal parts of equipments/ apparatus shall be connected as required.

The system shall have a common earthing system as described in the specification and as shown on the drawings. Individual earthing systems as per drawing shall be provided for following:

HT Electrical Earthing

LT Electrical Earthing

DG Generator Earthing

ELV Earthing

### Data Communication Earthing

Main HT / LT / Generator Electrical Earthing shall have two earth connections to the earthing system.

Sufficient numbers of electrodes interconnected by Copper / GI (as per requirement) to form earthing grid/mat so that the overall earth resistance is less than 1 ohm for each individual earthing mat.

The number of earth electrodes of the earthing mat shall be provided. The Contractor shall test the resistivity of soil at site and determine the exact number of earth electrodes to achieve the required earth resistance value with approval of Engineer-in-charge. Earth plate, earth mat detail to achieve the earth resistance value shall be included in the Contract for complete earthing installation.

The Contractor shall have approval of materials from engineer-in-charge before use on work. Execution of earthing shall be carried out only in the presence of the Engineer or the representative.

### Standards

Complete earthing system shall be designed and executed in accordance with the latest revision of the following standards and the appropriate BS/IEC:

1. IS: 3043 : Earthing
2. BS6651 : Lightning Protection System
3. IEC 61024-1-2 : Lightning Protection System
4. IEC 62305 1-3-5 : Lightning Protection System

The detail of the Earthing System shall also conform to the requirements of all relevant local codes as applicable together with the additional requirements referred to in the Specification and Drawings, whichever is the more stringent and acceptable to the Engineer-in charge.

### Submission

All technical submissions shall be approved by the contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of Engineer-in-charge for its review and approval.

As minimum requirement the submission shall include the following:

Shop Drawings and Sample Submission

Builder's work requirement

Testing procedures and report format for testing of the earth electrodes and/or earth strips

Soil resisting test report with calculation report for the details of the earthing system detail including quantity and layout of earth electrodes and/or earth strips to achieve the required earth resistance. The report shall be endorsed by the Contractor's Installation Engineer who supervise and endorse the installation upon completion.

Proposed details of earthing system including quantity and layout of the earth electrodes and/or earth strips according to the calculation result.

## **PRODUCT**

The resistance between earthing system and the general mass of earth shall not be greater than 1 ohm.

The earth loop resistance to any point in the electrical system shall not be in excess of 0.5 ohms in order to ensure satisfactory operation of protective devices.

The resistance to earth shall be measured at the following:-

At each electrical system ground or system neutral ground.

At one point each grounding system used to ground electrical equipment enclosures.

At one point each grounding system used to ground wiring system enclosures such as metal conduits and cable sheaths or armoured.

All earthing conductors shall be of high conductivity copper/ G.I. and able to protect against mechanical damage as per requirement. The cross-sectional area of earth conductor shall not be smaller than half that of the largest current carrying conductor. Common earth mats of resistivity of less than one (1) ohm shall be constructed below the lowest floor structure prior to any ground work construction. The earth mats shall comprise the complete earth electrodes, earth strips/grids, earth inspection chambers, earth leads, main earth terminals, earth test link boxes at ground level, etc. Each individual earthing system shall have earth leads connecting its main earth terminal directly to an earth electrode underground as specified.

All earthing products/accessories shall be in accordance to IS standards.

The mating surface of all tapes at joints etc shall be cleaned before clamping and riveted with proper connector or exothermic welded. All connections to electrical apparatus shall be made by bolted connection in a visible and accessible position

## **Pipe Earth Electrode**

G.I. pipe shall be of medium class 100mm dia and 3m in length.

G.I. Pipe electrode shall be cut tapered at bottom and provided with holes of 12mm dia drilled not less than 7.5cm from each other up to 2m of length from bottom.

The electrode shall be buried in the ground vertically with its top being 20 cm minimum below ground level.

Clamping of the earth leads to the earth rod shall be made by earth clamp. The clamps shall be capable of providing high pressure contact between the earth rod and the earth leads to achieve low contact resistance.

When two or more electrodes are driven to form a group, the heads of the electrodes in the group shall be bonded to each other by means of a 25 mm x 3mm GI / Copper strip, laid at a depth of at least 600 mm in soil.



Recommended water seal insert sleeve approved by Engineer-in-charge shall be provided with all earth electrode penetrations through basement water proofing membranes and the installation shall be done under strict supervision.

### **Plate Earth Electrode**

The plate earth electrode shall consist of copper plate or G.I. plate as per item of work. The plate electrode shall be buried in ground with its faces vertical and top not less than 4.5m below Ground level. The plate shall be filled with charcoal dust and common salt filling, extending 15 cm around it's on all sides.

A watering pipe of 50mm dia of medium class G.I pipe shall be provided.

The top of the pipe shall be provided with a funnel and a G.I. mesh screen for watering the earth. In the case of pipe electrode a removable plug shall be provided.

The earthing lead from electrode onwards shall be suitably protected from mechanical injury by suitable dia medium class G.I. pipe in case of wire and size according to strip size.

The overlapping of strips at joints shall done in approved manner

GI strips shall be riveted with rivets/ bolted and welded.

Copper strips shall be riveted with rivets/ bolted brass nuts, bolts and washers and brazed.

The protection pipe within ground shall be buried at least 30 cm deep (to be increased to 60cm in case of road crossing and pavements).

The portion within the building shall be recessed in walls and floors to adequate depth.

In the case of plate earth electrode the earthing lead shall be securely bolted to the plate with two bolts, nuts, check nuts and washers.

In case of pipe electrode it shall be connected by means of a through bolt, nuts and washers and cable socket.

Main earthing conductor is taken from the earth electrode with which the connection is to be made.

No earth pit shall be fixed within 1.5 M of a wall of foundation. The location of the earth electrode will be such where the soil has reasonable chance of remaining moist. Effort shall be made to locate them in grass lawns or near flower beds or water taps.

### **Chemical Earthing**

Self-contained ground electrode(s) using electrolytically enhanced grounding where specifically indicated on the drawings. The electrode shall operate by hygroscopically extracting moisture from the atmosphere to activate the electrolytic process. Electrodes shall be UL® listed.

Electrode shall be 100% self-activating, sealed and maintenance free. No additions of chemical or water solutions required.

## Types & Technical Specifications (Long Life Maintenance Free Earthing)

### Earth Inspection Chamber

Earth electrode shall be fitted with a heavy-duty pre cast concrete inspection chamber / pit complete with heavy-duty cover as specified on drawings.

For earth electrodes located outside or on the apron of the building, earth inspection chambers shall extend to a depth of not less than 300 mm below finished ground level and kept free of soil. For earth electrodes located inside building, earth electrodes shall be buried not less than 100 mm below the floor slab structure. Each earth electrode shall be clearly marked 'Safety Electrical Earth Connection – **Do Not Remove**'.

The chamber and cover shall be heavy duty detail to consider the traffic load at the location of installation.

The cover shall be recessed cover to receive the Architectural floor finish at the location of installation.

### Earth Strip

Earth strips/grids shall be of bare GI/ Copper strips of 25 mm x 3 mm or as specified.

Earth strips shall be riveted or joint with proper connector to earth electrodes underground below the floor slab structure, and shall be buried not less than 300 mm below the floor slab structure. In order to minimize the mutual inductance between strips, earth strips shall be positioned at a distance not less than 6 m apart unless otherwise specified.

## EARTH BONDING

### Circuit Protective Conductor

Circuit protective conductor (CPC) is a system of conductors joining together all exposed conductive parts and connecting them to the main earth terminal. The purpose of circuit protective conductor is to provide a path for earth fault circuit so that the protective device will operate to remove dangerous potential differences during a fault condition. The circuit protective conductors shall take the form of separate cable with a sheath in green/yellow color or copper tape of minimum size 25mm x 3mm. All exposed non-current carrying metal parts of light fittings, switchgears, motors, enclosures, etc. shall be effectively earthed by circuit protective conductors for earth continuity protection. For equipment where an earth terminal is provided, the earth continuity wire shall be firmly clamped. Where no earth terminal is provided, the exposed metal part shall be cleaned of paint and surface rust before welding the earth continuity lead.

The minimum size of the principal protective conductors shall be in accordance with to the current edition of IS: 3043/ BS7671 and BS7430. The external earth terminal on the outside of the end panel of any switchboard shall be connected to the main earth bar provided in two independent points.

Circuit protective conductors shall be provided in electrical and mechanical rooms and along the routes for the bonding of all exposed conductive parts and extraneous conductive parts. A suitably sized earth terminal shall be provided at each zone of the building for this purpose.

All exposed conductive parts shall be effectively connected in an approved manner to the principal protective conductors. The circuit protective conductors shall be single core copper cables or high

conductivity annealed copper tapes specified. Unless otherwise specified, the minimum cross-sectional area of the circuit protective conductors shall be selected in accordance with IS: 3043/ BS7671.

## **SUB HEAD – 9**

### **LIFE SAFETY/ FIRE DETECTION, DIGITAL VOICE EVACUATION SYSTEM**

#### **GENERAL DESCRIPTION**

Provide Fire Detection and Alarm System in accordance with NFPA 72 (Latest edition) and requirements of the Contract Documents. Provide a complete operable and intelligent analog addressable Fire Alarm and Detection System with associated communication and notification systems. The system shall include interfaces for foreign systems, as described herein and in accordance with the Contract Documents, and all applicable Codes, Standards.

All Plant furnished shall be new and the latest state-of-the-art, products of a single Manufacturer engaged in the manufacturing of analog fire detection devices for at least 5 years.

All software licenses shall be supplied as part of the contract (If applicable). Renewable & subscription license is not acceptable.

The system shall be supplied, installed, tested, and approved by Engineer-in-charge, and turned over to the Contractor in an operational condition.

The contractor shall contract with a single supplier for the fire alarm Plant, engineering, programming, inspection and tests, and shall provide a “UL Listing Certificate, FM/ EN-54Vds/LPCB Approval” for the complete system.

Drawings: The Drawings shall serve to indicate the general arrangement of the various Plant and their generic functional interconnections. However, layout of Plant, accessories, specialties, conduit system and wiring, are diagrammatic and do not necessarily indicate every required device, fitting, etc., required for the complete installation.

#### **SCOPE**

A new intelligent reporting, microprocessor controlled fire detection system shall be installed in accordance to the project specifications and drawings.

#### **Basic Performance:**

Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Class A Signaling Line Circuits (SLC).

Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D) as part of an addressable device connected by the SLC Circuit.

Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z) 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 Signaling 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 shall be arranged such that there is a minimum of one speaker circuit per floor of the building or smoke zone whichever 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 telephone communication circuits shall be supervised for open and short circuit conditions.

### **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 multi sensor detectors, beam detectors, 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 a 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.

- a. The System Alarm LED on the main fire alarm control panel shall flash.
- b. A local sounder shall be sounded.
- c. 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.
- d. 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.
- e. 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.

## **DRAWINGS & TECHNICAL SUBMITTALS**

### **General**

Two copies of all submittals shall be submitted to the Engineer-in-charge 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. Equivalent compatible UL-listed equipment from other manufacturers may be substituted for the specified equipment as long as the minimum standards are met.

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.

### **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.

### **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.

### **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.

### **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.

### **WARRANTY**

All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance. The full cost of maintenance, labor and materials required to correct any defect during this one year period shall be included in the submittal bid.

### **POST CONTRACT MAINTENANCE**

Complete maintenance and repair service for the fire alarm system shall be available from a factory trained authorized representative of the manufacturer of the major equipment for a period of five (5) years after expiration of the guaranty.

As part of the bid/proposal, include a quote for a maintenance contract to provide all maintenance, tests, and repairs described below. Include also a quote for unscheduled maintenance/repairs, including hourly rates for technicians trained on this equipment, and response travel costs for each year of the maintenance period. Submittals that do not identify all post contract maintenance costs will not be accepted. Rates and costs shall be valid for the period of five (5) years after expiration of the guaranty.

Maintenance and testing shall be on a semiannual basis or as required by the AHJ. A preventive maintenance schedule shall be provided by the Contractor describing the protocol for preventive maintenance. The schedule shall include:

Systematic examination, adjustment and cleaning of all detectors, manual fire alarm stations, control panels, power supplies, relays, and water flow switches and all accessories of the fire alarm system.

Each circuit in the fire alarm system shall be tested semiannually.

Each smoke detector shall be tested in accordance with the requirements of NFPA 72 Chapter 7.

## POST CONTRACT EXPANSIONS

The Contractor shall have the ability to provide parts and labor to expand the system specified, if so requested, for a period of five (5) years from the date of handover.

As part of the submittal, include a quotation for all parts and material, and all installation and test labor as needed to increase the number of intelligent or addressable devices by ten percent (10%). This quotation shall include intelligent smoke detectors, intelligent heat detectors, addressable manual stations, addressable monitor modules and addressable modules equal in number to one tenth of the number required to meet this specification (list actual quantity of each type).

The quotation shall include installation, test labor, and labor to reprogram the system for this 10% expansion. If additional FACP hardware is required, include the material and labor necessary to install this hardware.

Submittals that do not include this estimate of post contract expansion cost will not be accepted.

## 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.

National Fire Protection Association (NFPA) - USA:

NFPA 13	Sprinkler 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 Electrical Code
NFPA 72	National Fire Alarm Code
NFPA 76	Telecommunication Facilities
NFPA 318	Clean Room Applications
NFPA 101	Life Safety Code
NFPA 90A	Air conditioning & ventilation system

Underwriters Laboratories Inc. (UL) – USA:

UL-50	Cabinets and Boxes
UL-268	Smoke Detectors for Fire Protective Signalling Systems

UL-864	Control Units for Fire Protective Signalling Systems
UL-268A	Smoke Detectors for Duct Applications
UL-521	Heat Detectors for Fire Protective
UL-228	Door Closers-Holders for Fire Protective Signalling Systems
UL- 464	Audible Signalling Appliances
UL-38	Manually Actuated Signalling Boxes
UL-346	Water-flow Indicators for Fire Protective Signalling Systems
UL-1481	Power supplies for Fire Protective Signalling Systems.
UL-1076	Control Units for Burglar Alarm
UL-1971	Visual Notification Appliances
UL-318	Clean Room Application (9th Edition)

## **NATIONAL BUILDING CODES / IS CODES**

The Video Display Terminal (VDT) shall comply with Swedish magnetic emission and X-radiation guidelines MPR 1990:10.

### **APPROVALS:**

- UL listing
- ULC listing
- FM approval

The system shall have proper listing and/or approval from the following nationally recognized agencies:

UL Underwriters Laboratories Inc (**9th Edition**)

The fire alarm control panel shall meet UL Standard 864 9th Edition

**The system shall be listed by the national agencies as suitable for extinguishing release applications.  
The system shall support release of high and low pressure gases.**

## **GENERIC SYSTEM CAPABILITIES**

- i. Analogue addressable microprocessor-based fire alarm system with initiating devices, notification appliances, monitoring and control devices as indicated on the drawings and as specified herein.
- ii. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation.
- iii. All software operations shall be stored in a non-volatile programmable memory within the fire alarm



- control unit. Loss of primary and secondary power shall not erase the instructions stored in memory.
- iv. Panels shall be capable of full system operation during new site specific configuration download.
  - v. Remote panel site-specific software and executive firmware downloads shall be capable of being performed over proprietary fire alarm network communications and via TCP/IP Ethernet network communications. Ethernet access to any fire alarm panel shall be capable of providing access only to authenticated users through a cryptographically authenticated and secure SSL tunnel.
  - vi. Panels shall automatically store all program changes to the panel's non-volatile memory each time a new program is downloaded. Panels shall be capable of storing the active site-specific configuration program and no less than 9 previous revisions in reserve. A compare utility program shall also be available to authorized users to compare any two of the saved programs. The compare utility shall provide a deviation report highlighting the changes between the two compared programs.
  - vii. Panels shall provide electronic file storage with a means to retrieve a record copy of the site-specific software and up to 9 previous revisions. Sufficient file storage shall be provided for other related system documentation such as record drawings, record of completion, owner's manuals, testing and maintenance records, etc.
  - viii. The media used to store the record copy of site-specific software and other related system documentation shall be electrically supervised. If the media is removed a trouble shall be reported on the fire alarm control panel.
  - ix. The system shall provide a means to recall alarms and trouble conditions in chronological order for the purpose of recreating an event history. A separate alarm and trouble log shall be provided.

## REMOTE ACCESS

- i. Fire Alarm Control Panel (FACP) shall have the capability to provide a remote service access feature using Ethernet and TCP/IP communications protocol. The Remote Access feature shall provide automatic notification of system faults and remote diagnostics of system status for responding technicians prior to arrival on site.
- ii. The internet remote access service function shall provide automated real time off-site reporting of discrete system events to a remote service support center with details of internal FACP fault conditions allowing a pre-site visit analysis of repair requirements.
- iii. Existing FACP controls shall be capable of retrofitting the Remote Service module as a plug-in upgrade feature.
- iv. The remote service network shall work on the customers Ethernet infrastructure and be Fire-Wall friendly for two-way communications for off-site reporting. The feature shall be compatible with existing proxy servers and firewalls shall not require any special changes or modifications.
- v. The remote service system shall be a non-Windows based application to protect against conventional virus attacks.
- vi. The remote service system shall be compatible with virtual LANS (VLAN).

- vii. The remote service system shall work on an outbound communication premise (panel calls home) in order to eliminate the possibility of any inbound connection into the network (from trusted or non-trusted sites).
- viii. The remote service system shall have capability to provide an audit trail of all events and service connections.
- ix. The FAS shall be compatible to Remote Service program that provides the following requirements if asked for 24/7 recording of FACP service activity Off-site diagnostics by a technical specialist to provide repair and parts guidance to the service technician prior to a site visit.

## NETWORK COMMUNICATION

- i. Network node communication shall be through a token ring, hub, or star topology configuration, or combination thereof.
- ii. A single open, ground or short on the network communication loop shall not degrade network communications. Token shall be passed in opposite direction to maintain communications throughout all network nodes. At the same time the status of the communication link shall be reported.
- iii. If a group of nodes becomes isolated from the rest of the network due to multiple fault conditions, that group shall automatically form a sub-network with all common interaction of monitoring and control remaining intact. The network shall be notified with the exact details of the lost communications.
- iv. Fiber optics communication shall be provided as an option via a fiber optics modem. Modem shall multiplex audio signals and digital communication via full duplex transmission over a single fiber optic cable, either single mode or multi mode.
- v. The communication method shall be in accordance to NFPA 72 style 7.
- vi. Network communication shall be “Peer-to-Peer” and the complete or filtered event indication shall be possible in keeping with the system architecture and requirements of this document.
- vii. Initiating device signals, voice signals and cause-n-effect logic shall travel in seamless and hassle-free manner over the FDA network communication channel and even the worst condition load / full load shall keep the response time within the limit specified by NFPA-72 / 2013 edition.

## REQUIRED FUNCTIONS

- i. **Operator Console/HMI:** The operator console/HMI shall offer the means to display, monitor and control all the ALARM, TROUBLE and SUPERVISORY signals from the initiating devices connected to the FACP. The operator console/HMI shall meet the specifications mentioned for it under “Product Specification” part of this document.
- ii. **Annunciation:** Operation of ALARM, TROUBLE and SUPERVISORY initiating devices shall be annunciated at the FACP and the Remote Annunciator indicating the type of device, the operational state of the device (Alarm, Trouble or Supervisory) and shall display the custom label associated with the device.

- iii. **Priority of Signals:** Fire Alarm events shall have highest priority. Subsequent alarm events are queued in the order received and do not affect existing alarm conditions. Priority Two, Supervisory and Trouble events have second, third, and fourth-level priority, respectively. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. However, all the events shall be annunciated regardless of priority or order received.
- iv. **Non interfering signals:** An event on one zone does not prevent the receipt of signals from any other zone. All zones are manually resettable from the FACP after the initiating device or devices are restored to normal. The activation of an addressable device does not prevent the receipt of signals from subsequent addressable device activations.
- v. **Alarm:** A system alarm shall include:
- Indication of alarm condition at the FACP and at the annunciators.
  - Identification of the device / zone triggering alarm at the FACP and the annunciators.
  - Operation of audible and visible notification appliances until silenced at FACP.
  - Selectively closing doors normally held open by magnetic door holders on the fire floor, floor above and floor below.
  - Unlocking designated doors.
  - Shutting down supply and return fans serving zone where alarm is initiated.
  - Closing smoke dampers on system serving zone where alarm is initiated.
  - Initiation of smoke control sequence as defined.
  - Transmission of signal to the supervising station.
- vi. **Alarm Silencing:** If the "Alarm Silence" button is pressed, all audible signals shall cease operation. The visible signals shall be off at Panel Reset.
- vii. **System Reset:** System Reset shall do the following
- The "System Reset" button shall be used to return the system to its normal state. Display messages shall provide operator assurance of the sequential steps ("IN PROGRESS", "RESET COMPLETED") as they occur. The system shall verify all circuits or devices are restored prior to resetting the system to avoid the potential for re-arming the system. The display message shall indicate "ALARM PRESENT, SYSTEM RESET ABORTED."
  - Should an alarm condition continue, the system will remain in an alarmed state.
- viii. **Supervisory Operations:** Upon activation of a supervisory device such as a fire pump power failure, low air pressure switch, and tamper switch, the system shall operate as follows
- Activate the system supervisory service audible signal and illuminate the LED at the control unit and the remote annunciator.
  - Pressing the Supervisory Acknowledge Key will silence the supervisory audible signal while maintaining the Supervisory LED "on" indicating off-normal condition.
  - Record the event in the FACP historical log.
  - Transmission of supervisory signal to the supervising station.
  - Restoring the condition shall cause the Supervisory LED to clear and restore the system to normal.
- ix. **Evacuation (Drill) Switch:** Evacuation / Drill Switch shall be provided to operate the notification appliances without causing other control circuits to be activated.

- x. **Walk Test:** The system shall have the capacity of 8 programmable pass-code protected one person testing groups, such that only a portion of the system need be disabled during testing. The actuation of the "enable one-person test" program at the control unit shall activate the "One Person Testing" mode of the system as follows:
- The city circuit connection and any suppression release circuits shall be bypassed for the testing group.
  - Control relay functions associated with one of the 8 testing groups shall be bypassed.
  - The control unit shall indicate a trouble condition.
  - The alarm activation of any initiating device in the testing group shall cause the audible notification appliances assigned only to that group to sound a code to identify the device or zone.
  - The unit shall automatically reset itself after signaling is complete.
  - Any opening of an initiating device or notification appliance circuit wiring shall cause the audible signals to sound for 4 seconds indicating the trouble condition.
    - a) Spoken Walk Test: In case the system is equipped with Integrated Voice Evacuation and Public Address System, the Walk Test shall have an option to notify the findings of each device through voice notification.
    - b) Install Mode: The system shall provide the capability to group all non-commissioned points and devices into a single "Install Mode" trouble condition allowing an operator to clearly identify event activations from commissioned points and devices in occupied areas.

It shall be possible to individually remove points from Install Mode as required for phased system commissioning.

It shall be possible to retrieve an Install Mode report listing that includes a list of all points assigned to the Install Mode. Panels not having an install mode shall be reprogrammed to remove any non-commissioned points and devices.
    - c) Service Gateway: The system shall be compatible to a service gateway as described. If asked for a Service Gateway software application shall be provided that allows an authorized service person to remotely query panel status during testing, commissioning, and service without the need to return to the panel using standard email / Instant Messaging Tools / Smart Phones / Tablets / I Pads etc.

### **Fire Alarm Control Panel (FACP)**

- Comply with UL 864, "Control Units and Accessories for Fire Alarm Systems". The following FACP hardware shall be provided:
- Power Limited base panel with Platinum / Red cabinet and door, 240 VAC input power.
- 2,000-point capacity where (1) point equals (1) monitor (input) or (1) control (output).
- 2,000 points of Network Annunciation at FACP Display when applied as a Network Node
- 2000 points of annunciation where one (1) point of annunciation equals:
- 1 LED driver output on a graphic driver or 1 switch input on a graphic switch input module.

- 1 LED on panel or 1 switch on panel.
- Fire Alarm Control Panel is able to connect per loop 250 devices Detector or Module in any combination to keep flexibility remains at site.
- Panel shall include 854 character/Touch Screen approx. 6", expanded content multi-line QVGA LCD display.
- Municipal City Circuit Connection with Disconnect switch, 24V DC Remote Station (reverse polarity), local energy, shunt master box, or a form "C" contact output.
- One Auxiliary electronically resettable fused 2A @24V DC Output, with programmable disconnect operation for 4-wire detector reset.
- One Auxiliary Relay, SPDT 2A @24 - 32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.
- Three (3) Class B or A (Style Y/Z) Notification Appliance Circuits (NAC; rated 3A@24VDC, resistive).
- Where required provide Intelligent Remote Battery Charger for charging up to 110Ah batteries.
- Power Supplies with integral intelligent Notification Appliance Circuit [Class B] [Class A] for system expansion.
- Four (4) form "C" Auxiliary Relay Circuits (Form C contacts rated 2A @ 24VDC, resistive), operation is programmable for trouble, alarm, supervisory of other fire response functions. Relays shall be capable of switching up to ½ A @ 120VAC, inductive.
- The FACP shall support up to (5) RS-232-C ports and one service port. All (5) RS-232 Ports shall be capable of two-way communications.
- Remote Unit Interface: supervised serial communication channel for control and monitoring of remotely located annunciators and I/O panels.
- Modular Network Communications Card.
- Programmable DACT for either Common Event Reporting or per Point Reporting.
- Service Port Modem for dial in passcode access to all fire control panel information.
- Microprocessor based Fire Alarm Control Panel (FACP) with 80 character displaying at least 600 or more characters in multiple lines at a time and shall accommodate the no. of detection loops and the quantity of field devices. The HMI shall have at least 5 or more customer programmable buttons with LED indication in order to freely configure its programmed response as per project requirement.

- Each Detection Loop of FACP shall accommodate, monitor and control a minimum of 250 intelligent addressable devices in any combination. The exact combination of the field devices in a detection loop shall be at the discretion of the design consultant based on the project requirement & System Design. However the System Proposed by the Solution Provider / System Integrator shall accommodate all the field devices/components and shall meet all the requirements
- FACP shall connect all the field devices (Detectors, MCPs, Control Modules, Monitor Modules, Hooter cum Strobes etc.), shall fully monitor them and communicate to them for their status and shall be able to take intelligent decision of ALARM, TROUBLE, SUPERVISORY based on the programmed cause-n-effect logic. It should have an interactive HMI (display cum operation interface), with status monitoring LEDs for AC Power, Fire Alarm, System Trouble, System Supervisory, Ground Fault and shall have at least 5 programmable switch with LED for seamless operation & maintenance.
- FACP shall be UL and ULC listed and FM approved.
- FACP shall comply to UL-864 9<sup>th</sup> edition.
- FACP shall have a dedicated mass storage memory to store project related critical back-up like Auto-CAD as-built drawings, reports, logs, customer-text files etc in line with NFPA-72, 2013 requirements. The memory shall be fully monitored by the FACP CPU and shall be password-protected.
- FACP shall support multiple System Power Supplies and Expansion Power Supplies in cascade to ensure the optimum power as required by the system load and system design.
- Each power supply shall provide total of 9 Amp current out of which 2 Amp per NAC shall be dedicated to the current requirement of Notification Appliance Circuit.
- FACP shall house 2 nos. of 50 AH batteries in its own housing and shall have the proper, trouble-free charging capacity for them. However the FACP shall be able to charge up to 110AH of batteries if required by the system design and system load.
- FACP shall have the networking capability with the other control panels of same family by adding a network module.
- FACP shall be compatible to Modbus over RS-232, Modbus over RS-485, Modbus over IP and Bacnet over IP as different open protocol variants for 3rd party Integration. Exact variant and module shall be considered. The selection of exact protocol variant shall be at sole discretion of the design consultant based on the project & system requirement. Any deviation in this regard needs a prior formal approval of the design consultant.
- FACP shall be compatible to seamless integration of aspiration system via application specific interface module. The FACP shall be able to view, monitor and control the aspiration system from its HMI.

- FACP shall have peak value logging capability and shall be able to analyse the peak value of individual sensors for individual sensitivity selection.
- FACP shall provide min 5 or more RS-232 ports for printers and other serial port utilities.
- FACP shall have IP communication capability.
- FACP shall have battery brackets for seismic area protection.
- FACP shall support the intelligent Cause-n-Effect programming based on the Boolean logic or equivalent to ensure the achievement of complete system functionality as required by this document.
- FACP shall be capable of indicating different events of varying priority and shall be able to map those events in intelligent cause-n-effect logic to achieve “Positive Alarm Sequence” and notification activation & deactivation as required by “Cause-n-Effect” programming. The exact requirement of cause-n-effect will depend at sole discretion of design consultant in line with the code requirement and protected premise requirement.
- FACP shall be capable of delivering all the functionalities mentioned under “Required Functions” of this document in “General Specification” part.
- FACP shall support priority setting of various events.
- FACP shall support the password protected authority level & assignment.
- FACP shall have forward and backward compatibility with various generations of devices in its family to protect client’s investment.
- FACP shall support distributed architecture / arrangement for the components of the same control panel / Network Node where it shall allow the mounting of various components like analogue addressable detection loop interfaces, amplifiers, fire fighter telephones, power supplies and other accessories in multiple remote enclosures at different locations away from the main FACP to facilitate effective and efficient field wiring terminations, avoid unnecessary cable runs. However the functionality of the FACP shall be intact. A single communication failure between FACP and remote enclosures shall not affect any system performance (but report the trouble condition at FACP) and complete communication failure (by multiple discontinuities or short-circuits) of a remote enclosure shall enable it to operate as a conventional system and report the complete status of the trouble at the FACP.
- FACP shall be UL & ULC listed and FM approved.

### **Voice Alarm**

Provide an emergency communication system, integrated with the FACP, including voice alarm system components, microphones, amplifiers, and tone generators. Features include:

Amplifiers comply with UL 1711, "Amplifiers for Fire Protective Signaling Systems." Amplifiers shall provide an onboard local mode temporal coded horn tone as a default backup tone. Test switches on the amplifier shall be provided to test and observe amplifier backup switchover.

Each amplifier shall communicate to the host panel amplifier and NAC circuit voltage and current levels for display on the user interface. Each amplifier shall be capable of performing constant supervision for non-alarm audio functions such as background music and general paging.

Dual alarm channels permit simultaneous transmission of different announcements to different zones or floors automatically or by use of the central control microphone.][none] All announcements are made over dedicated, supervised communication lines. All risers shall support [Class A] / [Class B] wiring for each audio channel.

Eight channel digitally multiplexed audio for systems that require more than two channels of simultaneous audio. Up to 8 channels of audio shall be multiplexed Class A twisted pair.

Emergency voice communication audio controller module shall provide up to 32 minutes of message memory for digitally stored messages. Provide supervised connections for master microphone and up to 5 remote microphones.

Status annunciator indicating the status of the various voice alarm speaker zones and the status of fire fighter telephone two-way communication zones.

When required, Redundant Voice Command Centers shall be capable of generating voice paging from more than one node in a network audio system.

## **Evacuation System**

**Non-Alarm Audio:** The fire alarm control panel shall provide non-alarm audio from paging and/or music source over the fire alarm evacuation speakers. This feature shall be an integral part of the fire alarm system, and shall use some or all of the audio components from the fire alarm evacuation system.

The fire alarm system and the non-alarm audio operation shall comply with NFPA 72 requirements for non-emergency purposes at a fire command center that is not constantly attended by a trained operator.

All fire alarm system hardware and software shall be U.L. listed for non-alarm audio use. The fire alarm system shall supervise for system hardware and field wiring faults while playing non-alarm audio over the evacuation speakers. Any hardware failure or speaker circuit fault detected when the system is playing non-alarm audio shall report a trouble on the fire alarm control panel. All audio components used for both the non-alarm audio and the fire alarm evacuation system shall be manufactured by the same supplier.

The non-alarm audio shall have two dedicated audio inputs to the fire alarm control panel. Terminal strip connections and an industry standard RCA receptacle shall be provided at the fire alarm control panel for terminating the audio source. The fire alarm input shall be 600-Ohm impedance. The inputs on the fire alarm control panel shall be electrically isolated via an isolation transformer.

The fire alarm control panel shall accept industry standard "line level audio input" from the non-alarm audio source. The fire alarm system hardware and software shall distribute the audio over the fire alarm



evacuation speakers. The selection of which speaker zones to distribute the non-alarm audio to the building occupants shall be coordinated.

The fire alarm control panel shall be able to make audio input level adjustments from the non-alarm audio source. This adjustment will match the non-alarm audio source to the fire alarm input. After the audio levels are adjusted, control the volume level from the non-alarm audio source.

The fire alarm system will provide "buttons" have the capability to provide operator "buttons" that will adjust the volume level of pre-assigned non-alarm audio zones. The volume level of non-alarm audio that is being broadcast to any audio zone will also be individually adjustable by time of day via a pre-specified schedule.

The non-alarm audio shall be the lowest priority audio on the fire alarm system. The non-alarm audio shall not interfere with any of the fire alarm emergency signals that may include live voice, pre-recorded emergency voice messages, or any alert tones. Switches shall be located on the fire alarm control panel to turn on or off the non-alarm audio system feature. The fire alarm control panel shall have LED lamps to indicate the ON vs. OFF status of the non-alarm audio feature. Speaker circuits that are actively broadcasting non-alarm audio will also be indicated by LEDs.

The non-alarm audio shall be synchronized throughout the fire alarm life safety system amplifiers and speaker circuits. Any remote amplifier panels located on the fire alarm system network shall also be synchronized. The system shall be capable of accepting a system-wide non-alarm audio input at the main fire alarm control or another local non-alarm audio input at a remote amplifier panel to serve only the areas served by that remote panel.

Multiple non-alarm audio sources must be accessible by the fire alarm non-alarm audio system. Each separate non-alarm audio source will have the ability to be broadcast into a distinct fire zone, depending on occupant preference. Any system restricted to a limited number of non-audio sources will not be accepted.

The system must have the capability of broadcasting an unlimited number of non-alarm sources, except as determined by the number of individual fire zones served by the fire alarm system

Non-alarm audio shall be automatically turned off in the event of primary power failure to the fire alarm control panel or any of the remote amplifier panels controlled by the main fire alarm control panel.

Fire fighters' telephone communication system: Arrange system to use dedicated, two-way, supervised voice communication links between the FACP and remote fire fighters' telephone stations throughout the building.

**Distributed Module Operation:** FACP shall be capable of allowing remote location of the following modules; interface of such modules shall be through a [Style 7 (Class A)] / [Style 4 (Class B)] supervised serial communications channel (SLC):

Amplifiers, voice and telephone control circuits

Addressable Signaling Line Circuits

Initiating Device Circuits

Notification Appliance Circuits

Auxiliary Control Circuits

Graphic Annunciator LED/Switch Control Modules

In systems with two or more Annunciators and/or Command Centers, each Annunciator/Command Center shall be programmable to allow multiple Annunciators/Command Centers to have equal operation priority or to allow hierarchal priority control to be assigned to individual Annunciator/Command Center locations.

Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures.

Alphanumeric Display and System Controls: Panel shall include 854 character, expanded content multi-line QVGA LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands.

The system shall include the necessary hardware to provide expanded content, multi-line, operator interface displays as indicated on the drawings and specifications. The expanded content multi-line displays shall be Quarter-VGA (QVGA) or larger and be capable of supporting a minimum of 854 char/ Approx 6" Touch Screen standard ASCII characters to minimize or eliminate the levels of navigation required for access to information when responding to critical emergencies and abnormal system conditions. The QVGA operator interface shall provide operator prompts and six context sensitive soft-keys for intuitive operation.

Expanded content, multi-line operator interfaces shall be capable of providing the following functions:

Dual language operation with Instant-Switch language selection during runtime.

Activity display choices for:

### **First 8 Events**

First 5 Events and Most Recent Event (with first and most recent event time and date stamps). First Event and Most Recent Event (with first and most recent event time and date stamps). Scrollable List Display [displays a scrollable list of active points for the event category (alarm, priority 2, supervisory, or trouble) selected. The position in this list will be the last acknowledged point (not flashing) at the top followed by the next 7 unacknowledged points (flashing)].

General Event Status (alarm, priority 2, supervisory, or trouble in system)

### **Site Plan**

Equal or hierarchal priority assignment. In systems with two or more operator interfaces, each operator interface shall be programmable to allow multiple operator interfaces to have equal operation priority or to allow hierarchal priority control to be assigned to individual operator interfaces (locations).

Up to 50 custom point detail messages for providing additional point specific information in detailed point status screens.

Bitmap file import for operator interface display of site plan and background watermark images.

Expanded content, multi-line displays shall [have the capability] include the necessary hardware and software] to provide Dual-Language operation.

Language selection shall be via a switch on the operator interface panel. Operator interface panels shall support instant-language-switchover during runtime to allow the operator to toggle between languages each time the language selection switch is operated, without requiring complicated multi-step processes.

Both one-byte and two-byte characters shall be supported.

### **Smoke Control System**

Smoke Control System: Provide a smoke control system which is UL 864 listed for smoke control system service. The system shall provide automatic operation of smoke exhaust fans, makeup air fans, air handling units, and dampers in accordance with the smoke control sequence indicated on the drawings. The smoke control system shall be located in the fire command center.

Provide and install smoke control relays within 3 feet of each smoke exhaust fan controller, makeup air fan controller, air handling units controller, and damper controlled by the smoke control system. The building automation/temperature control system shall terminate the relays to the fan controllers, air handling unit controllers, and dampers.

Provide and install addressable modules to monitor status/operation of each smoke exhaust fan, makeup air fan, air handling unit, and damper controlled by the smoke control system. The contractor shall terminate the modules to status indicators.

Enclosure: Finish to match Fire Alarm Control Units. The locking cover/display assembly is hinged on the left. Key and lock shall be common to all secured fire alarm system enclosures.

### **Carbon Monoxide Sensor:**

Carbon Monoxide (CO) detector detects CO concentrations in the air at or below the UL 2034 sensitivity limits for CO exposure and before symptoms of CO exposure appear, It alerts to FAP by using interface module and alert through audible and visual alarm.

The CO detectors shall have three color visual LED display indicates status and contamination level. A green display indicates the detector is operating normally. An amber display indicates a system trouble. A red display indicates dangerous CO levels.

Fire Fighters' Telephones

Telephone Hand Sets: High-impact plastic handset, heavy-duty coil cord, and hook switch; connected to the FACP by means of dedicated, supervised communication lines. Handsets have a dynamic receiver and a carbon transmitter, operating on 24VDC.

A black master telephone handset with a push to talk button and a flexible-coiled self-winding five (5) foot cord shall be provided and recessed within a protective unit-mounted enclosure at the command center.

Cabinet: Flush- or surface-mounted as indicated, 18-gage, minimum, painted steel with a latched hinged door with trim labeled "Fire Fighters' Phone." Size to accommodate handset and cord.

Remote CRTs, PC Annunciator And Printers

Fire Alarm Control Unit shall be capable of operating remote CRT's and/or printers; output shall be ASCII from an RS-232-C connection with an adjustable baud rate.

Fire Alarm Control Unit shall be capable of operating an Agency Listed PC Annunciator Client/Server which provides status annunciation and limited system control using a convenient and familiar Microsoft Vista Business operating system based interface. Other compatible Operating Systems shall include Microsoft XP Professional and Windows® 2000 Professional. The PC Annunciator Client/Server shall provide the following functions:

Login/logout password protection with time duration selectable automatic logout.

Display Alarm, Supervisory, Priority 2, and Trouble conditions with numerical tallies for each.

Display first and last alarms.

Different event types have separate visible indicators with a common audible indicator.

Event logs can be searched and printed.

View and/or print TrueAlarm status reports and service reports. (printing requires an available local or network printer).

Alarm Silence; System Reset; and Priority 2 Reset.

Global and individual point acknowledge.

Set system time and date and clear event log.

Individual point access for control or parameter revisions.

WALKTEST system test is supported for service convenience.

Up to (8) Simultaneous Client connections shall be supported by the PC Annunciator Server. Remote Clients shall be capable of connecting to the PC Annunciator Server via Ethernet LAN/WAN connections.

Each RS-232-C port shall be capable of supporting and supervising a remote Printer, CRT/Keyboard, or PC Annunciator; the FACP shall support as many as five (5) remote RS-232 devices. The Fire Alarm Control Panel shall support five (5) RS-232-C ports.

#### Remote LCD Annunciator

Provide a remote LCD Annunciator with the same "look and feel" as the FACP operator interface. The Remote LCD Annunciator shall use the same Primary Acknowledge, Silence, and Reset Keys; Status LEDs and LCD Display as the FACP.

Annunciator shall have super-twist LCD display. Annunciator shall be provided with four (4) programmable control switches and associated LEDs.

Under normal conditions the LCD shall display a "SYSTEM IS NORMAL" message and the current time and date.

Should an abnormal condition be detected the appropriate LED (Alarm, Supervisory or Trouble) shall flash. The unit audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.

The LCD shall display the following information relative to the abnormal condition of a point in the system:

Type of device (e.g., smoke, pull station, waterflow).

Point status (e.g., alarm, trouble).

Operator keys shall be key switch enabled to prevent unauthorized use. The key shall only be removable in the disabled position. Acknowledge, Silence and Reset operation shall be the same as the FACP.

#### Remote 854 Char/Approx 6" Touch Screen QVGA LCD Annunciator

Provide a remote 854 char/Approx 6" Touch Screen, QVGA LCD enunciator, with the same "look and feel" as the FACP operator interface. The Remote QVGA LCD Annunciator shall use the same Primary Acknowledge, Silence, and Reset Keys as the FACP.

The QVGA Annunciator shall have an expanded content, multi-line display capable of supporting a minimum of 854 standard ASCII characters/5.7" Touch Screen to minimize or eliminate the levels of navigation required for access to information when responding to critical emergencies and abnormal system conditions. The QVGA Annunciator shall provide:

Operator prompts and six context sensitive soft-keys for intuitive operation.

Seven (7) programmable control switches and associated LEDs.

Three (3) programmable general purpose LEDs.

Capability of supporting Dual Languages with Instant-Switchover between languages in runtime operation.

Support for both one-byte and two-byte characters.

Under normal conditions the QVGA LCD shall display [a "SYSTEM IS NORMAL" message, the current time and date, and the quantity of abnormal status conditions for each event category (i.e., fire alarm, priority 2, supervisory, and trouble)][ with a watermark background image] [a site plan of the facility layout][ with status icons to indicate area status for highest priority active events].

The QVGA Annunciator shall be programmable for the following Activity display choices:

First 8 Events.

First 5 Events and Most Recent Event with First and Most Recent event time and date stamps.

First Event and Most Recent Event with First and Most Recent event time and date stamps.

Scrollable List Display [displays a scrollable list of active points for the event category (alarm, priority 2, supervisory, or trouble) selected. The position in this list will be the last acknowledged point (not flashing) at the top followed by the next 7 unacknowledged points (flashing)]. General Event Status (Alarm, Priority 2, Supervisory, or Trouble in system).

Site Plan with optional status icons to indicate area status for highest priority active events.

Should an abnormal condition be detected the appropriate LED (Alarm, Priority 2, Supervisory or Trouble) shall flash. The unit audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.

The QVGA LCD shall display the following minimum information relative to the abnormal condition of a point in the system:

854 character custom location label.

Type of device (e.g., smoke, pull station, waterflow).

Point status (e.g., alarm, trouble).

QVGA Annunciators shall be protected from unauthorized use via a locked door or equivalent means. In addition, in systems with two or more Annunciators, each Annunciator shall be programmable to allow multiple Annunciators to have equal operation priority or to allow hierarchical priority control to be assigned to individual Annunciators (locations). Acknowledge, Silence and Reset operation shall be the same as the FACP.

Network Annunciators

Network Display Unit shall contain the following features:

- LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands.

- Capacity to annunciate 12,000 network points and/or point lists.

- Historical event logs shall maintain separate 600 Alarm and 600 Trouble events.

The network shall provide a means to log into any node on the system via a laptop computer or CRT/Keyboard and have complete network access (Set Host) for diagnostics, maintenance reporting, and information gathering of all nodes in the system. Systems not meeting this requirement must provide all diagnostic tools required to support this function from selected points on the network.

### **Graphical Software Workstation**

The Graphical Workstation shall consist of:

#### **Fire Graphic Software**

- Graphic Software must be UL 864 Listed and work as per UL -54 norms of fire Alarm System.
- The proposed software should be from the same manufacture of fire alarm system & should be UL & FM approved.
- To provide Annunciation, Status display, Monitoring & Control of each and every element connected to Fire Alarm System and Networks.
- The software should have a capacity of 62,500 points or point lists.
- Should be able to store 5,00,000 event logs.
- Quad Monitor supports. Should support multiple active windows such as putting alarm list window in one monitor and the graphic window in another monitor.
- Should be able to customize alarm & messages.
- Pan & Zoom features within a graphic screen for rapid & convenient selection.
- Multiple password option should be available in the software.
- Should operate on Windows 7 32 bit Operating system.
- The proposed software should be from the same manufacture of fire alarm system & should be UL & FM approved.

**Client workstation** which shall have the the following specifications:-

Processor Intel ® i7 750 2.66 GHz with internal memory of 8 GB (expandable to 16 GB) RAM, 2 TB HDD. Operating system Windows® 7 Professional 64-bit. Dual or compatible pair of NICs, 1 Gbps. NVIDIA 2 GB dedicated Graphic Card with detachable keyboard and mouse with required operating system CPU Mother Board with 8 Expansion Slots (7 PCI, 2 ISA) and Dual Video Outputs (1 SVGA, 1 DVI)

Two 1 TB Hard Drives (minimum) capacity with real-time, mirror imaging operation and survivability. Should a failure occur on any one hard drive, the workstation operation shall immediately transfer to the alternate mirror drive without loss of operation and a trouble shall be reported on the Graphical Workstation until the failure mode has been cleared.

24"-inch high-resolution color LCD monitors

DVD Read/Write

4GB RAM (minimum)

4 available USB Ports, 1 Dedicated for Security Dongle

Two Ethernet Ports to support Remote Clients over Ethernet

[Parallel Port][Serial Port][USB Port] for Event Printer

[Parallel Port][Serial Port][USB Port][Ethernet Port] for Graphics and Reports Printer

[UPS Secondary Standby Power Supply, UL Listed for Fire Alarm use]

Pre-programmed functions

Field editor for graphics representations with ability to Import and Export graphic files to AutoCAD

Capability to interface to Legacy 2120 Multiplex Systems.

A fully functional Network Node communicating on the network. Capability to interface with up to seven (7) Network Loops.

The graphical workstation shall be capable of the following operations:

Dynamic pan-and-zoom operation, systems that require multiple graphic screens for each zoom-in/zoom-out view are not acceptable

Ability to create predefined zoom levels for rapid zoom into predefined areas within a graphic screen

Ability to automatically jump to a graphic screen or a predefined zoom level within a screen for each device upon an abnormal status change

Dual Screen operation with floatable/dock able windows allowing one screen to display a text-based list of event activity and an alternate screen to display graphical maps simultaneously Information displayed for Point Status, Control, Alarm Lists, Historical Logs, and Reports shall be capable of being sorted by individual categories of information; e.g., Number, Time, Date, Event, Detail, Status, etc.

Ability to assign operator preferences on a per operator basis. The selectable operator preferences shall be:

Font Size: Small or Large

Toolbar Size: Small or Large

User Interface Theme: MS Office 2021

Menu Bar and Toolbar Options: Show/Hide Menu bar, Show/Hide Toolbar

Graphic files shall be capable of being modified in the graphical workstation editor or exported back to AutoCAD file formats where files can be edited in AutoCAD and re-imported for system changes and upgrades

It shall be possible to import a custom site-specific system banner bitmap used to display a corporate logo or other user preferred system banner background



It shall be possible to import a custom site-specific main screen bitmap used to display a corporate logo, facility photograph and layout, or other user preferred main screen background image

The graphical workstation shall have an option for a configurable inactivity timer that automatically logs out inactive users based on a pre-defined inactivity time limit. When no user is logged in, the graphical workstation shall provide view access to system activity. Login to the system shall be required for access to additional control operations.

The Graphical Workstation shall operate by receiving system events and displaying specified graphic representations of the building(s), and system devices. Individual system events shall include a description of the building or area associated with each point in the workstation's views and reports.

The workstation monitor shall be [touch sensitive][mouse operated] and serve as the interactive interface between the operator and the network system. From the touch screen or mouse the operator shall be able to perform the following tasks:

Silence signals

Acknowledge all alarm supervisory and trouble events and return to normal conditions

Log operator notes associated with individual event activity

Select a command link from a graphic screen to call-up an associated web-page, web-camera, or web-link

Reset system

Display list menus

Select the individual message screens

Perform manual operation of system(s) control points

Enable points into Test Mode to allow testing of selective devices without nuisance interruptions to the workstation operator

Test Mode events shall be recorded in the background to the workstation's historical logs

Test mode historical log events shall be flagged with a Test Mode Indicator for easy identification

Request the "HELP" menu

Perform operator login / logout

Generate reports that can be printed or saved as an electronic text file. Reports shall include Historical Log, Analog Device Status Report, Analog Device Service Report, AMZ Calibration Report, and Active List Report.

Connect (Set Host) to other nodes

Perform graphic editing functions

Set the system time and date

The unit shall be equipped with at least seven (7) levels of password-protected access.

Remote Ethernet Client Support: The Graphical Workstation server shall be capable of supporting up to 10 Simultaneous Remote Client Connections over Ethernet (maximum of 5 supervised or 10 unsupervised simultaneous client connections, total combined simultaneous client connections not to exceed 10). When the maximum simultaneous client connections have been reached a notice shall be communicated to any additional client connection attempts indicating the connection capacity limit has been reached.

Remote Clients shall be configurable for "Restricted Feature" view only or for "Protected Feature" full control operation.

A minimum 3 Mb/s connection speed shall be provided to Remote Clients

Logins/Logouts at Remote Clients shall be logged in the Historical Log. Supervised Clients shall be specified by client name.

The Graphical Workstation server shall be capable of supporting both Agency Listed Fire Alarm Ethernet LAN Applications and Supplemental Annunciation over the Customer's Ethernet LAN/WAN. Where a Fire Alarm Ethernet LAN is specified only Agency Listed Ethernet hardware shall be installed.

DACR Support. For fire alarm control panels that are not network compatible or may be to remote for a network connection, the Graphical Workstation shall be capable of, and agency listed for, communication with Digital Alarm Communicating Receiver (DACR) via an RS-232 port. Remote fire alarm panels equipped with DACTs shall communicate their local event status to the DACR using dial-up telephone connections / TCP/IP protocol / Wireless communications. The DACR shall forward the individual panel status to the Graphical Workstation for information processing and history logging.

DACR Events. The Graphical Workstation shall handle DACR points as though they were network points. Graphics shall be capable of being displayed on point status changes. Point status changes shall be easily acknowledged locally on the Graphical Workstation. Remote panels need to be Acknowledged, Silenced, or Reset at the panel. Point events shall be entered into the Graphical Workstation history log. The history log shall have a 500,000 event storage capacity minimum.

Supported DACR/DACT Formats: The Graphical Workstation DACR interface shall support standard reporting formats including: SIA, BFSK, 4/2, and ADEMCO CID (Contact ID® format). A CID account shall be configurable on the Graphical Workstation to be either panel event reporting or individual point reporting. The other formats provide panel event reporting only.

Public Points: The Graphical Work station shall be capable of assigning DACR points as public points to the fire alarm network for monitoring by other network nodes if required.

DACR Status Tracking by the Graphical Workstation: The DACR connection to the Graphical Workstation shall be supervised with the following trouble conditions tracked by the Graphical Workstation:

Communications Loss (between DACR and Graphical Workstation)

Initialization Failed (the Graphical Workstation to DACR connection did not successfully establish)

Unknown DACR Message (the DACR sent a message that was not understood by the Graphical Workstation)

Unknown DACR Account (the account information received does not correlate to an Graphical Workstation point)

Supervision of DACTs: The Graphical Workstation shall be programmed to expect and log periodic supervisory transmissions from the DACTs via the DACR. Failure to receive a supervisory transmission shall cause a trouble event on the Graphical Workstation.

Event Restoration: When the Graphical Workstation receives an event restoration from the DACR, it shall restore that point's status

Custom Reports: The operator shall be able to create up to 8 user defined historical log reports. Each custom report shall be capable of being filtered by an individual DACR account

Graphical Workstation Operating Modes:

When no alarms or troubles are present, the workstation monitor shall display a graphics screen menu used to access other graphic screens. Each screen shall also display current time and date, system status, and present operator name and access level.

Upon activation of any alarm and on request by the operator, the workstation monitor shall display the [floor plan] [coverage zone] [active list] for the device in alarm. of the floor in alarm with all devices shown. The device in alarm shall flash until acknowledged. The device in alarm shall then become steady until cleared.

If a second alarm is registered prior to the first being cleared, the second shall be identified by flashing, pending alarm indication. Touching the pending alarm area shall transfer the display to the second alarm point graphic screen. All subsequent alarms shall be displayed as indicated above. Alternately, the graphical workstation shall be configurable to automatically jump to the graphic screen for the device in alarm. If the auto jump operation is selected and the point in alarm is not associated with a graphic screen, the application shall jump to the active alarm list.

The Graphical Workstation shall cause a "Trouble" condition on all other Network Nodes to indicate an off-line condition.

The Graphical Workstation shall have the capacity to annunciate 50,000 network point and/or point lists.

Historical event logs shall maintain up to 500,000 system events.

Built-in diagnostics shall provide graphical views of the network topology and status. Network communication breaks or inactive nodes shall be clearly indicated as a guide in returning the system to normal.

Individual point access shall display "real-time" analog sensor point information.

The Graphical Workstation shall have the following editing functions:

Message Editor - System shall have the capability of on-site adding, changing, deleting or assigning of message screens.

List Editor - System shall have the capability of on-site editing of customer user lists.

Graphics Editor - System shall have the capability of on-site editing of graphics screens. Graphics editor shall have the capability of changing background graphics and adding or deleting point symbols. Capacity to create and edit up to 25,000 Graphic Screens.

Graphic Annunciator - Led Type

Annunciator Unit, zoned system: Provide an LED-indicating light located on the floor plan for each zone.

Mark zone boundaries on the annunciator floor plan.

Annunciator Unit, addressable system: Provide an LED-indicating light located on the floor plan for each device indicating the type of device and floor on which a signal was actuated.

Provide individual LED indicators for each alarm and supervisory device or zone and a LED to indicate system trouble. Additional LEDs indicate normal power and emergency power modes for the system. A toggle or push-button switch tests the LEDs mounted on the unit. The test switch does not require key operation.

Enclosure: Finish to match Fire Alarm Control Units. The locking cover/display assembly is hinged on the left. Key and lock shall be common to all secured fire alarm system enclosures.

System Printer

General: Provide a dot-matrix type, listed and labeled as an integral part of the fire alarm system.

Emergency Power Supply

General: Components include battery, charger, and an automatic transfer switch.

Battery: Sealed lead-acid or nickel cadmium type. Provide sufficient capacity to operate the complete alarm system in normal or supervisory (non-alarm) mode for a period of [4][24][48][60][90] hours. Following this period of operation on battery power, the battery shall have sufficient capacity to operate all components of the system, including all alarm notification devices in alarm mode for a period of [5][10][15] minutes.

### **Addressable Manual Pull Stations**

- Description: Addressable single- or double-action type, red LEXAN, with molded, raised-letter operating instructions of contrasting color. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units.
- Protective Shield: Where required, as indicated on the drawings, provide a tamperproof, clear LEXAN shield and red frame that easily fits over manual pull stations. When shield is lifted to gain

access to the station, a battery powered piercing warning horn shall be activated. The horn shall be silenced by lowering and realigning the shield. The horn shall provide 85dB at 10 feet and shall be powered by a 9 VDC battery.

- Manual Pull Station shall be addressable and shall sit on the detection loop of the FACP and shall communicate to the FACP to report its status.
- Manual Pull Station shall be able to generate a manual fire alarm.
- Manual Pull Station shall have an operating temperature range of 0°C to 50°C and humidity range up to 90% RH non-condensing.
- Manual Pull Station shall have manual DIP switch addressing method that does not require any special tool from manufacturer and commissioning activity for replacing the Manual Pull Station in case it goes faulty.
- Manual Pull Station shall be UL and ULC listed and FM approved.

### **Addressable Optical Electric Smoke Sensors With Base**

#### **General:**

Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:

Factory Nameplate: Serial number and type identification.

Operating Voltage: 24 VDC, nominal.

Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.

Plug-In Arrangement: Sensor and associated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. Base shall provide break-off plastic tab that can be removed to engage the head/base locking mechanism. No special tools shall be required to remove head once it has been locked. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control unit.

Each sensor base shall contain an LED that will flash each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the sensor base LED shall be on steady.

Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.

Photoelectric Smoke Detector shall offer multiple selectable sensitivity levels from 0.5% Obs/ft to 3.0% Obs/ft in order to customize the sensitivity settings.

Optical Smoke Detector shall have automatic drift compensation or environmental compensation capability for different contamination level of different areas in order to counter nuisance alarm.

Optical Smoke detector shall have selectable bases with Response Indicator, Isolator, Sounder, Relay and CO detection capability as an option so that the best fit solution is selected depending on the requirement.

Optical Smoke detector shall have manual DIP switch addressing method that does not require any special tool from manufacturer and commissioning activity for replacing the detector in case the detector goes faulty.

Optical Smoke Detector shall have an operating temperature range of -6°C to 50°C and humidity range up to 90% RH non-condensing.

Optical Smoke Detector shall be UL & ULC listed and FM approved.

Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5% obscuration for photoelectric sensor, but shall indicate a "Wrong Device" trouble condition.

The sensor's electronics shall be immune from nuisance alarms caused by EMI and RFI.

Detector shall be able to monitor or supervise the EMI of environment and report to the main panel.

Sensors include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP. Sensor address shall be located in base to eliminate false addressing when replacing sensors.

Removal of the sensor head for cleaning shall not require the setting of addresses.

Addressable Bases: Relay output, sounder and isolator bases shall be supported alternatives to the standard base.

#### **Addressable Duct Smoke Sensor:**

Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Sensor includes relay as required for fan shutdown.

Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct smoke sensor shall be provided by the FACP.

The Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC. This auxiliary relay output shall be fully programmable. Relay shall be mounted within 3 feet of HVAC control circuit.

Duct Housing shall provide a relay control trouble indicator Yellow LED.

Duct Housing shall have a transparent cover to monitor for the presence of smoke. Cover shall secure to housing by means of four (4) captive fastening screws.

Duct Housing shall provide two (2) Test Ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke sensor.

Duct Housing shall provide a magnetic test area and Red sensor status LED.

For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.

Each duct smoke sensor shall have a Remote Test Station with an alarm LED and test switch.

Where indicated provide NEMA 4X weatherproof duct housing enclosure that shall provide for the circulation of conditioned air around the internally mounted addressable duct sensor housing to maintain the sensor housing at its rated temperature range. The housing shall be UL Listed to Standard 268A.

### **Addressable Photo Thermal Smoke Sensors with Base**

#### **General:**

Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:

Factory Nameplate: Serial number and type identification.

Operating Voltage: 24 VDC, nominal.

Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.

Plug-In Arrangement: Sensor and associated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. Base shall provide break-off plastic tab that can be removed to engage the head/base locking mechanism. No special tools shall be required to remove head once it has been locked. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control unit.

Heat Detector shall have both Rate of Rise Temperature operation and Fixed Temperature operation freely configurable as per requirement of site.

Heat Detector shall have two selectable rate of temperature rise thresholds of 8°C per minute & 11°C per minute (or close to this value not deviating by more than 1°C) selectable from the FACP.

Heat Detector shall have two fixed temperature alarm thresholds of 57°C and 68°C (or close to this value not deviating by more than 1°C) configurable from the FACP.

Heat Detector shall have selectable bases with Response Indicator, Isolator, Sounder, Relay and CO detection capability as an option so that the best fit solution is selected depending on the requirement.

Heat Detector shall have manual DIP switch addressing method that does not require any special tool from manufacturer and commissioning activity for replacing the detector in case the detector goes faulty.

Heat Detector shall have an operating temperature range of 0°C to 50°C and humidity range up to 90% RH non-condensing.

Heat Detector shall be UL & ULC listed and FM approved.

Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.

True alarm photo sensing technology selectable sensitivity from 0.2% to 3.7% / ftobscuration or as per EN54 standard.

Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5%, but shall indicate a "Wrong Device" trouble condition.

The sensor's electronics shall be immune from nuisance alarms caused by EMI and RFI. Detector shall be able to monitor or supervise the EMI of environment and report to the main panel.

Sensors include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP. Sensor address shall be located in base to eliminate false addressing when replacing sensors.

Removal of the sensor head for cleaning shall not require the setting of addresses.

Addressable Bases: Relay output, sounder and isolator bases shall be supported alternatives to the standard base.

#### Addressable Heat Sensors with Base

Thermal Sensor: Combination fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; 54 deg C or 69 deg C fixed-temperature setting except as indicated.

Thermal sensor shall be of the epoxy encapsulated electronic design. It shall be thermistor-based, rate-compensated, self-restoring and shall not be affected by thermal lag.

Sensor fixed temperature sensing shall be independent of rate-of-rise sensing and] programmable to operate at 54 deg C or 69 deg C. Sensor rate-of-rise temperature detection shall be selectable at the FACP for either 8.3-deg C per minute.

Sensor shall have the capability to be programmed as a utility monitoring device to monitor for temperature extremes in the range from 32-deg F to 155-deg F.

#### Very Early Smoke Detection System

Provide an air sampling smoke detection system (Very Early Smoke Detection Apparatus - VESDA) for each area shown in the Contract Documents. Provide a [Laser Focus air sampling smoke detection system for areas up to 2500 sq. ft.][Laser COMPACT air sampling smoke detection system for areas up to 8000 sq. ft.][Laser PLUS air sampling smoke detection system for areas up to 20000 sq. ft.] or Micro Sensor, Pro Sense and Top Sense work on high power LED in accordance with manufacturer's recommendations.



The air sampling smoke detection system shall consist of highly sensitive smoke detectors with aspirating fans, air sampling pipe network, filters, networked controllers and a high-level interface to the building Fire Alarm System, as required.

The air sampling detectors shall provide a nominal obscuration level range from .0015 to 6% /ft., adjustable through the system operator control interface.

Multiple VESDA systems serving protected areas shall be integrated via closed loop VESDA net 2-wire communications and a high-level RS-232 interface with the building Fire Alarm System. The system will provide access to all VESDA features and functions through the Fire Alarm Control Panel operator's interface.

The Fire Alarm System supplier shall coordinate the installation and testing of the VESDA system, in accordance with applicable codes and the Contract Documents. Provide complete VESDA system design, installation, interface, and programming to include the following:

**Smoke Detector Assembly:** The smoke detector, filter, and aspirating fan shall be housed in a Detector Control Assembly Enclosure and arranged in such a way that air is drawn from the protected area through the filter and detector by the aspirating fan.

The Detector Control Assembly shall house the programmable intelligent controller, which will support air flow/detector supervision, automatic and manual sensitivity adjustment, time delay and remote reset functions. Laser COMPACT detector shall communicate with the FACP via IDNet channel.

The system shall provide 3 field-selectable levels of alarm status: Alert Level 1 (.04% obscuration/ft.), pre-Alarm Level 2 (1.06 % obscuration/ft.) and Alarm Level 3 (2.6% obscuration/ft.). Actual sensitivity levels will be determined in the field and programmed during system commissioning. Alarm Levels 1 and 2 will initiate a Supervisory Condition on the Fire Alarm System, and Alarm Level 3 will initiate the building-wide evacuation sequence as described elsewhere in the Contract Documents.

**Air Sampling Pipe Network:** Shall consist of a ¾ inch nominal inside diameter pipe arranged to provide optimal efficiency and air transport times which shall not exceed 60 seconds from the furthest point on the network. Sampling points shall be separated at intervals specified in NFPA 72; not more than 30 feet and typically in the range of 13 to 26 foot intervals along the path of the piping network. Air sampling calculations shall be provided from a registered VESDA sampling pipe aspiration modeling program ASPIRE rev. 1.8 or later.

**High Level Interface:** Where VESDAnet is used, provide interface module integral to the Fire Alarm Control Panel with connection to the High Level Interface Module and installed in the VESDAnet equipment rack assembly.

### **Addressable Very Early Aspiration Smoke Detection System**

Provide a Very Early Smoke Detection (Laser COMPACT/Micro Sense) air sampling smoke detection system for areas up to 400 sq.mtr. The air sampling smoke detection system shall consist of highly sensitive smoke detectors with aspirating fans, air sampling pipe network, filters, networked controllers and a high-level interface to the building Fire Alarm System, as required.

The air sampling detectors shall provide a nominal obscuration level range from 0.016% to 4.08% /ft., adjustable through the system operator control interface

The Fire Alarm System supplier shall coordinate the installation and testing of the VESDA system, in accordance with applicable codes and the Contract Documents. Provide complete VESDA system design, installation, interface, and programming to include the following: Smoke Detector Assembly: The smoke detector, filter, and aspirating fan shall be housed in a Detector Control Assembly Enclosure and arranged in such a way that air is drawn from the protected area through the filter and detector by the aspirating fan.

The Detector Control Assembly shall house the programmable intelligent controller, which will support air flow/detector supervision, automatic and manual sensitivity adjustment, time delay and remote reset functions. Laser COMPACT/Micro Sense detector shall communicate with the FACP via addressable loop protocol.

The system shall provide 3 field-selectable levels of alarm status: Alert Level 1 (.04% obscuration/ft.), pre-Alarm Level 2 (1.06 % obscuration/ft.) and Alarm Level 3 (2.6% obscuration/ft.) or as per EN54 standard. Actual sensitivity levels will be determined in the field and programmed during system commissioning. Alarm Levels 1 and 2 will initiate a Supervisory Condition on the Fire Alarm System, and Alarm Level 3 will initiate the building-wide evacuation sequence as described elsewhere in the Contract Documents.

#### **Addressable Aspiration Smoke Detection System (Normal Sensitivity)**

Aspiration unit with pre-installed addressable sensor is designed to cover areas up to 1800 to 3600 square feet based on the number of sensors. This coverage would be carried out by using single or two pipe networks, active air sampling techniques combined with addressable smoke sensing technology available with single / dual inlet detection system;

Provides remote sensor location for difficult service areas—up to 50 ft. with flexible tubing or 82 ft. with rigid pipe

Aspiration unit provides airflow monitoring circuitry and an aspiration system that is configurable. The airflow level is displayed on a ten-element bar graph with adjustments for flow sensitivity and high/low flow thresholds and can be adjustable air speed settings from the Aspiration unit for easy setup.

Individual smoke sensitivity selection and Aspiration smoke sensor have Sensitivity Range - 0.5% to 3.0% / foot obscuration

Optional water trap with drain prevents nuisance alarms associated with condensation buildup

Directly sit at addressable loop without using any interface module and communicate all information to panel and Ability to display and print detailed sensor information Smoke sensitivity in percent per foot and in easy-to-understand terms.

#### **Beam Detector**

Beam detector shall have selectable bases with Response Indicator, Isolator, Sounder, Relay and CO detection capability as an option so that the best fit solution is selected depending on the requirement.

Beam detector shall have manual DIP switch addressing method that does not require any special tool from manufacturer and commissioning activity for replacing the detector in case the detector goes faulty.

Beam Detector shall have an operating temperature range of -6°C to 50°C and humidity range up to 90% RH non-condensing.

Beam detector shall have range from 10Mtr – 50Mtr.

Beam Detector shall be UL & ULC listed and FM approved.

UL listed to Standard 268

A single unit houses both an infrared transmitter and receiver. The transmitter signal is received by a receiver where the internal microprocessor analyzes it for the presence of smoke. An alarm condition is determined when the selected sensitivity level is reached.

Operation at either 12 VDC or 24 VDC

The beam detector shall feature automatic gain control which will compensate for gradual signal deterioration from dirt accumulation on the lenses.

#### **Programmable Control Module**

Control Module shall be addressable and shall sit on the detection loop of the FACP and shall communicate to the FACP to report its status.

Addressable Control Module for switching ON of smoke extraction fans / Pressurisation Fans etc. and switching off AHU's, capable of being addressed electronically.

Control Module shall have an operating temperature range of 0°C to 50°C and humidity range up to 90% RH non-condensing.

Control Module shall have manual DIP switch addressing method that does not require any special tool from manufacturer and commissioning activity for replacing the control module in case it goes faulty.

Control Module shall be UL and ULC listed and FM approved.

#### **Programmable Monitor Module**

Monitor Module shall be addressable and shall sit on the detection loop of the FACP and shall communicate to the FACP to report its status.

Monitor Module shall supervise flow switches/ interface with any third party equipment capable of being addressed electronically.

Monitor Module shall be configurable to report supervisory signal and alarm signal.

Monitor Module shall have an operating temperature range of 0°C to 50°C and humidity range up to 90% RH non-condensing.

Monitor Module shall have manual DIP switch addressing method that does not require any special tool from manufacturer and commissioning activity for replacing the monitor module in case it goes faulty.

Monitor Module shall be UL and ULC listed and FM approved.

#### **Addressable Fault Isolator Module**

Fault Isolators shall be addressable and shall sit on the detection loop of the FACP and shall communicate to the FACP to report its status.

Fault Isolators shall be dual port, bidirectional communication isolator so that it isolates the short-circuited wire of any side (left side or right side).

Fault Isolators shall be compatible to isolation from the FACP for the field diagnostic purposes.

Fault Isolator shall power up in isolated mode and shall be directed by FACP to connect the detection loop segment. It shall connect the detection loop segment only if the segment is short-circuiting free and acceptable else shall remain in isolated mode to impart short-circuit survivability and tolerance to the remaining detection loop.

Fault Isolator shall be fully monitored and addressable by FACP. It shall report its status to the FACP and shall be controlled from FACP.

Fault Isolator shall have an operating temperature range of 0°C to 50°C and humidity range up to 90% RH non-condensing.

Fault Isolator shall have manual DIP switch addressing method that does not require any special tool from manufacturer and commissioning activity for replacing the fault isolator in case it goes faulty.

Fault Isolator shall be UL and ULC listed and FM approved.

#### **Magnetic Door Holders**

Description: Units shall be listed to UL 228. Units are equipped for wall or floor mounting as indicated and are complete with matching door plate. Unit shall operate from a 120VAC, a 24VAC or a 24VDC source, and develop a minimum of 25 lbs. holding force.

Material and Finish: Match door hardware.

#### **Addressable Alarm Notification Appliances**

##### **Addressable Notification Appliances:**

The Contractor shall furnish and install Addressable Notification Appliances and accessories to operate on compatible signaling line circuits (SLC).

Addressable Notification appliance operation shall provide power, supervision and separate control of horns and strobes over a single pair of wires or Horns and Strobes shall be addressable loop powered. The controlling channel (SLC) digitally communicates with each appliance and receives a response to verify the appliance's presence on the channel. The channel provides a digital command to control appliance operation. SLC channel wiring shall be unshielded twisted pair (UTP), with a capacitance rating of less than 60pf/ft and a minimum 3 twists (turns) per foot.

Class B (Style 4) notification appliances shall be wired without requiring traditional in/out wiring methods; addressable "T" Tapping shall be permitted. Up to 63 appliances can be supported on a single channel.

Each Addressable notification appliance shall contain an electronic module and a selectable address setting to allow it to occupy a unique location on the channel. This on-board module shall also allow the channel to perform appliance diagnostics that assist with installation and subsequent test operations. A visible LED on each appliance shall provide verification of communications and shall flash with the appliances address setting when locally requested using a magnetic test tool.

Addressable Controller: Addressable Controller shall supervise Channel (SLC) wiring, communicate with and control addressable notification appliances. It shall be possible to program the High/Lo setting of the audible (horn) appliances by channel from the addressable controller.

Horn: Addressable horn shall be listed to UL 464. Horn appliances shall have a High/Lo Setting, programmable by channel from the addressable controller or by appliance from the host FACP. The horn shall have a minimum sound pressure level of 83 or 89 dBA @ 24VDC. The horn shall mount directly to a standard single gang, double gang or 4" square electrical box, without the use of special adapter or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot.

Visible/Only: Addressable strobe shall be listed to UL 1971. The V/O shall consist of a xenon flash tube and associated lens/reflector system. The V/O enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. V/O appliances shall be provided with different minimum flash intensities of >2Cd. Provide a label inside the strobe lens to indicate the listed candela rating of the specific Visible/Only appliance.

Audible/Visible: Addressable combination Audible/Visible (A/V) Notification Appliances shall be listed to UL 1971 and UL 464. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. Provide a label inside the strobe lens to indicate the listed candela rating of the specific strobe. The horn shall have a minimum sound pressure level of 90 dBA @ 24VDC. The audible/visible enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. The appliance shall be capable of two-wire synchronization with one of the following options:

Synchronized Strobe with Horn on steady.

Synchronized Strobe with Temporal Code Pattern on Horn.

Synchronized Strobe with March Time cadence on Horn.

Synchronized Strobe firing to NAC sync signal with Horn silenced.

Speaker/Visible: Combination Speaker/Visible (S/V) units combine the speaker and visible functions into a common housing. Addressable functionality controls visible operation, while the speaker operates on a 25VRMS or 70.7VRMS NAC.

Twisted/shielded wire is required for speaker connections on a standard 25VRMS or 70.7VRMS NAC and UTP conductors, having a minimum of 3 twists per foot is required for addressable strobe connections.

The following taps are available: 1.5W, 3W, and 6.0W. At the 6.0W tap, the speaker has minimum UL rated/EN54 rated sound pressure level of 88dBA at 10 feet.

The S/V shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for general signaling.

The S/V installs directly to a 4" square, 1 1/2" deep electrical box with 1 1/2" extension.

Isolator Module: Isolator module provides short circuit isolation for addressable notification appliance SLC wiring. Isolator shall be listed to UL 864. The Isolator shall mount directly to a minimum 2 1/8" deep, standard 4" square electrical box, without the use of special adapter or trim rings. Power and communications shall be supplied by the Addressable Controller channel SLC; dual port design shall accept communications and power from either port and shall automatically isolate one port from the other when a short circuit occurs. The following functionality shall be included in the Isolator module:

Report faults to the host FACP.

On-board Yellow LED provides module status.

After the wiring fault is repaired, the Isolator modules shall test the lines and automatically restore the connection.

Addressable Textual Notification Appliance: Textual Notification Appliance is to operate on a compatible Signaling Line Circuit (SLC) and is to provide a high visibility, multi-color LED text message display.

Textual Notification Appliance shall be Listed to UL 1638 Visual Signaling Appliances.

Appliance shall be capable of up to thirty two (32) pre-programmed message selections that can be activated in response to pre-defined emergency situations or linked to specific system point status conditions.

Textual Notification Appliance shall be capable of displaying dual or single line emergency instructions.

Instructions can show as static, flashing, or scrolling with a variety of appearance/transition options.

Instructions shall be capable of displaying using multi-colors to emphasize instructions content.

Textual Notification Appliance shall be capable of providing non-emergency information during non-emergency conditions. Emergency conditions will override non-emergency message/instructions and display emergency instructions.

Textual Notification Appliance shall be capable of scrolling instructions of at least 854 characters in length.

Textual Notification Appliance shall be viewable from a distance of 100 feet.

Textual Notification Appliance shall be powered by a listed fire alarm power supply providing 24VDC with battery back-up.

Textual Notification Appliance shall be capable of wall or ceiling mounting options.

### **Standard Conventional Alarm Notification Appliances**

**Horn:** Piezoelectric type horn shall be listed to UL 464. The horn shall have a minimum sound pressure level of 85 dBA @ 24VDC. The horn shall mount directly to a standard single gang, double gang or 4" square electrical box, without the use of special adapter or trim rings.

**Visible/Only:** Strobe shall be listed to UL 1971. The V/O shall consist of a xenon flash tube and associated lens/reflector system. The V/O enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. V/O appliances shall be provided with different minimum flash intensities of 15cd, 75cd and 110cd. Provide a label inside the strobe lens to indicate the listed candela rating of the specific Visible/Only appliance.

**Audible/Visible:** Combination Audible/Visible (A/V) Notification Appliances shall be listed to UL 1971 and UL 464. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. Provide a label inside the strobe lens to indicate the listed candela rating of the specific strobe. The horn shall have a minimum sound pressure level of 85 dBA @ 24VDC. The audible/visible enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings.

**Speaker/Visible:** Combination Speaker/Visible (S/V) units combine the speaker and visible functions into a common housing. The S/V shall be listed to UL 1971 and UL 1480 standard.

Twisted/shielded wire is required for speaker connections on a standard 25VRMS or 70.7VRMS NAC.

The following taps are available: 1.50W, 3.0W and 6.0W. At the 6.0W tap, the speaker has minimum UL54 rated sound pressure level of 88dBA at 10 feet.

The S/V shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for General Signaling.

The S/V installs directly to a 4" square, 1 1/2" deep electrical box with 1 1/2" extension.

**Speaker:** Speaker notification appliances shall be listed to UL 1480/EN54.

The speaker shall operate on a standard 25VRMS or 70.7VRMS NAC using twisted / shielded wire.

The following taps are available: 1.50W, 3.0W and 6.0W. At the 6.0W tap, the speaker has minimum UL54 rated sound pressure level of 88dBA at 10 feet.

The S/V shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for general signaling.

The S/V installs directly to a 4" square, 1 ½" deep electrical box with 1 ½" extension.

Notification Appliance Circuit provides synchronization of strobes at a rate of 1Hz and operates horns with [an On Steady][a Temporal Code Pattern][a March Time cadence] operation. The circuit shall provide the capability to silence the audible signals, while the strobes continue to flash, over a single pair of wires. The capability to synchronize multiple notification appliance circuits shall be provided.

Accessories: The Contractor shall furnish any necessary accessories.

### **Network System Integrator (NSI)**

The Network System Integrator shall provide Agency Listed integration capable of communicating the status information from multiple brands and/or vintages of control panels onto the fire alarm network for reporting at a central command center location and at other network nodes (panels).

Protocol communication interfaces for systems integration that require ongoing protocol development necessary to maintain compatibility and agency listings with new versions of software releases shall not be substituted.

The Network System Integrator shall receive primary and secondary power from an alternate source

The Network System Integrator shall provide 8 isolated voltage monitor inputs for status communication onto the network

Inputs shall be rated to monitor voltages from 10 to 33 VDC

Inputs shall be compatible with direct switched or reverse polarity circuits

The Network System Integrator shall provide 8 dry contact relay outputs for interface to monitored equipment

Each output shall be configurable for normally open or normally closed contact operation.

Output contacts shall be rated for 1A @ 24VDC / 25VAC or 0.5A @ 70VAC

7 relay outputs shall be programmable

1 relay output shall be normally energized and dedicated for trouble operation

The Network System Integrator shall be capable of maintaining Fire Alarm Network communications with other network nodes (panels) when the monitored interface panel is powered down for service.

### **Active Repeater Panel**



Repeater panel should be active type where control switches should be available for system acknowledge, Alarm silence & system reset.

LCD test should be possible.

Active Repeater panel should be UL and ULC listed and FM approved.

### **Addressable Hooter with Strobe**

Hooter with strobe should be true addressable system.

Hooter with Strobe unit shall have both audible and visual output units housed within the same device. The audible output shall be multi-tone horn output up to 90DB and strobe output shall have selectable intensity of 15, 30, 75 and 110 candela.

Strobe unit shall have a flash rate of 1Hz synchronized throughout the Fire Alarm Network.

Hooter with Strobe unit shall be connected to the NAC of FACP and it shall be fully monitored by FACP.

Hooter with Strobe unit shall report its status with configured parameters of each unit (hooter and strobe) to FACP.

Hooter with Strobe unit shall support individual field testing in “Silent Mode” and “Non-Silent Mode” (full operational mode).

If asked for, it shall be possible for FDA system to generate, print and e-mail the diagnostic report of notification devices with tested and verified parameters.

Hooter with Strobe unit shall be controlled independently on the same 2-Core NAC as per programmed activation and deactivation criteria or from the FACP. Audible (hooter) and Visible (strobe) outputs shall be independently configurable from FACP for its activation and deactivation criteria as required.

In absence of any specific mention of activation and deactivation criteria, the hooter shall stop at “Alarm Acknowledge” or “Alarm Silence” and the strobe shall stop at “System Reset” or “Panel Reset”. This requirement shall not be deviated from unless otherwise stated cause-n-effect configuration or unless a formal written approval is taken from the design consultant.

It shall be possible to poll each and every hooter with strobe unit from the HMI / Display / Operator Console at FACP, isolate and include in the circuit (NAC), activate and deactivate, view the voltage received by it from the HMI / Display / Operator Console at the FACP & Network Repeater.

It shall be ensured that the last notification device at respective NAC receives at least 20Vdc (or 3 V above the min operating voltage) to ensure the desired performance. There shall be a provision to verify the same either from FACP or a hand-held testing device.

Hooter with Strobe unit shall support individual performance check by a hand-held testing tool during in “Silent-Mode” or “Sound-Mode” to facilitate performance check during normal working hour.

Hooter cum Strobe shall have an operating temperature range of 0°C to 50°C and humidity range up to 90% RH non-condensing.

Hooter with Strobe unit shall be UL and ULC listed and FM approved.

### **Fire Fighter Telephone Station**

Fire Fighter Telephone Station shall be complete with Telephone Jack, Handset and required accessories.

Operator at Command Centre shall be able to connect or disconnect to multiple simultaneous fire fighters / callers from the field with unambiguous addressability / identification of each caller.

It shall be possible for the operator at main command centre to set up a conference call among fire fighters trying to speak to the operator at the main command centre.

The Fire Fighter Telephone Station shall be UL listed.

## **PUBLIC ANOUCEMENT AND EVACUATION SYSTEM**

### **Introduction**

The Networked Digital Public address system is configured for broadcasting information and emergency announcements to the public. A public address system which will be provided should be IP networked system. The public address system is designed and installed to be suitable for use during emergency conditions accordingly.

### **General Description**

Public Address system provided should be completely networkable over IP. The system will distribute background music and pre-recorded messages through the graphical user interface and live announcements from the call stations. The recessed ceiling-type loudspeakers are to be used mostly providing PA coverage in where the false ceiling is present. For areas without false ceiling, wall mount loudspeakers will be installed to provide PA coverage. The PA system should provide an announcing console at the Main Centre Control Room. The system architecture should be daisy chain in nature complying with the following standards.

Applicable standards

BS 5839-8 – Code practice for the design, installation and servicing of voice alarm system.

IEC 60849 – Sound systems for emergency purposes

BS EN 54 -16 Voice control indicating equipment and alarms

Emergency according to

EN60849/EN54-16/ISO 7240-16

EN-54 - For entire Public Address system

The system should allow an undistorted speech reproduction of 85dB SPL at listening level. The system should also provide uniform coverage within +/-5dB for the entire area.

## **Function Summary**

### **Call Station Function**

Call Station: The operator/user can make an announcement to any zone or any combination of zones of that station via the call station. The type of announcements that are allowed from the call station are: Live announcements

Pre-recorded announcements

Background music

Pre-recorded emergency announcements

Emergency Announcements: The pre-recorded announcements can be initiated by the fire alarm signal that is sent from the fire alarm system.

The operator can make an announcement to any combination of zones in the system.

Pre-recorded Announcements: The pre-recorded announcement can be activated from the pre-defined keys at the call station, and scheduled to be played at specific times.

Fault Indication: The failure of the PA equipment will be notified to the call station in the system; and the fault will also be presented at the configuration / diagnostic and logging PC located in the communications equipment room in the building.

The PA system should be capable of integration with BMS system seamlessly. It provides digital audio signal processing and transmission of audio signals via a simple IP network system. The audio transmission in the system is in digital form except for the 100V line from the power amplifiers to the loudspeakers.

The PA system is comprised of the following basic elements:

Network controller

Power Amplifiers

PA call stations

Network cables

Loudspeakers

### Background Music Source

The PA system elements are connected by the daisy chain principle. The interconnection between the system units is achieved by using either plastic or glass optical fibre cable. The system cabling can be implemented in ring network whereby a single failure on the network cable will not affect the functioning of the system.

The equipment for the PA system, i.e. network controller, power amplifiers, and PA call stations, have built-in audio processing facilities, the audio processing is done in the digital domain.

The distribution of PA cables is configured to ensure that the failure of an amplifier, a cable or a speaker does not render the PA system inoperative or result in the total loss of PA facility in any part of any zone.

### Equipment Specification

#### Network controller

The control unit is the heart of the public address system. The unit shall be capable of routing minimum 28 audio channels, delivering power to the system, fault reporting and controlling of the system. This unit can work either as stand-alone mode or with a PC connected to it. It should have at least the following functionalities:

There shall be 8 control inputs, which should be freely programmable.

The network controller shall have analog audio line outputs for fire alarm signals, music sources etc. The network controller shall have the capability to handle at least 100 levels of priorities and 200 zones, 30 call stations or MMI (Man Machine Interface)

The network controller shall monitor the status of all zones in the system and the last 200 status change and fault events should be logged.

Attention and alarm tone definitions shall be stored in the network controller or recalled from an external storage device through control ports. These tones can be accessed by any call stations or control inputs for announcement broadcast or alarm broadcast.

At least 4 pre-recorded messages should be played simultaneously.

The network control unit shall have extensive audio processing possibilities for audio inputs and audio outputs. Parametric equalization, limiter, and gain can be adjusted with the configuration software.

The network controller shall monitor the status of all equipment including the status of the microphone capsule of a call station and report any fault.

The network controller should have hot standby auto switchover facility to redundant controller.

The system shall be able to make emergency calls (all calls) even if the network controller has failed.

The controller should 16X2 front panel LCD display and rotary control, through which debugging of faults will be possible.

The network controller is EN-54 certified and complies with the safety and emergency standards according to EN54-16 and EN60849 standards

### Technical Specification

Power Source	115/230 VAC $\pm 10\%$ , 50/60 Hz
Battery Power Supply	48V DC
Power consumption	14W with no load, 150W with maximum load
Audio inputs	28 channels
Control Inputs	8
Control Outputs	8
Line Outputs	4
Operating Temperature	-50C to +55C
Frequency response	20 Hz to 20 kHz (-3 dB)
Event Logs	200

### Power amplifiers

The main function of the power amplifier is the amplification of audio signals for the loudspeakers. It shall be possible to select the output voltage between 100V and 70V by changing jumpers.

It should have at least the following functionalities:

The amplifier should have DSP built in for Equalization, delay settings etc. The noise dependant Automatic Volume Control (AVC) circuitry should be built in. Each amplifier should have min two channels for AVC function.

The amplifier monitoring and changeover facility shall be incorporated with the power amplifier. The changeover relays shall be integrated with the standby unit. In case of failure of any working amplifier, the standby amplifier shall automatically come in the circuit.

The amplifier should have rotary or push control for selection of system enquiry mode and Headphone volume along with LCD display.

The amplifier should have the built-in line and loud speaker supervision, automatic volume control, automatic ventilation temperature control, auto change over to DC power supply.

The power amplifier should be capable of monitoring the speaker lines (zones) connected to it through pilot tone supervision

Separate amplifiers or separate channels of amplifiers for every zone.

The network controller is EN-54 certified and complies with the safety and emergency standards according to EN54-16 and EN60849 standards

**Power amplifier technical specifications are as follows:**

Mains supply	115/ 230VAC □ 10% at 50 - 60 Hz
Type of Amplifiers	Class D
Indication & Controls	854-character LCD display for status display; Rotary/push control for selection of system enquiry mode.
Output power	1x 1500W, 1 x 500W, 2 x 250W, 4 x 125W, 8 x 60W as required.
Outputs	Selectable 100V, 70V.
Audio Inputs	Mono, balanced
Control Inputs	8
Control Outputs	1 or 2 or 4 or 8 depending on the amplifier type.
Frequency response	60 Hz to 20 kHz (-3 dB).
Frequency Response (audio inputs)	Line: -3dB at 20Hz and 20KHz Mic: -3dB at 100Hz to 16KHz
Total harmonic distortion	<0.3% (1 kHz) at 50% of rated power
Cross talk	-70 dB (1 kHz) nominal (only multichannel).
Signal to noise ratio	>85 dB with pilot tone off
Battery Power Supply	48V
Safety and Emergency	According to EN 60849 and EN 54-16

**Loudspeaker**

**Metal grille Ceiling Speaker 6 Watts**

Compact 6 W ceiling speakers with fire dome for indoor areas. The product should have wide opening angle, with perforated metal grill of approved color and with the following specifications: The speakers are EN-54 certified and complies with the safety and emergency standards according to EN54 and EN60849 standards

**Technical Specifications:**

Rated Power	6W
Sound pressure level at 6 W	90 dB
Field Selectable Tappings at	1.5W, 3W, 6W
Frequency Range(-10dB)	90Hz -20 KHz
Opening Angle at 1 kHz/4 kHz (-6 dB)	180° / 50°
Rated Voltage	100 V / 70
Diameter	216 mm (8.5 in)
Maximum depth	90 mm (3.54 in)
Weight	1.3 kg (2.86 lb)
Colour	off-white (RAL 9010)
Safety compliance	EN60065

**Passive Line Array Loudspeaker**

The loud speaker should have excellent directivity and high power output, can handle medium and large indoor environments.

**Technical Specifications:**

Power output	60W RMS output, with multi tap for 60/30/15W
Frequency response	Better or equal to 190Hz to 18kHz
SPL level at 30W/1W (at 1KHz ,1m)	110 dB/92 dB(SPL)
Opening angle at (1kHz/4 kHz 6dB)	
Horizontal	210 deg/132 deg
Vertical	50 deg/22 deg
It shall have minimum 12 nos of 2”drivers	



Safety	acc. to EN 60065 and CE
Emergency	acc. to EN 54 24 / EN 60849
Water and dust protection	acc. to IEC 60529, IP 32
Dimensions (H x W x D)	1200x80x90mm(47.24x3.15x3.54 in)
Weight	6,4 kg (14,1 lb)
Color	Light gray (matches RAL 9022)

### Hemi-directional Loudspeaker

The speaker is suitable for large area and high-ceiling applications. Innovative loudspeaker which projects consistent and high quality sound, ensuring superb reproduction of background music and high speech intelligibility for paging or emergency calls. The opening angle and high sound pressure level allows it to be suitable for indoor high ceiling areas like warehouses, transport and exhibition halls, mega stores and swimming pools.

#### Certifications and Approvals

Safety acc. to EN 60065

Emergency acc. to BS 5839 8 / EN 60849

Self extinguishing acc. to UL- 94 V 0

Flame retardant acc. to UL 94 5VA

Water and dust protection acc. to EN 60529 IP 42

Chlorine resistant acc. to IEC 60068/2 60

Mechanical impact acc. to EN 50102 IK 07

#### Technical Specifications are as follows:

Power Output	150W
Sound pressure level at 100 W /1 W (1 kHz, 110/90dB 1m)	100W (100-50-25W)
Effective frequency range ( 10 dB)	60 Hz to 20 kHz
Rated voltage	100 V, 70 V and 28.3 V
Opening angle at 1 kHz / 4 kHz( 6 dB)	175° / 96° (horizontal)

	180° / 137° (vertical)
Rated impedance	100 ohm, 50 ohm and 8 ohm
Connector	Ceramic screw terminal
Dimensions (dia. x H)	800 x 425 mm (31.50 x 16.74 in)
Weight	27 kg (59.52 lb)
Color baffle	White (RAL 9010)
Color grille	Silver (RAL 9006)
Color top cover	Silver (RAL 9023)
Material	ABS TSG

### Call Station

#### Remote Call Station

Remote call station is to be used for car calling purpose and other applications with following functionalities:

Connects to call station interface via CAT-6A cable.

Up to 1 km from digital public address optical network.

Uses standard keypads for extension.

Built-in limiter.

Powered via CAT-6A and/or local power supply and complete supervision. Supervision of the microphone capsule should be present.

The network controller is EN-54 certified and complies with the safety and emergency standards according to EN54-16 and EN60849 standards.

#### Technical Specifications:

External power supply	18 to 56 VDC
Power consumption	2.9 W at 48 V without keypads

Microphone	
Nominal acoustic input level	75 to 90 dB SPL
S/N	>60 dB at 85 dB SPL
Frequency response	340 Hz to 14 kHz (-3 dB)
Loudspeaker	
S/N	80 dB at max.
Sound pressure level	85 dB (SPL) at 0.5 m and 1 kHz
Headset Connector	3.5 mm jack

### Call station keypad

Safety covers to prevent accidental activation of the keys should be available as an option.

The keypad gets its power from the call station it is connected to. The call station keypad shall have following features:

### Controls and indicators

- Eight function keys
- Eight two-color LEDs Interconnections
- Two serial data and power connections

### PC Call station

The PC call stations will be used for the Controller's call stations in the main Control Room.

The PC Call station is used for making live speech or pre-record announcements to any zone or a group of zones or to execute any pre-defined actions. The PC Call Station is comprised of a high quality Praesideo microphone on a gooseneck, user-friendly operation PC software and a PC with a 19" Touch screen LCD monitor. The PC Call station software provides the user with a powerful and easy-to-use tool that brings all aspects of announcements to a single point control.

The on-screen configuration sections allow the user to enter the properties of zones of individual zone such as entering the name of a zone/group, pre-defined input/output relay actions and selected attention/alarm tones or pre-recorded messages. After configuration, the user can operate the system via the Operation key layout section.

### **IP Audio Interface**

The VOIP interface is a universal, IP-based audio device supporting VoIP and Audio over IP applications. It is an ideal solution for bridging audio and contact closures over long distance LAN and WAN networks; the unit has analog audio inputs and outputs for easy interfacing with optional pilot-tone supervision for emergency sound purposes. One audio input can be switched to microphone sensitivity with built-in microphone supervision. Also, the control inputs offer cable and connection supervision. Control inputs and outputs can be used to set up an audio connection to start a remote call, but also to pass remote fault events to the system controller.

### **Audio Setting**

Multiple audio formats are supported: single channel, full duplex 16 bit PCM or G.711 for very low latency, and two channel send or receive MP3 for high quality audio with -various sample rates and compression

### **Network Interfaces**

The unit interfaces to 10 and 100 Mbit Ethernet networks and announces its IP address that was given by a DHCP server. It can also search the network for a free IP address or can be given a static IP address. A second Ethernet connection is available to support network redundancy. An RS 232 interface is build in to communicate additional serial data over the IP network.

Connector	Dual RJ45, DTE-pinout
Standard	802.3i / 802.3u
Speed	10 / 100 Mbps, auto-negotiation
Flow	Full / half-duplex, auto-negotiation
Protocol	TCP/IP, UDP, RTP, IGMP, DHCP, SNMP

### **Cable and Wiring**

#### **Network cable**

The network cable is a special cable with 2 plastic fibres for communication and 2 copper cores for the power supply. The cable is supplied with the network connectors fitted. This cable can be used to connect the network controller to power amplifiers, call station and etc.

Wire	Copper, stranded 1 mm <sup>2</sup>
------	------------------------------------

Resistance	<0.018 ohm/m
Optical Fiber	PMMA , 1 mm
Numeric aperture	0.5
Attenuation	<0.17 dB/m at 650 nm
Bending loss	<0.5 dB (r=20 mm, 90°) JIS C6861

### **LIGHT GUIDE INTERCONNECT UNIT (LIU)**

#### **TECHNICAL FEATURES:**

Rack Mount Type LIU fully populated with required modules, connectors, etc. shall be supplied and installed as required. It shall be installed for terminating the OFC cables. It shall provide minimum bending radius and the splice trays shall function as a splice cover for pigtail splicing. It shall be of complete aluminium fully powder coated. Cable glands shall be provided for secure anchoring the incoming cables.

Rubber grommets shall be provided at the cable entry point for tight sealing. The splice tray shall also be of aluminium powder coated with splice holder. Cable and spools shall be of flame retardant type.

#### **OFC CONNECTORS**

It shall be single mode SC/LC type with push-pull mechanism, fully in compliance, with latest industry standards. It shall be possible for selection of wide range of ferrule hole diameter selection.

#### **OFC ADAPTORS**

It shall be suitable for single mode SC/LC type fiber cable connectors which shall be fully in compliance with latest industry standard. It shall be with snap/latch mechanism.

#### **OFC PATCH CORDS**

It shall be suitable for single mode SC type fiber cable connectors with plastic moulded plug type connectors. Standard 2.5 mm ceramic ferrules shall be used. It shall be compact and easy to connect.

#### **PATCH CORDS**

Push & pull design with latch.

Shall be wired straight through.

Bend relief compliant boots to ensure proper Cat 6 performance.

#### **PATCH PANEL**

Conform to EIA standards.

Have Port identification numbers on both front and rear of the panel.

## **NETWORK SWITCHES**

- a. All network equipment offered shall be of One OEM.
- b. Ethernet Network shall consist of Layer 3 Core Switches in redundancy in Equipment room.
- c. Ethernet Network shall consist of Layer 3 Core Switches/ Layer 2 Distribution/ Zone Switches in field interconnected in such a manner that there is no single point of failure.
- d. Layer 3 Switches & POE enabled 24 port Layer 2 Switches shall be supplied fully populated with required modules, 24 port Jack Panel, 6/9U Rack, LIU, suitable power socket, SM Optic Fibre, Cat-6 patch cords, connectors etc. as required complete as per specifications.
- e. The Contractor shall get the Network design approved by client before execution.

### **LAYER 3, 12 SFP FIBER PORT, CORE SWITCH HAVING FOLLOWING CONFIGURATION:**

#### **TECHNICAL SPECIFICATIONS:**

##### **A. PERFORMANCE**

- a. 12 Fibre ports (populated with at least 6 Nos. of 1Gbps SM Fibre Modules).
- b. Dual Redundant CPU in Active-Active mode or a set of two nos. of Switches in Active-Active redundancy mode.
- c. It should be stackable with minimum 12 Gbps of Stacking Bandwidth.
- d. IPv6 fully compliant and ready from day one.
- e. Shall have minimum 8K MAC Address
- f. Minimum 06 active VLANs
- g. Shall have minimum 24 Gbps or more Switching Fabric h. Shall have minimum 17 Mpps forwarding rate

##### **B. RELIABILITY**

- a. Shall have hot swappable modules and fan modules

#### **TECHNICAL FEATURES:**

##### **C. IEEE STANDARDS**

- a. IEEE 802.1Q VLAN and VLAN tagging
- b. IEEE 802.3ad Link aggregation control protocol-Ether Channel

c. IEEE 802.1p Priority Tagging or equivalent d. IEEE 802.1

d Spanning Tree Protocol

e. IEEE 802.1w Rapid Reconfiguration of Spanning Tree

f. IEEE 802.1s Multiple VLAN Instances of Spanning Tree

g. IEEE 802.1x User Authentication

h. IEEE 802.3 Ethernet and IEEE 802.3ae

I Gigabit Ethernet

#### D. SECURITY

a. 802.1x user authentication and accounting

b. Support for Dynamic and Guest VLANs

c. Shall provide Local and Remote Port Mirroring

d. (Network Device Protection Profile/Evaluation Assurance Level) NDPP/EAL2 compliant or equivalent

#### E. QUALITY OF SERVICE

Shall have sophisticated QoS and Traffic Management

Shall have Per-port QoS configuration

Shall have strict priority queuing

Shall have IP differentiated service code point (DSCP) and IP precedence

Shall support Congestion Avoidance feature

Routing: Advanced routing protocol like RIPv2, OSPFv2, VRRPv2 from Day 1 and support for BGPv4

#### F. MANAGEMENT

a. Shall have GUI and CLI support

b. Shall have out of band Ethernet management port and/or console management port

c. Shall have SSH, SNMPv3 and NTP support

### **LAYER 2, 24 PORT POE SWITCH TECHNICAL SPECIFICATIONS:**

#### A. PORT DENSITY

- a. 24 Nos. 10/100/1000 Base-T PoE Ports with minimum 2 Nos. of additional SFP based Uplink ports and one console port
- b. Uplink ports populated with 2 nos. of single mode fibre ports connecting to core switches.

Support non-blocking architecture

Support multicasting for traffic.

Support stacking.

IP v6 fully compliant and ready from day one.

#### B. POWER OVER ETHERNET

Power over Ethernet to all 24 nos. 10/100/1000 Base-T ports

Support for up to 24 nos. Class 3 Powered devices at 15.4 watts

#### C. PERFORMANCE

128 MB RAM or more

64 or more VLAN

1,024 or more MAC address

Forwarding rate 12 Mpps or more

#### D. INTERFACE SUPPORT

10/100-TX RJ-45

10/100/1000TX RJ-45

1000-SX, 1000-LX/LH, 1000-ZX SFP slot

RJ45 or RS232 DB9 pin or male port or console port

#### E. MANAGEMENT

- a. Shall have GUI and CLI support

- b. Shall have out of band management console serial port.

- c. Shall have SSHv2, SNMPv3 and NTP support

#### F. QUALITY OF SERVICES



- a. Shall have sophisticated QoS Traffic Management

Shall have Per-port QoS configuration

DiffServ Precedence for 8 queues per port

Shall have IP Differentiated Service Code Point (DSCP) and IP precedence

## G. SECURITY

802.1x user authentication and accounting

Support for Dynamic and Guest VLANs

DHCP Snooping, IP Source Guard, BPDU Protection and STP Root Guard

Shall provide Local and Remote Port Mirroring

RADIUS Accounting or equivalent

## H. GENERAL STANDARDS

- a. IEEE 802.1Q VLAN and VLAN tagging
- b. IEEE 802.3ad Link aggregation control protocol
- c. IEEE 802.1p Priority Tagging or equivalent
- d. IEEE 802.1D Spanning Tree Protocol
- e. IEEE 802.1w Rapid Reconfiguration of Spanning Tree
- f. IEEE 802.1s Multiple VLAN Instances of Spanning Tree
- g. IEEE 802.1x User Authentication

### **General Details for Wiring**

All copper conductor wires shall be PVC insulated, FR, unsheathed, solid / stranded annealed electrolytic grade copper conductor.

1100 volt grade in accordance with IS 694 / 1990 and ISI marked.

1.0 and 1.5 sq. mm. PVC insulated FR copper wires shall be solid conductor.

2.5 sq. mm. PVC insulated FR copper wires and above shall be stranded conductor.

Cable shall be of Class-2 Copper conductor as per BS EN 60228, twisted, with Glass Mica (Fire barrier) tape covered by an extruded layer of Cross-linkable Low smoke zero halogen (LSZH) insulation as per BS EN 50363 and LSZH inner & outer sheath as per BS:7846 (Latest edition).

The cable should maintain circuit integrity under fire conditions as per BS 5839-1 when tested in accordance to BS 8434-2 i.e Simultaneous action of Fire, Impact & water phase @ 9500C for 120 mins on single sample (Independent lab report to be submitted)

The cables should not emit toxic gases in case of fire. The toxicity index should be less than 3 (refer NES 713).

The cables shall comply with the requirements of IEC-61034 Part 1&2 (Measurement of Smoke density of cables burning under defined conditions).

The cables shall comply with the requirements of BS EN 50267-2-1 (Determination for amount of halogen acid gas content which shall not be greater than 0.5%)

The cable manufacturer should provide factory production control certificate related to the manufacturing of fire resistant wires & cables from LPCB/BRE-Global.”

**SUB HEAD – 10****DRY TYPE TRANSFORMER****SCOPE**

This section covers the detailed requirements regarding supply, of transformer required for the sub-station. The transformer shall be suitable for locating in sub-station building with a maximum ambient temperature of 50°C

**CODES AND STANDARDS**

The transformers shall comply with the following Standards as amended upto date :

1. IS 2026 - Part I to V power Transformers.
2. IS 1886 - Installation and Maintenance of Transformers.
3. IS 2099 - Bushings.
4. IS 2705 - Current Transformers.
5. IS 11171 - Dry type power Transformers.
6. IS 1271 - Insulating Materials.
7. IS 10028 - Code of Practice for Selection, Installation and maintenance of Transformers.

Relevant IEC code

**GENERAL CONSTRUCTION**

The transformer shall be totally enclosed of IP 23 protection class step down transformer from 11 KV to 415 volts, Copper wound and of approved make. The sheet steel thickness of enclosure sides shall be at least 3.0 mm. It shall be double wound cast resin dry indoor type with Delta connections on HV side and star on low tension side. The arrangement of the winding shall be such that there is electrical and magnetic balance under all conditions of operation. The design, treatment and construction of the transformer and bracings of the winding shall be such as to withstand the heavy mechanical and thermal stresses which may be experienced under conditions of daily cycles of heating and cooling due to fluctuations in loads and of dead short circuits on either side of the transformer. The inter-turns and end-turns of the HV and LV winding shall be insulated for protection against surges and transients. The insulations shall be of class 'H' with temperature rise limited to class 'F' or higher conforming to IS 1271. The transformers shall be provided with OLTC (Range +5% to – 15% @ 2.5%) and RTCC. In order to view the tapping position an inspection window with glass and neoprene gasket shall be provided on the transformer enclosure. The winding insulation shall be suitable for earthed 11 KV system. The rated frequency shall be 50 Hz and the

transformer shall be designed with the frequency varying by 3% above or below 50 Hz. The desired impedance shall be as per IS without tolerance at normal tap and 75°C temperature. All components, frame etc. shall be suitably earthed. Losses not more than as per IS 1180 Level-2/ ECBC-2017 whichever is stringent. Losses of load and no load condition shall be limited to ECBC norms. (No positive allowed on guaranteed data furnished by vendor)

## **FITTINGS**

The transformer shall be complete with the following accessories:-

ON LOAD TAP CHANGER WITH RTCC.

Winding temperature indicator complete with RTD type Sensor and annunciator (Alarm and trip).

Diagram, rating plate, terminal marking plate.

Two earthing terminals with lugs at the centre of the bottom channels supporting the transformer.

Lifting arrangement.

Four bi-directional rollers.

HV Cable Box. suitable for 3x400 sq.mm aluminium conductor armoured XLPE (E) cable. (with top/bottom entry), with detachable glade plate.

LV cable Box. suitable for terminating 10 nos. of 3.5Cx 300 sq.mm aluminium conductor armoured XLPE cable / aluminium conductor OR bus-duct.

Control Box for indications.

Separate neutral bushing with earth bar supported on insulator.

Disconnecting chamber for H.T cable.

Control terminal blocks of Nylon 66 material preferably of Wago/Phoenix make, cage clamp type.

Disconnecting type CT terminal.

11KV Surge arrester

## **CORE**

The transformer shall have core type construction built up with high grade alloy, low loss CRGO silicon steel laminations with resistant double insulation. The transformer shall be capable of withstanding thermal and mechanical effects of short circuit on the terminals of any winding with full voltage maintained on other winding as per IS: 2026. The impedance at rated voltage and frequency shall be as per IS. Appropriate danger boards shall be fixed around the transformer in order that nobody touches the bare parts of HV and LV windings.

## **ACCESSORIES**

The transformer shall conform to the IS 11171 and 2026 subject to latest corrections and modifications. HV cable box shall be suitable for XLPE cable of specified size and the entry of cable shall be from a cable trench from the bottom of the enclosure. Separate neutral bushing shall be provided for earthing. Earthing of transformer shall be provided at least at two points. Enclosure shall also be solidly grounded. The bottom of the gland of HV cables should be more than 600 mm. from ground level.

## TESTS

All routine tests/any test which will be done at manufacturer shall be eye witness by Engineer-in-charge without any additional cost. The transformer shall be subjected to the following routine tests at the manufacturer's works before dispatch.

Measurement of winding resistance.

Voltage ratio, polarity and phase relationship.

Measurement of impedance voltage.

Load losses.

No load losses and no load current.

Induced over voltage withstand.

Separate source voltage withstand.

Partial discharge 25 PC upto 1.2 times the rated voltage.

The quoted rate for the transformer shall include all routine tests to be carried out at the manufacturer's works and all routine tests to be carried out at site as per specifications. The Contractor shall quote separately for type tests, which shall be carried out only on the written instructions of Engineer-in-charge.

### Type Test :-

Heat run test shall be carried out for anyone transformer of similar capacity. For this test manufacturer will submit certificate & test report but the same should be within five years from the date of supply of equipments to site of similar or higher capacity and voltage rating.

The following type tests may be made as per details in IS 2026. Also the following tests will perform directly on the project transformers

Lightning impulse-test.

Temperature rise test.

Short-circuit test

Air pressure test

Unbalanced current test: the value of unbalance current shall not be more than 2% of the full load current.

Guaranteed Technical Parameters (To be furnished by the contractor)

**S. NO. TECHNICAL PARAMETERS**

- i. Type and class of insulation
- ii. Output in KVA (Continuously rated)
- iii. Rated Voltage
  - a. HV (Volts)
  - b. LV (Volts)
- iv. Rated Current
  - a. HV (amps)
  - b. LV (amps)
- v. No. of phase
- vi. Type of cooling
- vii. Frequency
- viii. Winding Connection
- ix. Tapings
- x. Vector Group
- xi. Ref. Ambient temperature  
Temperature rise winding  
Class of insulation
- xii. Physical Dimensions
  - a. Length (in mm)
  - b. Width (in mm)
  - c. Height (in mm)
- xiii. % Impedance
- xiv. X/R ratio
- xv. Iron losses at normal voltage ratio

- xvi. Copper losses at normal voltage ratio at full load
- xvii. Efficiency at unity power factor
  - a. Full load
  - b. 75% load
  - c. 50% load
- xviii. Regulation at unit power factor
- xix. Regulation at 0.8 power factor
- xx. Approximate weight
  - a. Core & winding (Kgs.)
  - b. Total Weight (Kgs.)

**SUB HEAD – 11****MAINS FAILURE STANDBY GENERATING SYSTEM (D.G. SETS)****Work Description**

The specification covers supply, installation, testing and commissioning of D.G. Sets and associated equipment/ materials, panels, cables etc. The DG sets shall be suitable for prime power continuous duty applicable after considering de-rating in capacity due to ambient temperature at site.

**Scope of Work**

The scope of work shall include design, manufacturing, pre delivery inspection, supply, loading / unloading, storage, installation, testing and commissioning of D.G. Sets with alternators and associated equipment/materials, panels, cables etc. including labor, tools, tackles and plants, hardware and consumables, steel fabrication and items as described below:

**DG Sets less than 1000 KVA will be with acoustic enclosure**

**DG Sets more than 1000 KVA will be open type i.e. without acoustic enclosure**

In order to reduce the noise level as per CPCB norms, the DG Sets room will be acoustically treated and will be provided ventilation through air washer for supply and exhaust fans.

The cooling system of DG Sets is proposed with heat exchanger and cooling towers in secondary circuit. The cooling Towers are proposed to be installed at terrace level.

Diesel engine & alternator set complete with base frame and accessories.

Integrated control panel duly wired up to terminal box for engine safeties, Full Authority Electronic Fuel injection system, digital Governor, metering and protection & compatible for inter facing with PLC Engine mounted or separately mounted. Gen set Controller shall be microprocessor based.

Fuel oil system with piping, valves filters etc. from engine to service day oil tank. Return fuel line with fuel cooler and piping with accessories up to day service tank or collecting point as called for.

Lube oil system with inbuilt pump & connecting piping etc.

Exhaust emission meeting pollution norms (CPCB & SPCB) with Critical grade silencer, exhaust piping with mineral wool insulation and aluminum cladding as called for.

Bulk high speed Daily oil storage tanks shall be provided for DG Sets.

Engine cooling will be achieved through heat exchanger mounted along with each engine connected to a cooling tower.

Steel fabricated independent structure/support/hanger including fixing, grouting and bolting etc.

Painting of steel work.



L.T. / Control cabling.

D. G. Auxiliary control panel.

The bidder shall indicate in his offer schedule for routine maintenance, overhauling and operating instructions for smooth and satisfactory continuous operation of D.G. Set.

All equipment shall be of the class most suitable for working under the conditions specified and shall withstand the atmospheric conditions without deterioration.

The Contractor shall be responsible of coordination with civil and other contracting agencies to ensure completion of work in the required manner. Minor civil works required to execute the work shall be in the scope of contractor at no extra cost.

D.G. supplier shall furnish back up combined guarantee minimum for 2 years from the date of successful commissioning from Engine and alternator supplier for their smooth operation. In case any defect is noticed during operation or for any other reason, the same shall be attended promptly and repair/replacement of any component in part or in whole will be made immediately at no extra cost to the Engineer-in-charge.

The Contractor shall provide lifting cranes of suitable capacity (2 nos.) for operation & maintenance of DG sets in the DG room. Minor civil works required to execute the work shall be in the scope of contractor at no extra cost.

### **Design**

The design and workmanship shall be in accordance with the best engineering practices, to ensure satisfactory performance and service life. The equipment offered by the Contractor shall be as per IS standards and complete in all respects. Any materials or accessories, which may not have been specifically mentioned, but required and necessary for the completion of the system, shall be provided without any extra cost to Engineer-in-charge. This shall also include the cost of spares (if required) for commissioning of the equipment.

The specification defines the basic guidelines to develop a suitable electrical system as necessary for the Complex. All data required in this regard shall be taken in to consideration to develop a detailed engineering for the system. Site conditions as applicable are mentioned elsewhere.

Compliance with these specifications and/or approval of any of the Contractor's documents shall in no case relieve the Contractor of his contractual obligations.

All work to be performed and supplies to be made be as a part of contract shall require specific approval/review of Engineer-in-charge or his authorized representative.

The engineering activities shall comprise the submission for approval of the following from Engineer-in-charge.

**Bidder shall be responsible for:**

Submission of shop drawings for installation of DG set like foundation, fuel piping, DG Exhaust structural with design calculations and frame, cable connection from PLC panel to DG set, etc required to complete the work prior to start of work for approval.

Detailed co-ordination with other services, submission of shop drawings for various electrical layouts, such as equipment, cabling, and earthing, equipment installation and cable termination etc, prior to start of work.

Preparation of bill of materials for cabling, earthing and miscellaneous items etc.

Cable schedules.

Interconnection drawing.

Protection co-ordination drawings/ tables for complete power system.

Shop inspection and testing procedures.

Field-testing and commissioning procedures.

Preparation of as built drawings.

**Bidder shall also be responsible for:**

Any other work / activity which is not listed above, however is necessary for completing of electrical system and installation of equipment's.

Bidder shall clearly understand and quote accordingly. All clauses given in this part of the specifications shall also apply to all other electrical works of other segments. The bidder shall bring to the drawings show only the general run of services and approximate location of equipment, outlets, panels, etc. Any change in location of equipment, outlets, panels, etc. necessary to meet field conditions shall be brought to the attention of the Engineer-in-charge for review. The alterations may be made only with approval of Engineer-in-charge at no extra cost.

Space requirements with other division works may be checked carefully to ensure that equipment can be installed in the space allotted.

Proper co ordination with other trades shall be maintained to ensure interconnection with other services or equipment. It may be ensured that all such items which are to be installed / suspended in ceiling are identified and marked on drawing and hand over copy to the concern agency.

Wherever motor controls and distribution equipment are of the same manufacturer the installation may be done after consultation.

For passage of risers through structural masonry, concrete walls, floors and elsewhere proper sleeve as required shall be provided for proper protection of each riser passing through building surfaces.

Provide fire stopping around all pipes, conduits, ducts, sleeves, etc, which pass through fire compartments.

Provide required strength supports and hangers for equipment to avoid excessive loading of structures.

Wherever the work is of complexity adequate care be taken by examining the site or preparing detail drawings to scale for coordination between different trades. Detailed work shall be clearly identified on the drawings indicating the area to which it applies and for attention of concern agency through Engineer-in-charge. On completion a set of these drawings shall be included in with final drawings for record.

Coordinate with the local utility companies/authorities for their requirements for service connections and provide all necessary provisions, grounding, materials, equipment, labor, testing, and appurtenances.

Proper site inspection shall be carried out and coordinated among working agencies to avoid hindrances and progress of the work.

The Contractor shall be responsible for all modifications required due to failure on their part for not coordinating the services among different agencies.

The notice of the Engineer-in-charge the differences, if any, and get the same clarified failing which the Engineer-in-charge may impose the more stringent of the specification / clauses at the sole risk and costs of the Contractor.

### **Date of Commencement and Completion Period**

The Contractor shall be allowed admission to the site from the date of commencement as described in the General Conditions. He shall there upon and forthwith begin the works and shall regularly proceed with and complete the same on or before the date of completion subject, nevertheless to the provisions for the extension of time. The time being the essence of the contract, the Contractor will adhere to the time, progress chart and project schedule and will give proportional output/progress in proportional time

### **Schedule and Manner of Operations**

Time being the essence of this Contract, the Contractor is expected to mobilize all labour and materials in sufficient quantities before the start of work. He shall expedite and schedule the work as required and manage the operation as such that the work will be completed within the time stated in the Contract.

### **Coordination of Work**

Contract documents establish scope, materials and quality but are not detailed installation instruction.

Coordinate work with related trades and furnish, in writing, any information necessary to permit the work of related trades to be installed satisfactorily and with the least possible conflict or delay.

The drawings show the general arrangement of equipment and appurtenances. Follow these drawings as closely as the actual construction and the work of other divisions will permit. Provide off-sets, fittings, and accessories which may be required but not shown on the drawings. Investigate the site, and review drawings of other divisions to determine conditions affecting the work, and provide such work and accessories as may be required to accommodate such conditions.

The locations of thermostats, switches, panels and other equipment indicated on the drawings are approximately correct. Exercise particular caution with reference to the location of panels, thermostats,

switches, etc., and have the precise and definite locations accepted by the Engineer-in charge before proceeding with the installation.

### **Examination of Site**

The tenderer is advised to visit the site and understand himself about the nature of work prior to the submission of bids as no allowance whatsoever will be made for the same.

The Contract Documents do not make representations regarding the character or extent of the sub-soils, water levels, existing structural, mechanical and electrical installations, above or below ground, or other sub-surface conditions which may be encountered during the work, based on examination of the site or other information. Failure to examine the drawings or other information does not relieve the Contractor of responsibility for satisfactorily completion of the work.

### **Excavation and Backfill**

Wherever required provide trenches details, duly approved by the Engineer-in-charge with all relevant section etc. as per IS codes to the contractor minimum one-month prior of laying the pipes etc. Co-ordinate with the sub - contractor during the excavation, and ensure that the excavation and backfilling is done properly as per requirement.

Where provisions of trenches are in the scope of work in contractor's scope, it is deemed that the quoted prices are inclusive of cost of the pipe, laying, trench digging and backfilling.

The following points need to be taken care of while making the trenches:

The trench shall be of required width as per specification for proper execution of the work.

The trench bottom shall be graded accurately to provide uniform bearing and support the work on undisturbed soil at every point along its entire length.

Except where rock is encountered, do not excavate below the depths indicated.

Where rock excavations are required, excavate rock to a minimum over depth of four inches below the trench depth as indicated in the specification or indicated on the drawings.

Backfill over depths of the rock excavation and unauthorized over depths with loose, granular, moist earth, thoroughly machine tamped to a compaction level of at least 95% to standard proctor density or 75% relative density or as specified by the Engineer-in-charge.

Wherever unstable soil that is incapable of supporting the work is encountered in the bottom of the trench, remove soil to a depth required and backfill the trench to the proper grade with coarse sand, fine gravel or other suitable material.

Excavate the trenches for utilities to provide the following minimum depths of cover from existing grade or from indicated finished grade as required by local authorities:

Trenches should not be placed within 3 meters of foundation or soil surfaces which may resist horizontal forces.

Do not backfill until all required tests are performed and installation checked by the Engineer-in-charge.

Backfill shall be done with non-expansive soil of limited porosity. 15 cm layers shall be laid throughout and carefully tamp until the work has a cover of not less than 30 cm. Backfill and tamp remainder of trench at 30 cm intervals until complete.

Grade the finished surface uniformly.

### **Cutting and Patching**

All kind of cutting and repairing of brick walls or partitions etc are in scope of work of the Contractor for proper laying and routing of pipe. However, cutting and repairing of RCC wall or ceiling shall be in the scope of contractor.

The details of cutting of wall, drilling in floors, walls and partitions etc required to anchor conduits or equipment, shall be planned in advance. Any damage to the structure shall be made good to match the surface at no extra cost.

### **Sealing of Penetrations**

#### **Air Tight Seals**

All penetrations through the building fabric subject to suction or pressurization shall be sealed airtight.

#### **Holes in Roof**

Roof penetrations for passage of conduits or circular PVC and PVC Cables shall be sealed watertight using a flexible polypropylene conical sleeve manufacturer to seal the cable to the roof structure, regardless of the roof profile.

All sharp metal edges which may come in contact with the cable shall be suitably bushed.

#### **Fire Rated Penetrations**

Where services penetrate any fire rated barrier the Contractor shall seal the penetration with the use of an appropriate material to ensure the integrity of the fire barrier.

The Contractor shall seal the cable enclosures through fire rated barriers to ensure the integrity and rating of the fire barrier.

#### **Acoustic Penetrations**

Where services penetrate acoustic barriers sealant shall be supplied and provided to maintain the acoustic separation at least equal to the barrier penetration.

#### **Mounting Heights**

Verify exact locations and mounting heights with the Engineer-in-charge before installation.

#### **Supports**

Provide proper supports, hangers, auxiliary structural members and supplemental hardware in accordance with the best industry practice required for support of the work.

Provide supporting frames or racks extending from floor level to ceiling slab for work indicated as being supported from walls where the walls are incapable of supporting the weight. In particular, provide such frames or racks in electric closets and equipment room.

Provide supporting frames or racks for equipment which is installed in a free standing position.

Supporting frames or racks shall be of standard angle, channel or specialty support system steel members rigidly bolted or welded together and adequately braced to form substantial structure. Racks shall be of ample size to assure a workmanlike arrangement of all equipment mounted on them.

Adequate support of equipment (including outlet, pull and junction boxes and fittings) shall not depend on ducts, pipe, electric conduits, raceways, or cables for support.

Equipment shall not rest on or depend for support on suspended ceiling media (tiles, lath, plaster, as well as splinters, runners, bars and the like in the plane of the ceiling). Provide independent support of equipment. Do not attach to supports provided for ductwork, piping or work of other trades.

Provide required supports and hangers for equipment so that loading will not exceed allowable loading of structure. Equipment and supports shall not come in contact with work of other trades.

### **Fastenings**

Fasten equipment to building in accordance with the best industry practice.

Where weight applied to the attachment points is 45 kg or less, conform to the following as a minimum:

- |                               |   |   |
|-------------------------------|---|---|
| 1. Wood                       | : | Wood screws   |
| 2. Concrete and solid masonry | : | Dash Fastener of appropriate ratings-HILTI/FISHER   |
| 3. Solid metal                | : | Machine screws in tapped holes or with welded studs |

Where weight applied to the building attachment points exceeds is equal to 135 kg and exceeds 45 kg the following shall conform as minimum:

For concrete slabs provide 60 cm x 60 cm x 13 cm steel fishplates on top with through bolts. Fishplate assemblies shall be chased in and grouted flush with the top slabs screed line, where no fill is to be applied.

At steel decking or sub-floor for all fastenings, provide through bolts and threaded rods. The top of bolts and rods shall be set at least one inch below the top fill screed line and grouted in. Suitable washers shall be used under bolt heads or nuts. In cases where the decking or sub-floor manufacturer produces special hangers to work with his decking or sub-floor such hangers shall be provided.

Where weight applied to building attachment points exceeds 135 kg, coordinate with and obtain the approval of Engineer-in-charge and conform to the following as minimum:

Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide Threaded rods or bolts for bridging members shall be provided.

For items which are shown as ceiling mounted at locations where fastening to the building construction element above is not possible. All such areas shall be provided with suitable auxiliary channel or angle iron bridging tying to the building structural elements.

Wall mounted equipment may be directly secured to wall by means of steel bolts. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars.

### **Identification**

Black phenol nameplates with 13 mm high white engraved lettering shall be used for equipment identification. Identification details shall include equipment name or load served as appropriate. Nameplates shall be fixed with cadmium plated screws. Peel and stick tape or glue on type nameplates is not acceptable.

Service runs shall be properly identified as per the requirements in the Contract.

See individual section for additional identification requirements.

### **Prohibited Labels and Identifications**

In all public, tenant areas and similar locations within the project the inclusion or installation of any equipment or assembly, which bears on any surface any name, trademark, or other insignia intended to identify manufacturer, vendor, or other source(s) from which such object has been obtained, is prohibited.

Neither test lab certification labels nor identification specifically provided under various technical sections of the Specifications shall be removed.

### **Equipment Pads and Anchor Bolts**

Provide all details with proper sections for the equipment pads and anchor. The equipment pads casting and making provision for anchor fastening as per the final unaltered drawing duly approved by the Engineer-in-charge shall be in the scope of contractor. However, the Contractor shall ensure proper coordination with sub - contractor.

All equipment pads for all vibrating equipments shall have cork vibration pads sandwiched between the finish surface and the bottom surface of required thickness to ensure minimum vibration travel below.

Provide galvanized anchor bolts for all equipment placed on concrete equipment pads, inertia blocks, or on concrete slabs. Provide number and size of recommended bolts by the manufacturer of the equipment and locate by means of suitable templates. Equipment installed on vibration isolators shall be secured to the isolator. Secure the isolator to the floor, pad, or support as recommended by the vibration isolation manufacturer.

Where equipment is mounted on gypsum board partitions the mounting screws shall pass through the gypsum board and securely attached to the partition studs.

**Miscellaneous:**

A site order book will be maintained at site, which will be in the custody of the Engineer-in-charge, or his representative and all instructions given to the Contractor will be recorded in the site order book and the same has to be signed by the Contractor to comply with the instructions given therein.

**Contractor's Superintendence:**

The Contractor shall be responsible to depute manpower required and authorized by Engineer-in-charge for supervision of the work during execution. The Contractor authorized representatives approved by Engineer-in-charge shall be available all time at site of work for continuous monitoring the progress and Supervision. He shall receive and follow are directions and instructions issued by the Engineer-in-charge or his representative. Engineer-in-charge reserve the right to remove the staff from site of work if found undisciplined or involved in mal practice or criminal activity.

The Contractor shall provide details of the execution and supervisory team deployed for the works with names and CV's, of all key staff before the commencement of work and get it approved of in writing by the Engineer-in-charge. Contact telephone or Mobile numbers for emergency and/or twenty-four (24) hour call shall also be included.

If in any case of withdrawal of any worker/ technician/Engineer from the execution team, the replacement of the same shall be done with equivalent qualification, and shall be approved in writing by the Engineer-in-charge.

After completion of the work the whole installation shall be tested by the Contractor in the presence of the Engineer-in-Charge. The tests shall comply the following I.E.E. Regulations and shall be submitted along with the final bill:

The result of the insulation test shall comply with the I.E.E. Regulations 1101 to 1108A and 1008B as may be applicable.

Test shall be carried out to ascertain that all the non-linked SP switches have been connected to the phase conductor.

The continuity test of the earthing system shall comply with I.E.E. Regulations 1108 to 1109 to the latest addition.

The Contractor shall be responsible to provide all necessary testing instruments, such as megger insulation tester, earth tester multi-meter, AVO meter etc for carrying out the above tests.

If the result of the above tests do not comply with the I.E.E. Regulations, the Contractor shall rectify the defects or replace the materials to achieve the desired results.

The work will not be considered as complete and taken over by the Engineer-in-charge till all the components of the work after completion at site in all respects are inspected / tested by the Engineer-in-charge to his entire satisfaction and completion certificate is issued by the Engineer-in-charge to this effect.



At the completion of the work and before issuance of certificate of virtual completion, the Contractor shall submit 6 sets of drawing and two tracing of each drawing to Engineer-in-charge of each layout drawings drawn at approved.

## **PRODUCT, TESTING & COMMISSIONING**

### **LT Power Distribution System:**

Voltage: 415V

Frequency: 50 Hz

Neutral: Grounded

Short Circuit Fault withstand capacity: as per calculations and specifications

### **Painting of Panels:**

Powder coating of approved shade as per Specification. (Refer clause of painting)

### **Painting of Structural steel:**

Powder coating of approved shade as per Specification. (Refer clause of painting)

### **Cable Details:**

LT Control Cables: Copper conductor armored PVC insulated 1.1 KV grade.

LT Power Cables: Aluminum conductor armored XLPE insulated.

Grounding Conductors: Copper/ G.I. as specifications

### **Accuracy Class of Meters:**

Revenue Meters: Class-I or as approved by SEB

Ammeters, Voltmeters & Other Instruments: Digital Type

### **Drawings:**

The list of drawings is enclosed along with the specification. These drawings are meant to give general idea to bidder regarding the nature of work covered under specifications.

Any information or data missing in the drawings shall not relieve the Contractor of his responsibility to carry out the work as per the specifications. Additional information if required by the bidder can be obtained from Engineer-in-charge for completing the work successfully.

### **Shop drawings:**

The Contractor shall prepare detailed coordinated electrical shop drawing indicating D.G. set layout, control panel and cable schedule with other relevant services and submit for Engineer-in-Charge approval

before commencing the work. The shop drawings shall indicate all setting out details and physical dimensions of all components with wiring and cable details including system operating write up in the system i.e. control and relay panel, diesel generating sets, cable schedule and routes, manhole trap and fixing details for the above mentioned work. All work shall be carried out only after approval of the drawings. However, approval of these drawings do not relieve the Contractor of his responsibility for providing maintenance free and full proof system including any missing component / accessories to meet with the intent of the specifications. Contractor will submit 2 (two) prints for preliminary approval and finally 6 (six) prints for distribution.

### **Manufacturer's Instructions**

Where manufacturers have furnished specific instructions, relating to the material / equipments to be used on this job, covering points not specifically mentioned in this document, manufacturer's instructions should be followed.

### **Completion Documents and Drawings**

Three copies of operation manuals/catalogues of all standard equipment are to be furnished by the Contractor immediately after commissioning of plant.

Three copies of write up on preventive maintenance, trouble shooting and operating instructions of the system along with as-built drawings are to be supplied by the Contractor at the time of commissioning.

On completion of the work in all respects, the Contractor shall supply five portfolios (300x450 mm), each containing complete set of drawings on approved scale, clearly indicating complete layouts, location; wiring and sequencing of automatic controls, location of all concealed wiring and other services. Each portfolio shall contain consolidated control diagrams and technical literature on all controls. The Contractor shall frame under glass one set of these consolidated control diagrams for display in the panel room.

### **Materials and Equipment:**

All the materials and equipments shall be of the approved make and design unless otherwise called for any approval by Engineer-in-charge. Only the best quality materials and equipment shall be used.

### **Space Heaters:**

Suitable number of adequately rated heaters thermostatically controlled with On-Off switch and fuse shall be provided to prevent condensation in panel compartment. The heaters shall be installed in the lower portion of the compartment and electrical connections shall be made from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

### **Fungi static Varnish:**

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts, which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with

the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

### **Ventilation Opening:**

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

### **Degree of Protection:**

The degree of protection in the enclosures of the control cabinet, junction and marshalling boxes, panels, etc shall be as detailed here under:

1.	Installed indoor	: IP-55
2.	Installed indoor in air-conditioned area	: IP-31
3.	Installed in covered area	: IP-42
4.	Installed indoor in non-air-conditioned area Where possibility of entry of water is limited	: IP-41
5.	For LT Switchgear (AC and DC distribution boards)	: IP-42

The degree of protection shall be in accordance with IS: 13947 (Part –I) and IEC-947 (Part –I). Type test report for degree of protection test on each type of the box shall be submitted for approval of Engineer-in-charge.

### **Rating plates, Name plates and Labels:**

D.G. Sets, control panel and auxiliary items installed in the building are to be permanently attached to it in conspicuous position. A rating plate of non-corrosive material with engraved manufacturer's name, year of manufacture, equipment details type or serial number together with details of designed loading conditions of operation.

Equipment rating plate shall be in accordance to IEC requirement.

All such name plates, instruction plates, rating plates shall be bilingual with Hindi inscription first followed by English. Alternatively, two separate plates one with Hindi and another with English inscriptions may be provided.

### **First fill of consumables, Oil & Lubricants:**

All the first fill of consumables such as oils, lubricants, filing compounds, touch up paints, welding/ soldering/ brazing material for all Copper/ G.I earthing and essential chemicals etc. which will be required to put the equipment/ scheme covered under scope of the specifications, into successful operation, shall be

furnished by the Contractor unless specifically excluded under the exclusions in the specifications / documents.

**Quality Assurance Programme:**

To ensure that the equipment and services under the scope of this contract whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at site are in accordance with the specifications. The Contractor shall adopt suitable quality assurance program to control such activities at all points necessary. The programme shall be outlined by the contractor and approved by the Engineer-in-charge. A quality assurance programme of the contractor shall generally cover the following:

His organization structure for the management and implementation of the proposed quality assurance programme.

Documentation control system.

Qualification data for bidder's key personnel.

The procedure for purchases of materials, parts components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.

System for shop manufacturing and site erection controls including process controls and fabrication and assembly control.

Control of non-conforming items and system for corrective actions.

Inspection and test procedure both for manufacture and field activities.

Control of calibration and testing of measuring instruments and field activities.

System for indication and appraisal of inspection status.

System for authorizing release of manufactured product to the Engineer-in-charge.

System for maintenance of records.

System for handling storage and delivery

The Engineer-in-charge or his duly authorized representative reserves the right to carry out quality audit, surveillance of the system and procedure of the Contractor / Vendor's quality management and control activities.

**Quality Assurance Documents:**

The Contractor shall be required to submit the following Quality Assurance Documents within three weeks after dispatch of the equipment.

All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication and reports including radiography interpretation reports.

Welder and welding operator qualification certificates.

Welder's identification list, listing welder's and operator's qualification procedure and welding identification symbols.

Raw material test reports on components as specified by the specification and / or agreed to in the quality plan. Stress relief time temperature charts/oil impregnation time temperature charts.

Factory test results for testing required as per applicable codes/mutually agreed quality plan/standards referred in the technical specification.

The quality plan with verification of various customer inspection points (CIP) as mutually and methods used to verify the inspection and testing points in the quality plan were performed satisfactory.

### **Inspection, Testing and Inspection Certificates**

The Engineer-in-charge shall have at all reasonable times free access to the Contractor's premises or works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection, if part of the works is being manufactured or assembled at other premises or works, the Contractor shall obtain permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. Inspection may be made after manufacturing prior to dispatch at site at the option of the Engineer-in-charge and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

DG Set factory acceptance test witness shall be offered for 2 hrs. with water load bank on unit power factor after assembly to Engineer in-charge and following minimum tests should be offered:

No load test – 10minutes

25% Load – 10minutes

50% Load – 10minutes

75% Load – 30minutes

100% Load – 30minutes &

110% Load – 30minutes

DG SET PERFORMANCE PARAMETERS LIKE VOLTAGE, HZ, AMP, KW, PF, COOLANT TEMP., LUB.

OIL Pr. ETC. SHALL BE RECORDED DURING TRIAL.

Fuel consumption at 100% load & vibration checks also needs to be done & ensured.

All equipment being supplied shall conform to type tests and shall be subject to routine tests in accordance with requirements stipulated under respective sections. Bidder shall submit the type tests reports for approval. The Contractor shall intimate the Engineer-in-charge the detailed program about the tests at least

three (3) weeks in advance in case of domestic supplies. If for any item type test were pending payment would be made on successful completion of type/routine test(s) actually carried out as per Engineer-in-charge instructions.

The Contractor shall give the Engineer-in-charge thirty (30) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account. The Engineer-in-charge unless witnessing of the tests is virtually waived will attend such tests within thirty (30) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed with the test which shall be deemed to have been made in the presence of Engineer-in-charge and shall forward duly certified copies of tests in triplicate.

The Engineer-in-charge within fifteen (15) days from the date of inspection as defined shall inform in writing to the Contractor of defects noticed during inspection and any objection to drawings or workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and make the necessary modifications accordingly.

When the factory tests have been completed at the Contractor's or Sub-contractor's works, the Engineer-in-charge shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Engineer-in-charge, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Engineer-in-charge. Failure of the issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificate shall not bind the Engineer-in-charge to accept the equipment should, it, on further tests after erection, is found not to comply with the Specification.

The equipment shall be dispatched to site only after approval of test reports and issuance of MICC by the Engineer-in-charge.

For tests whether at the premises or at the works of the Contractor or of any Sub Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labor, materials, electricity, fuel, water, stores, apparatus and instruments as may be required by Engineer-in-charge or this authorized representative to carry out effectively such tests of the equipment in accordance with the Specification.

The inspection by Engineer-in-charge and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance program forming a part of the Contract.

The Engineer-in-charge will have the right of having any other tests(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests to satisfy that the material comply with the specifications.

The Engineer-in-charge reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipment's for these tests shall be provided by the Contractor.

## **Tests**

### **Charging (Pre-commissioning tests):**

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Engineer-in-charge and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The pre-commissioning tests to be performed as per relevant I.S. / manufacturer/ bidder submittal and as included in the Contractor's quality assurance program.

**Commissioning Tests:**

The available instrument and control equipment will be used during such tests and the Contractor will calibrate all such measuring equipment and devices as far as practicable. However, immeasurable parameters shall be taken into account in a reasonable manner by the Contractor for the requirement of these tests. The tests will be conducted at the specified load points and as near the specified cycle condition as practicable. The Contractor will apply proper corrections in calculation, to take into account conditions which do not correspond to the specified conditions.

All instruments, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.

Pre-commissioning test shall be carried out as per relevant IS/ manufacturer recommendations and/or as specified in the relevant clause.

The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning of the equipment. However necessary fee shall be reimburse by Engineer-in-charge on production of requisite documents.

**Packaging:**

All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of availability of Railway wagon/truck/trailer sizes in India should be taken account of the Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Engineer-in-charge takes no responsibility of the availability of any special packaging/transporting arrangement.

**Protection:**

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

**Finishing of Metal Surfaces:**

All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts and bolts and spring washers shall be electro galvanize.

All steel conductors used for earthing/grounding (above ground level) shall be galvanized according to IS: 2629.

**Painting:**

All sheet steel work shall be degreased and phosphated in accordance with the IS-6005 “Code of practice for Phosphate iron and sheet”. All surfaces which are not easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swab shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

After Phosphating thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stove type zinc chromate primer. The first coat may be “flashing dried” while the second coat shall be stove.

Powder coating/electrostatic painting of approved shade shall be applied.

The exterior color of the paint shall be as per IS-5 or as approved by Engineer-in-charge. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments, if required.

In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures like electrostatic painting etc. the procedure shall be submitted along with the Bid for Engineer-in-charge attention and consideration.

**Handling, Storage and Installation**

In accordance with the specific installation instructions as shown on manufacturer’s drawings or as directed by the Engineer-in-charge or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, and square and properly aligned / oriented.

Instruction of manufacturer or Engineer-in-charge shall be followed for unloading, transporting, toring, testing and commissioning of various equipments supplied by contractor.

In case of any doubt/misunderstanding and for correct interpretation of manufacturer’s drawings or instructions, necessary clarifications shall be obtained from the Engineer-in-charge. Contractor shall be held responsible for any damage to the equipment consequent for not following manufacturer’s drawings/instructions correctly.

Where assemblies are supplied in more than the one section, contractor shall make all necessary connections between sections. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning.



Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the contractor at his own expense.

The Contractor shall submit to the Engineer-in-charge every week, a report detailing all the receipts during the week. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Engineer-in-charge in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material after erection until expiry of guarantee period and protection against theft, corrosion, damages etc.

The Contractor shall be responsible for making suitable facilities to store all equipment which require indoor storage.

The words 'erection' and 'installation' used in the specification are synonymous.

Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.

The minimum phase to earth, phase to phase and section clearance along with other technical parameters for the various voltage levels shall be maintained as per relevant IS.

### **Protective Guards**

Suitable guards shall be provided for protection of personnel from all exposed rotating and/ or moving machine parts. All such guards shall be designed for easy installation and removal for maintenance purpose. The Contractor shall conform to the general regulations governing personnel on the site and must keep to the working space allocated for their use.

The contractor shall be responsible for any kind of mishap etc to working personnel. All safety precautions shall be provided to the staff. The Engineer-in-charge shall in no way be held responsible for the treatment or any facility.

### **Tools and Tackles**

The Contractor shall supply one complete set of all special tools and tackles for the erection, assembly, dismantling and maintenance of the equipments.

### **Performance Requirements**

The equipment shall be capable of delivering power continuously at the generator terminals. Net output shall not be less than the specified value at 0.8-p.f. excluding auxiliary power (shall be included over and above), when operating under the site ambient conditions described in the specification. Generating set

should have minimum 50% single step loading capacity and it should be able to take full load in less than 30 seconds from the time of start with PCC 3.3 Controller (The set shall be suitable for prime duty). The bidder shall furnish detailed de rating calculations due to temperature and other parameters with supporting document.

DG Set shall be suitable for 10% overload for 1hour in each 12 hours of operation.

The design parameters of the generator and excitation system shall be so chosen that the set is stable while running at any load between no-load and full load and also during starting of motors as specified. It should also have iso-synchronous speed control with load sensing governing system suitable for parallel running of D.G. sets.

Engine should be heavy-duty four strokes, turbo charged after cooler 'V' construction, electric start. Engine should have minimum lube oil change period of 300 hrs.

The total harmonics contents should be less than 3% as per IS 4722/1969. The graph & calculation for harmonic distortion shall be submitted.

Contractor to specify guarantee maintenance contract cost and to give an undertaking to take a comprehensive maintenance contract after expiry of warranty period for which price may be quoted.

The successful bidder will submit shop drawing of the equipments/accessories selected for this work for the approval of Engineer-in-charge.

### **Diesel Engine – Construction**

Material of construction of major parts shall be as under or as per manufacturer's standard design.

M.S. base frame with anti-vibration mountings.

Crankcase – Aluminium alloys.

Crank shaft, connecting rods – Forged Alloy Steel.

Piston – Al. alloy casting

Piston rings – Alloy steel

Engine block – Cast iron.

Cylinder liner – Cast

All other materials of construction shall be as per relevant standard/code and the copies of same shall be supplied free of cost to Engineer-in-charge.

The Diesel Engine shall be multi-cylinder, 4-stroke, water cooled with engine mounted heat exchanger , totally enclosed, continuous duty, direct fuel injection, turbo charged, compression ignition, inter cooled oil engine or with individual cylinder head with provision to measure exhaust temperature.

One common base frame shall be provided for mounting the engine and alternator complete with AVM pads between DG set and foundation, leveling lines etc. as required.

All externally mounted hardware shall be high tensile steel only.

The engine shall be fitted with an exhaust gas driven turbo charger of air/water cooled type complete with its own self-contained lubricating system. The turbocharger shall be positioned at the free end of the engine preferably.

The engine shall be fitted with a charge air inter cooled of the air/water type. Air from the turbo-charger compressor passes through the inter cooler and then to the engine manifold. The inter cooler shall be of tubular construction or as per manufacturer design with aluminium bronze tubes, mild sheet steel and cast iron water headers.

Contractor shall indicate the maximum time for which the Diesel Engine can be operated.

### **Governing System**

The Governor shall be electronic fuel control type for coupled Generating set with over speed trip protection.

### **Engine Starting System**

Starting of the Diesel Engine shall be done by electric starting system.

The electric starting system shall comprise starter motor, batteries (4nos. 12V 160AH capacity OR as per manufacturer's recommendation suitable for 3 consecutive starts) and battery charger including with all required instruments and accessories.

The engine mounted charging alternator shall charge the batteries while engine is running and Panel /floor panel mounted solid state battery charger while engine is stationary. The battery charger shall be rated for boost and trickle charge with all metering and control instruments and protections for A/C and D/C circuit. The total system shall be suitable for auto and manual operation including their wiring etc. Calculation for the battery and battery charger capacity as well as complete descriptive circuit diagram based on three consecutive start commands shall be submitted for approval of Engineer-in-charge.

### **Fuel Oil System**

The manufacturer shall furnish a mild steel day tank of required capacity for individual engine. The day tank shall be suitably located to avoid gravity feed to the engine, shaft driven fuel oil pumps and shall be complete with gauges, filling, draining and vent connection with valves and level switch for auto filling of tank and for alarm in case oil level goes beyond specified limit.

The fuel system shall be provided with full flow simplex oil cartridge filter.

The fuel oil system shall be equipped with a crankshaft driven fuel oil transfer pump which will draw the fuel oil from the day tank via filters and shall be as per the engine manufacturer design.

Multi point (electronically controlled) fuel injection system or direct injection/through isochronous fuel Governing system shall be designed taking into account the type of fuel used, engine speed etc. so as to achieve safe knock free performance with low emission smoke.

### **Lubricating Oil System**

All lubricating parts of the engine shall be connected to a pressurized lubricating oil distribution piping system being continuously charged by gear type lube oil pump mounted at the free end of the engine and driven from the engine crank shaft. The pumps shall take suction from a sump tank integral with the engine through a foot valve, suction filter through oil cooler and deliver oil to main supply header. High-pressure oil shall be supplied to the main and big end bearings, crankshaft bearings, governor, auxiliary drive gear etc. Suitable lubricating arrangement for engine cylinder valve gear, cams and pistons at the required level shall be arranged. A pressure relief valve shall be mounted on the main supply header for safety against too high-pressure while starting with cold oil. A timer based, auto running (auto priming pump) shall be provided to keep engine primed all the time complete with control system (if required).

The lube oil system shall be provided with full flow simplex lube oil cartridge filters. The minimum lube oil change shall be after 300 hrs of operation.

Arrangement shall be provided to bypass the lube oil pressure switches and safety at the starting till the pressure is built up.

The lube oil sump shall be provided to sense the low level of lube oil in the sump and fill it up automatically from the main lube oil tank/sump and stop the transfer pump, once the lube oil is filled in the sump without stopping the engine. Pressure switches to give alarm under extreme low pressure of lube oil and subsequently to trip the unit, when the minimum safe pressure has reached, shall be provided.

All necessary accessories such as pressure gauges, temperature indicators, pressure relief valves, bypass valves, pressure switches shall be provided and the safeties shall be wired up to junction box

### **Exhaust System**

Engine emission exhaust silencer shall be critical type Silencer to ensure minimum 25 dba insertion loss as per CPCB, ducting, bends, hood/canopy, thermally insulated 75mm thick compressed mineral LBR (Rock wool) having 150Kg/m<sup>3</sup> density for D.G. exhaust pipe with 22 gauge aluminium sheet cladding etc. shall be provided along with structural support with stays for each engine. Heat resistant paint shall be provided on exhaust pipe for the portion, which is outside of the building/ stack un insulated. Exhaust system pollution level shall be indicated and got approved by authorities. (Exhaust smoke quality & quantity should be within the norms of central & state pollution control board).

Emission standards in brief for above 800KW (at 0.8pf) Engines – Generator set application

NO<sub>x</sub> (up to 75MW) – 710 ppmv

HC – 100 ppmv

PM – 75 mg/Nm<sup>3</sup>

CO – 150 mg/Nm<sup>3</sup>

Sulphur contain in fuel - <2%

### **Engine Alternator Control Panel**

Engine alternator (D.G.) controller panel shall be provided with digital display for speedometer, lubricating oil pressure gauge, jacket water temp, battery charging, for local indication & panel mounted on / near the engine itself.

Engine shall be supplied with microprocessor based Genset Controller for diesel generating set monitoring control system, which should be equipped with (digital) electronic Governor along with digital AVR to facilitate discreet control of speed and voltage in synchronous mode..

The system shall be equipped with starting control including integrated fuel ramping to limit the black smoke frequency overshoot with optimized cold weather starting. The engine instrument panel shall be equipped with digital alarm and status to monitor and display the following parameters. The inter face modules, converter, probe and their wiring up to terminal block in panel with 485 ports etc. making compatibility with PLC. The necessary CT/PT shall be included and wired accordingly to meet the requirements.

### **Engine Indicators:**

Digital tachometer with running hour meter

Lubricating oil pressure low

Over speed

Engine fail to start

Lack of fuel due to low level.

Volts RY-YB-BR.

Amps R-Y-B.

### **AMF Control Panels**

#### **Control Philosophy:**

#### **Automatic Starting and Stopping of Engines:**

The system should come in operation after sensing of Grid Failure and / or the voltage drops below preset value. For this purpose the NB-2 or equivalent “Engine Control & Automatic Mains Failure Stand by System” shall be provided to perform the following functions.

Sensing the healthiness of supply from Supply Company, the engine shall be at rest.

On sensing the supply healthiness (the supply fails or drop below the preset value) the command shall be given to start the D.G. Set.

In case the D.G. Set does not start in the 1st command than two more commands shall be given to start the D.G. Set at an equal interval of time (5 Sec). Even then if the engine does not start the indication shall appear on window / screen “Set fail to start” and alarm shall be generated.

On starting of D.G. Set & monitoring the healthiness of supply, the load shall automatically be transferred on D.G.

On restoration of the supply & monitoring the healthiness of the system, the load shall be transferred to Mains automatically & vice versa.

**Manual Mode:**

Select manual mode on the relay unit.

The Set shall only be started by pushing the “start button” on the relay.

On attaining the requisite voltage & frequency, the D.G. breaker / Contactor will be closed or tripped manually without shutting down the engine.

The Engine shall be shut down manually by pressing the push button.

**Test Mode:**

The test mode operation is independent of the conditions of the mains supply & thereby enables routine testing or exercising of the D.G. Set without closing the D.G. breaker / contactor. (Select the switch on selector mode & is similar to the auto mode except closing of the breaker).

The relay shall have following features such as:

Mode selector switch (Auto/Manual/Test/Off)

Engine Control switch (On/Off push button)

Reset/Acknowledge push button.

Breaker close/open push button.

Test push button.

Set of visual indication

Load on Mains.

Load on D.G. Set.

Set fails to start.

Low-pressure alarm & Trip.

High temperature alarm & Trip.

Engine over speed.

Alternator overload & short circuit.

Voltages, phase to phase & phase to neutral.

Ammeter Line / Phase current.

Power factor meter.

Kilowatt-hour meter.

Frequency meter.

Tachometer.

### **Alternator (415V – 3 Phase, 4 Wire System)**

The alternator shall be brushless synchronous and suitable for 3 phase 415V, 4 wire, 50 Hz, 0.8 p.f., 1500 RPM.

The alternator shall be suitable for coupling directly to the diesel engines described earlier in clause no. 1.0 It shall be Drip proof, screen protected as per IP 23. It shall include one set of suitable rated foot mounted anti - condensation heaters. The alternator shall be single /double bearing type and self-ventilating. The Alternators shall be provided with fully interconnected damper windings to facilitate parallel running. The alternators shall be continuously rated and shall have class 'F' insulation designed and built to withstand tropical conditions. It shall generally conform to BS: 5000 ( part - 99 ). The rated output of alternators at specified site condition at 0.8 lagging power factor shall be 1600 KW for 1500 KVA DG Set at 415V. Each DG set shall be suitable for sustaining a 10% overload for 1 hour in any 12 hour period without injury. Additional adopter box to be provided for accommodating outgoing Al. Conductor cables including G.I. nut bolts for termination.

The alternator shall also have a digital automatic voltage regulator (AVR inbuilt in Genset Controller) suitable for single and parallel running with control limits of 1% from no load to full load under normal load changes when running single.

The Engine and Alternator shall be direct coupled and mounted on a common rigid fabricated steel base frame with suitable vibration isolation system.

The Alternator shall withstand an over speed of 20% for a period of 2 minutes without mechanical damage.

The generator/alternator shall with stand over load of 10% for 1 hour every 12 hourly. The terminal voltage shall be adjustable and the range of adjustment shall be +/- 5% of nominal voltage.

The Alternator shall be capable to withstand 3-phase short circuit at its terminals for 3 seconds when operated at rated KVA and power factor at 5% over voltage with fixed excitation (3 times the line current for 10 Sec) without damage / injury.

The alternator shall be capable of withstanding 50 % excess of rated current for 30 seconds at maintained rated voltage, consistent with max capacity of the prime mover.

Six Nos. embedded (RTD) resistant temperature detector platinum (100-ohm resistance at 0 Degree) to measure the winding temperature and 1/2 Nos. (BTDS) bearing temperature detector shall be provided.

The leads of embedded RTD shall be wired up to the terminal block in a separate auxiliary terminal box.

Manufacturer shall indicate the setting values for each RTD/BTD for alarm and trip.

All external nuts and bolts shall be of high tensile steel only.

Alternator shall be provided with anti-condensation space heater of adequate rating suitable for 240V, 50 Hz. single ph A.C. supply and shall be wired up to a separate terminal box. (Wiring and equipment shall be provided by D.G. supplier).

Two independent earth terminals on the frame complete with nuts, spring washer and plain washer shall be provided.

Alternator shall be provided with suitable terminal box for terminating cables drop and protection. CTS within the terminal box duly wired up to the panel shall be provided.

The alternator shall be capable to sustain the unbalanced current between the phases minimum 25% of rated current provide that the KVA rating.

The alternator shall be fitted with radio interference suppressors in accordance with BS-613-1977 and shall be within the limit of CISPR standard.

The alternator shall be dynamically balanced complete with rotor and shaft.

Alternator should have bearings at one /both shaft ends.

Damper winding shall be provided in the pole to damp the oscillations and ensure satisfactory performance during parallel operation.

Winding of 3 phase alternator shall be of star connected and neutral point shall be brought out to the terminal box through protection and earthed with independent earth or through contactor as per scheme. Protection CT's/PT's shall be mounted above the terminal box with enclosure. Bus duct / cable shall be terminated on terminals through this.

Diesel generating set shall be able to start motor of 30% capacity of D.G. set with a 20% base load.

### **Automatic Voltage Regulator**

An automatic / digital high speed voltage regulator (inbuilt in genset controller) shall be provided with all accessories. The regulation system shall be with equipment accessories for automatic control.

The combined voltage regulation shall be  $\pm 1\%$  from full load to no-load, from hot to cold at 0.8 power factor with 4% speed regulation of the engine.



Necessary equipment for field suppression and surge protection shall be provided.

The response time of the exciter and the generator shall be matched to avoid hunting.

Reactive load sharing of parallel operating generator shall be in proportion to their ratings. The quadrature drop current transfer compensation feature should be provided on exciter regulation and drop voltage shall be within 1% variation.

D.G. Set Vendor shall inspect the existing system and include all necessary hardware, input/ output modules and junction box with terminal block and its wiring complete as required to make the system operational in PLC / Manual mode and to be included in price bid.

### **PLC System**

#### **Note:**

D.G. Vendor shall include all necessary hardware, input/output modules and junction box with terminal block complete as required to make the system operational in PLC/Manual mode and to be included in price bid.

### **Control Philosophy (Only for Information)**

#### **Automatic Starting & Stopping of Engines:**

The system should come in operation after sensing of grid failure or the voltage drops below preset values. The 'PLC' shall issue the command to 'Master' D.G. set. In case the D. G. set fails to start in the 1st cranking, two more cranking attempts shall be made with proper intervals. Even then if engine fails to start, indication must appear on MMI / Monitor 'Set Fails to Start' & alarm shall be generated. The PLC shall give the command to the next DG set selected in sequence.

DG set on load operation system shall start monitoring voltage, frequency and load. If the load exceeds settable limit the next D.G. shall be started to prevent D.G. over loading. The process shall continue till all the D.G. sets have been started.

At any point of time the engines are under loaded and the load is capable of being catered by less than the numbers of running DG sets. Stop command shall be given to DG running for shortest duration at that moment.

On restoration of mains and sensing the healthiness of the same, the load shall be transferred to mains. The DG sets shall be given stop command after settable time delay ensuring adequate cooling down of the engine.

#### **Auto Synchronization:**

Synchronization facility shall be available both for 'Auto & manual' mode. In auto mode, the synchronization will be achieved by 'PLC' (PLC will control voltage, frequency and phase angle and issue command to breaker), However if due to any reason auto synchronization fails repeatedly the 'PLC' system should initiate start command to next DG for operation as well as synchronize the system automatically.

In manual mode the system shall be manually operated backed by relays.

In auto mode facility the closing of breaker shall be automatic, whereas in manual mode breaker will be closed by panel switch through synchronizing relay.

In any case if the auto synchronization is failed to achieve in a settable time an alarm shall be generated and displayed that the 'DG Failed to Synchronize' and the same shall be aborted.

**Automatic Load Sharing:**

'PLC' shall monitor active & reactive power generated by the various sets continuously and shall issue command to achieve proper load sharing.

**Back up Protection:**

The system shall have built in protection as listed below and shall continuously monitor the parameters and on sensing of any electrical fault PLC shall trigger 'Trip command'. Through Trip relay of the corresponding breaker similarly in case of semi auto mode and in case of manual mode it shall be through master trip relay.

Over voltage/ Under voltage

Over frequency/ Under frequency

Over Current

Reverse power active

Active Power reactive

Synchronizing check (MMI)

Earth fault relay unbalance

Differential protection through relay interface with PLC/PC

Engine Protection as listed under DG sub-head shall also be interfaced with PC/PLC for generating trip command/alarm and generating report etc.

**Programmable Logic Controller (PLC):**

The entire operation of the captive power generation system and grid supply shall be controlled automatically through PLC. These PLC's shall be state-of-the-art equipment using latest technology and of most rugged and reliable design. Since system will be operating in the harsh and unfriendly environment of D.G. Room, they should be suitable to operate trouble free under the conditions. The selected equipments should be able to withstand high temperature, humidity and voltage fluctuations, thus making it suitable for the operating conditions described above.

Automatic PLC system basically shall consist of but not limited to:

Main processor unit

EEPROM for CPU

Power supply unit I KVA UPS with maintenance free batteries for 30 minute Capacity

Mounting chassis 16 / slot mounting rack

Line Synchronization module

Digital input module

Digital output module

Computer to PLC communication card with cable (MMI)

Operator interface graphics software package (Windows based)

Analog I / P & O / P module 16 / 8 channels

Outgoing circuit (KWH) meter with pulse counter interface with PLC for generating report 20% spare incoming / outgoing shall be provided for future use. Interfaced connectivity for engine safeties and meters with cabling etc.

System diagnostic card control for DG auxiliary (Pump, fans, oil, fuel, cooler. etc.) Monitoring of HT voltage Transformers alarm and trip mimic of 33 KV & L V system

Monitoring of electrical parameters, incoming and outgoing Circuit Breaker of high and low voltage circuit and PC complete with CPU, colored monitor, keyboard, laser printer, required software shall be installed and commissioned.

### **Sequence of Operation for Auto Start-Stop, Auto Synchronizing, Auto Load Sharing and Load Management of D.G. Sets:**

‘On Grid’ Supply failure or on sensing of grid supply voltage (voltage drop than preset value), the master DG shall start automatically and closes its breaker/neutral contactor. Bus breaker also closes to feed the loads.

On attainment of maximum permissible load on master DG set (I). The 2nd shall start automatically.

Auto Synchronizing system shall verify the phase angle and also compensate closing time of incoming breaker by initiating closing command to breaker ahead of the actual on predictable Synchronizing ensuring thereby a zero (0) degree phase difference, as well as the system shall monitor the slip frequency, beat (hunting) voltage of the machine or system.

First DG neutral contactor shall remain in circuit even if the 1st DG set is shut-off. The neutral contactor of the other working set shall get closed first before tripping of the shutting off DG Set.

The process shall continue for incoming DG's such as 3rd, 4th so on.

The starting sequence of the DG sets can be altered through (MMI/PLC).

ON restoration of grid supply and sensing of healthiness of the same. The DG's & bus breaker shall be 'out' and grid breaker shall be 'in' to feed the power.

Active power on DG's is balanced automatically through Governor Control with the help of Active Load Balancing System.

Reactive load balancing system to achieve KVAR and regulation within preset bank value through the motorized potentiometers.

In the event set fails to synchronize the alarm generated through Annunciation panel shall invite the attention of the Operator for 'Manual' intervention. If the sets do not synchronize the bus breakers shall be switched off and both the sets start feeding their respective loads.

In the event of a D.G. standing idle more than 8 hours lube oil priming pump shall be started for 3-5 minutes.

DG auxiliary feeders shall be controlled through 'PLC' for starting/stopping of respective DG auxiliary system.

The system shall have total manual over-side w/o (without) by-passing the safeties and protections.

The system shall facilitate program changeability / settings / time delay etc. through MMI on PC.

#### **Stand Alone Mode (No Synchronizing):**

In this case the system shall work independently with electrical inter-linking to prevent parallel operation of two supply sources.

#### **Function/ Feature of PLC System:**

In general terms the following will be the functions of PLC. During final freezing of the controls, logic & Dos, addition and deletions can be made through PLC (MMI)

The system shall directly accept CT & PT signals without need of any transmitters for electrical parameter monitoring and control system or the same shall be met through energy monitoring / management relays with RS 485 communication port.

Starting and stopping of DG sets automatically with by-pass arrangement in PLC depending upon the load requirement.

Automatic selection of next DG as master after stopping/ tripping of master DG & to close or open of neutral contactor respectively.

Automatic Synchronizing of DG sets in auto mode.

The system shall run on manual mode with relay protection back up in the event of PLC failure.

Key for selection of number of DG sets to start and synchronize at no load for kick (starting) load requirements.

Active & reactive power sharing of each DG sets.

Monitoring of electrical parameter on each D.G., voltage, frequency, reactive load, active load, and energy produced etc.

Status and control of outgoing breakers.

Backup protection electrical by time delayed tripping of DG set.

Alarm and trip for reverse power, reverse KVAR, under voltage, over voltage, under frequency, over frequency, over current, low lube oil pressure, over speed and other safeties.

Data acquisition system will be incorporated with the system for the purpose of recording. The maintenance of the system and in totality operation system 1 important and critical parameters of the engine, alternator will be through operator interface and displayed with graphic screen.

PLC system should be capable to take care of all the protection (relay features) in auto mode. Relay base protection features of manual mode shall also be compatible with PC.

'B' checks alarm after each DG complete 500 hours or as recommended by DG supplier of running for proper maintenance.

Tripping of less priority loads in the building in case of under frequency of bus both in isolation as well as synchronized mode.

PLC input/output cards should be dedicated to individual DG'S without intermingling of signals from different DG'S.

PLC system shall have provision to test the DG in auto mode without closing the breaker to do the routine electrical/ mechanical test without interruption of power generation.

Monitoring of 6 points alternator winding, 2 points bearing temp drive and non-drive, ends for alarm & trip respectively. Provision for monitoring of 2 points exhaust gas temperature and smoke quality.

Besides DG'S PLC will also monitor grid supply parameter such KW, KWH, KVA, KVAR, as well as of the outgoing feeders etc. these parameter shall also be available to connect to BMS system as well.

The system supplier shall include the cost of the 1 spare card for each system to facilitate maintenance.

The system supplier will supply 6 sets of as built drawings along with trouble shooting with suggested measurer operational and maintenance guidelines through Engineer-in-charges.

### **Manual Mode**

In this case complete system operation will be done manually. Hence the starting of the DG sets, synchronization procedure, breaker closing, tripping etc will be done through respective switches, push buttons provided on respective feeders.

In this mode load sharing units will be effective hence starting or stopping of DG sets is done manually only.

Note: Any hardware/ software required making the system operational in PLC/manual mode shall be provided by the contractor.

### **Neutral Closing System for Parallel Running of DG set**

A suitably rating L.V. contactor shall be provided for each DG set for neutral isolation controlled through PLC (auto/ manual) from remote. Neutral contactor of the DG set started first will be closed and then command for that ACB closing can be effective. Only one neutral contactor (of the first DG set) will be closed during parallel operation.

In event of tripping of neutral contactor for master D.G. set the next selected DG'S N.C should close before the N.C of the master DG trip. While switching 'OFF' the DG sets which have started first is selected then the neutral contactor of either of remaining set will be switched on and then tripping signal to the first started D.G set will be actuated.

After voltage and frequency reached the set band, PLC shall issue close command to N.C 1st and then to ACB of selected DG set. This will prevent fault level current from flowing into the system. At any moment of time only neutral is the system to avoid any circulation current in other alternator.

The operational mimic shall also be provided on for complete function of mains & DGs etc on the box.

### **Commissioning Checks**

In addition to the checks and test recommended by the manufacturer, the Contractor shall supervise the following commissioning checks to be carried out at site.

#### **Load Test (at site):**

The engine shall be given test run for a period of at least 6 hours. All instruments, materials, consumables (fuel oil, lub. Oil etc.)load and labour required for carrying out of the test at site shall be arranged by contractor. The set shall be tested as per instructions by Engineer-in-charge without exceeding the specified D.G. Set rating:

During the load test, half hourly records of the following shall be taken:

Ambient temperature

Lubricating oil temperature

Lubricating oil pressure.

Color of exhaust gas.

Speed.

Voltage, wattage and current output.

Oil tank level.

**Insulation Resistance Test for Alternator:**

Insulation resistance in mega-ohms between the coils and the frame of the alternator when tested with a 1000V megger shall not be less than

$$IR = 2 \times (\text{rated voltage in KV}) + 1$$

**Fuel consumption Check:**

A check of the fuel consumption shall be made during the load run test. This test shall be conducted for the purpose of proper tuning of the engine.

Insulation Resistance of Wiring:

Insulation resistance of control panel wiring shall be checked by 500V megger. The IR shall not be less than one mega ohm.

**Functional Tests:**

Functional tests on control panel.

Functional test on starting provision on the engine.

Functional tests on all Field devices.

Functional tests on AVR and speed governor (visual).

**Vibration Measurement:**

The vibration shall be measured at Load as close to maximum achievable load and shall not exceed 130 microns/ ISO 8528limits.

**Noise Level Measurement:**

DG Room Noise level shall be measured as per ISO 8528, noise level should be within limits of CPCB / MOEF guidelines.

**Test Certificates and Reports:**

Test Certificate shall be submitted in four (4) copies.

The test certificates shall be furnished to the Engineer-in-charge for prior approval before dispatch of any equipment from works and the approval in writing from Engineer-in-charge shall be essential to effect dispatch of the equipment.

The test reports shall furnish complete data for equipment identification.

### **Earthing:**

Quantify and Identify the earthing pits requirement for neutral and body as per IS 3043/CEA/IE Rules.

The following shall be earthed:

D.G. Set neutrals.

D.G. Housing.

Non-current carrying metallic parts of electrical equipment such as switchgear, bus ducts, D.G. Control panel/ distribution boards, cable trays (electrical wiring accessories).

For earthing of electrode shall consist of copper/G.I. plate (size as per item) which shall be provided with holes. The plate electrode shall be buried in the ground vertically with its top not less than 3.5M below ground level. The earth plate shall be buried in the ground below the permanent moisture level but not less than 3.5 meter below ground. The plate shall be filled with charcoal dust and common salt filling extending 15 cm around it on all sides up to the ground level for water pipe. The top of the pipe shall be provided with a funnel and a GI mesh screen for watering the earth. This will be used in a masonry sump with cement plastering not less than 40 cm square and 30 cm deep. M.S. frame heavy duty CI cover with hinged and locking arrangement shall be suitably provided over the sump. The earthing lead from electrode onwards shall be suitably protected from mechanical injury by GI pipe. The portion of this protection pipe within ground shall be buried at least 30 cm deep (to be increased to building shall recessed in walls and floors to adequate depth). In the case of plate earth electrode the earthing load shall be securely bolted to the plate with two bolts, nuts, check nuts and washers.

In case of pipe earth electrode, it shall be connected by means of through bolt, nuts and washers and cable socket. All materials used for connecting the earth lead with electrode shall be of tinned brass in case of tinned copper plate electrode.

### **Cooling Tower**

#### COOLING TOWERS: -

##### Scope:

The scope of this section comprises the supply, erection, testing and commissioning of cooling towers in accordance with the Drawings, DBR and Scope of work. In general, BS-4485 should be followed for the same.

##### Type:



Cooling Towers shall be Forced/Induced Draft Series in accordance with the Drawings. These cooling towers should be designed with special emphasis for minimizing water losses especially drift loss and splash losses.

FRP Forced/Induced Draft Cooling Tower: -

Fibre glass-reinforced plastic Cooling Towers shall be suitable for outdoor installation. Tower shall be vertical, Forced/Induced Draft counter flow type in fibre-glass reinforcement plastic construction, complete with fan, motor, surface and spray section, eliminators, steel supports etc.

Capacity:

The cooling tower capacities shall be as per the Drawings and requirement.

Side Casing:

This shall be made out of FRP with smooth surface for minimum resistance to airflow. It shall have sufficient structural strength to withstand high wind velocities and vibration. The casing shall be installed in the fibre glass-reinforced basin. The tower supporting structure shall be made out of hot dipped galvanized frame. The tower shall have FRP panels with adequate reinforcement.

Cold Water Basin:

Cold water basin shall be a deep fiberglass reinforced sump with which cooling tower super structure shall be supported. Basin fittings shall include the following:

- Bottom Outlet.
- Drain at underside of suction side sheet.
- Overflow fixed to inside of casing side sheet.
- Ball type automatic make-up water valve.
- Equalizing connection where required.

Distribution System:

Hot water distribution system should be Gravity Flow comprising of static header and branch arms system.

Fillings:

Fillings shall be made of corrosion proof and rigid film in cross fluted design and arranged in square / rectangular form, and shall be elevated from the floor of the cold water basin to facilitate cleaning and easy replacement. They shall be arranged in such a manner as to ensure negligible resistance to airflow and to eliminate backwater spots and prevent fouling through scales that may form. In order to reduce carry-over losses through entrainment of moisture drops in air stream, PVC drift eliminators shall be installed. The fills shall be of High efficiency.

Mechanical Equipment:

Fan shall be made of Cast Aluminium Alloy and the propeller type, lightweight rotor fitted with multiple aerofoil blades. The entire fan assembly shall be balanced. Fan shall be direct driven motor 415 +/- 10% volts, 3 phase, 50 cycles AC supply, totally-enclosed, fan-cooled, weather-proof construction, designed and selected to operate in humid air stream. Fan shall be protected by fan guard and shall be easily accessible for inspection and maintenance. A service ladder shall also be provided for greater convenience. The mechanical equipment assembly shall be adequately supported on a rugged steel base welded to tubular support assuring vibration-free support. Fan guard shall be provided to prevent birds from nesting during idling periods. All fans shall be direct driven. Towers from 165 TR onwards wherever possible, shall have twin fans with twin motors, direct driven.

#### Panel Colour

For FRP cooling towers, the contractor shall obtain approval from the Engineer-in-charge for available colors for the casing panels. The cooling tower shall be procured of the colour, strictly in accordance with written approval of Architect/Engineer-in-charges and should have a striking finish.

#### Accessories:

Each cold water basin shall be provided with a deep, non-cavitating, and outlet sump complete with a suitable suction strainer having duplicate screen. The strainer shall have handles for easy removal.

The cooling tower basin shall be provided with automatic float valve with a stop valve for continuous make up water flow, quick fill arrangement with stop valve, over-flow and drain connections with stop valves.

Steel ladders shall be provided in such a manner and location as necessary to give safe and complete access to all parts of tower requiring inspection. Each ladder shall be made of 40mm x 40mm x 6mm angle iron sides and 16mm straps and shall be bolted to the tower on the top and bottom.

Hot dipped galvanized Bird Screen should be fixed on top to prevent any particles from entering the cooling tower.

All hardware shall be electroplated. All pipe connections shall be hot dip galvanized. All other technical parameters should confirm to FD/ID series cooling towers.

#### **Testing and Commissioning:**

Testing and commissioning shall be done as per the programme/instructions to be given by Engineer-in-charge authorized representative. All testing equipments necessary to carry out the tests shall be arranged by the Contractor. Before the electrical system is made live, the Contractor shall carry out suitable tests to the satisfaction of Engineer-in-charge that all equipment wiring and connections have been correctly done and are in good working condition and will operate as intended.

## **DG SETS INSTALLATION**

The size of DG Sets room will be such that adequate distance sufficient for maintenance is provided between two DG Sets. Fuel Day Tanks and water circulation pumps of DG Sets cooling system will also be installed in the same room with DG Sets. All other equipment will be installed in separate rooms near the DG Sets Room. Trench for Cable, fuel pipes etc will be provided as per requirement.

## **ROOM FOR DG SETS**

The Room (all walls and ceiling) will be treated acoustically with 75 mm thick resin bonded fiberglass with minimum density of 32 Kg/ Cum. The fiber glass will be fixed with 0.6 mm thick GI Sheet channels of size 25 +75+50+75+25 mm. The fiber glass will be finished with perforated aluminium sheet 0.8 mm thick.

The acoustic doors will be provided behind the rolling shutters. All other door of the DG Sets room will be acoustic doors.

The DG Sets room will be designed so as to achieve sound level outside the DG Sets room as per CPCB guide lines.

## **DG Sets Exhaust System**

Residential silencer shall be provided for each DG Set. It is proposed to provided two independent structures of MS which will support the DG Sets exhaust pipes of each DG Sets. Minimum stack height will be subject to approval by State Pollution Control Committee. The pipe sizes shall be selected as per manufacturer's design considering back pressure calculation. MS Pipes shall be minimum 5.5 mm thick and will be provided with 75 mm thick rockwool insulation and will be cladded with 0.8 mm thick aluminium sheet. The structure shall be suitable for number of pipes to be supported and designed for wind velocity prevailing at site. ACP Cladding will be provided on all sides of the structure. Suitable RCC foundation will be provided as per approved structural design.

## **HSD Storage System**

It is proposed to provide one number buffer tank of 990 Liters capacity each for Station Building and Office Building respectively. The tanks will be mounted at suitable height on suitable MS structure. The arrangement of pipes and pumps shall be as per schematic which shall be duly approved and all pumps will be operated automatically with level switches. One number 990 Liters capacity tank shall be installed underground for receiving overflow and drain from day tanks of DG Sets. Two number fuel pumps will be installed in this tank for transfer of oil from basement to ground level. At ground level, provision of filling point for transfer of oil will be kept which shall meet the norms of explosives department.

## **DG Sets Cooling System**

The DG Sets proposed are Heat Exchanger Cooled with cooling Towers which will be installed at terrace level as per site. End suction, top discharge water circulation Pumps (One Working + One Standby) shall be provided for circulation of water between heat exchanger and cooling towers. The capacity of the pump shall be adequate as per DG Sets manufacturer's requirement. MS Class C pipe shall be used for water circulation. Strainers, NRV, Butter Fly Valves etc. shall be provided as per design

The Cooling System shall be independent for each DG Set. However the pipe header will be common.

**DG Set Room Ventilation System**

It is proposed to provide closed ventilation in the DG Sets room. The fresh air requirement is subject to confirmation by DG Sets manufacturer. It is proposed to provide two fans for supply and two fans for exhaust of suitable capacity. Suitable Static Pressure is to be maintained. For reducing the sound level, silencers shall be provided at the inlet and exhaust of air through grills/ louvers.

**Electrical Work****DG Synchronizing Panel:**

It is proposed to synchronize the DG Sets. The entire system will be designed so that in case of normal supply failure, it shall be possible to transfer the load on DG Sets in 30-40 Seconds. The Synchronizing will be done through Microprocessor Based PLC Panel. (PCC 3.3 or advanced version).

**MV Panels: Motor Control Centers** shall be provided for operation of water circulation pumps, Cooling Towers, Ventilation Fans (Supply and Exhaust), HSD Pumps.

**MV Cable Work:** The work shall include complete cabling of 1.1 KV Grade. The specification of cable work shall be in accordance with Sub-station / Internal Work. Cables will be laid in trench / cable trays as the case may be.

**SUB HEAD – 12****LIGHTNING PROTECTION SYSTEM****Work Description**

This section comprises the engineering, supply and installation, testing necessary for the Lightning Protection System for common structures of less/more than 60 meter high and of open areas (storage, leisure, office areas etc) It includes the protection against the electrical consequences due to the lightning current flow through the lightning protection system including each level has a fixed set of maximum & minimum lightning current parameters.

**Notes:**

This standard does not cover the protection of electrical equipments or system against voltage surges of atmospheric origin which are transmitted by networks entering the structure.

Other standards describe lightning protection systems using simple rod lightning conductor, stretched wires and meshed conductors.

The Lightning Protection System shall be installed in accordance with NBC-2016, IS / IEC 62305-3 & IS 3043 and additional requirements of this specification. The system shall consist of air terminations, down conductors, joints and bonds, testing joints, earth terminations and earth electrodes. The general arrangement shall be as indicated on the drawings. The lightning protection system shall comprise:-

Air terminal (as per rolling sphere or mesh or protective angle method.)

Down Conductors

Joints and Bonds

Test Links

Maintenance free earthing system based on chemical earth compound

Lightning protection system employing steel structural and reinforcement system as part of the down conductors shall be adopted as per Drawing specified. All requirements in the specification included cast-in re-bar down conductors shall be applied unless otherwise specified.

**Standards**

Complete supply and installation of the lightning protection system shall be followed for engineering, construction and installation in accordance of the following standards and with the latest revision with update amendments:

IS / IEC 62305-3 & IS lightning arrestor air terminals 3043

IS/ IEC 62561 Lightning and Earthing Material

NFC 17102 Updated standards for Lightning Protection

The detail of the lightning protection system shall also conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in this Specification and Drawings, whichever is the more stringent and acceptable to the Engineer.

In the adoption of standards and requirements, the Contractor shall take the following precedence:

Engineer's decision

Drawings

Specification

International standards and requirements.

### **Submission**

All technical submissions shall be approved by the contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of Engineer-in-charge for its review and approval.

A prior survey may be conducted to determine the protection level to be considered, the ESE lightning conductor location(s), the down –conductor path(s), the earth termination system location(s) and type(s). All technical submissions shall be approved by the Engineer prior to the respective stages of construction.

Architectural constraints may be taken into account in the lightning protection system design and the design shall be based in a manner so that there is no reduction in the lightning protection system effectiveness.

As a minimum requirement, the submission shall include the following:

Equipment submission with manufacturer's data;

Sample submission;

Shop Drawings showing the co-ordinate routing of air terminations, down conductors bonding to re-bar and foundation earth terminations, methods of fixing etc.

Builder's works requirement.

Proposal on testing procedures and report format for testing of the Lightning Protection System.

Detail of the Contractor's installation Professional Engineer who supervise and endorse the installation for occupation permit application.

### **AIR TERMINAL**

Lightning Protection System shall be in accordance with IS / IEC 62305-3 & IS 3043 / NFC 17102 Latest standards.

### **Zone of Protection/ Area Protection**

The zone of protection of a lightning conductor defines the space within which Air Terminal provides protection against a direct lightning strike with probability of protection as per LPL.

### **LPL (Lightning Protection Level)**

LPL is a number associated with a set of lightning current parameters relevant to the probability that the associated minimum & maximum values do not exceed the normally occurring lightning. LPL can be determined by Risk analysis as explained in IS / IEC 62305-2.

### **LPL levels and probability of protection:**

<b>Lightning protection Class</b>	<b>Lightning current peak value MINIMUM</b>	<b>Lightning current peak value MAXIMUM</b>	<b>Interception probability</b>
LPL 1:	3 kA	200 kA	98%
LPL 2:	5 kA	150 kA	95%
LPL 3:	10 kA	100 kA	88%
LPL 4:	16 kA	100 kA	81%

### **Components of External LPS**

- 1.) Air terminal (as per rolling sphere or mesh or protective angle method.)
- 2.) Down conductor
- 3.) Earthing

### **Air termination system:**

No drilling is allowed in the terrace for fixing the air terminal, if the roof is made of concrete. Parapet wall is exception to this.

### **Values of Rolling sphere radius, Mesh size and protection angle as per Class of LPL/LPS.**

<b>Class of LPL/LPS</b>	<b>Rolling sphere radius(m)</b>	<b>Mesh size (m)</b>	<b>Protection angle</b>
1	20	5*5	As per Standards
2	30	10*10	As per Standards
3	45	15*15	As per Standards
4	60	20*20	As per Standards

### Material and Dimensions

Material of air terminal, down conductor, earth termination etc. shall be as below:

<b>Material</b>	<b>May be destroyed by galvanic coupling with</b>
Copper(Solid)	GI and Aluminium
Hot galvanized steel(Solid)	Copper
Stainless steel(Solid)	
Aluminium(Solid)	Copper

Dissimilar metals (eg. Copper with Aluminium) must be connected only by using bimetal connectors.

### Minimum thickness of metal in air termination system for LPL /LPS

<b>Material</b>	<b>Thickness (a) in mm</b>	<b>Thickness (b) in mm</b>
Galvanized steel	4	0.5
Stainless steel	4	0.5
Copper	5	0.5
Aluminium	7	0.65

### Material, Configuration and Minimum cross sectional area of air terminal & down conductors

#### Air terminal holder:

Concrete Roof structure:



Conductors shall be securely fixed on the terrace by means of air terminal holder which is fixed on the roof by adhesive of good quality taking care of varying weather conditions. Air conductor holder is an insulator & should be of minimum 50 mm height so that even small amount of water logging on terrace is below the level of conductor holder.

#### **Metal Roof structure:**

Conductors shall be securely fixed on the terrace by means of air terminal holder which is fixed on the roof by metal conductor holder of good quality which is tested for lightning current as per IEC standard. Vendor need to give proof. As metal roof structures are normally tapered at an angle, there is no min. height criteria for metal conductor holder.

#### **Recommended distance between air terminal holders:**

Arrangement	Recommended distance	Recommended distance
	For SOLID TAPE	For ROUND conductors
Horizontal conductor on horizontal surface	500 mm	1000 mm
Horizontal conductor on vertical surface	500 mm	1000 mm
Vertical conductor from Ground to 20m height	1000 mm	1000 mm
Vertical conductor above 20m height	500 mm	1000 mm

If antenna, air cooler or any other electrical equipment is present above terrace level, the same have to be protected by using vertical air terminal after calculating the safety or separation distance. The vertical air terminal has to have suitable supports to hold it. Wind speed need to be taken into account. Vertical air terminal must be connected to horizontal air terminal by using suitable connectors.

The crossings of the horizontal air terminals, suitable Cross connector has to be used for secure connection which is tested for lightning current as per IEC standard. Vendor has to provide proof.

#### **Safety or Separation distance:**

It is must to calculate safety or separation distance in order to avoid flash over to the electrical equipment when the lightning current is passing through the vertical air terminal.

$$\text{Safety/Separation distance (S) in m} = (k_i * k_c * L) / km$$

Coefficient  $k_i$  depends on class of LPL/LPS

$k_i = 0.08$  for LPL1,  $k_i = 0.06$  for LPL 2,

$k_i = 0.04$  for LPL3 and 4.

Coefficient  $k_c$  depends on no of down conductors:

$k_c = 0.66$  for 2 down conductors

$k_c = 0.44$  for 3 or more down conductors

Value of coefficient  $k_m = 1$

Value of  $L$  is the total distance between the equipment to be protected (for e.g. Antenna) to the equipotential bonding bar situated just above the ground.

### Expansion piece

In order to take care the expansion of the metal in summer and contraction of the metal in winter, expansion piece with suitable connectors have to be used at every 20m distance of horizontal air terminal.

### Joints and Bonds

The lightning protective system shall have few joints as far as possible & air terminal & down conductor have to be straight. Where it is not possible, it should NOT be bent at 90 degree (right angles) & should have a curved path of 45 degree bend.

### Down conductor system

In order to reduce the probability of damage to electronic/electrical equipment, the down conductors shall be arranged in equi distance in such a way that from the point of strike to earth, several parallel current paths should exist & length of the current path should be minimum. Down conductors can be installed separately or more wisely it can be part of natural components of the building. Examples are steel reinforcement in RCC columns, metal facades, profile rails, metal doors & windows. Down conductors should be installed at each exposed corner of the structure as a minimum.

### Value of distance between down conductors as per Class of LPL / LPS

Class of LPL/LPS	Typical distance (m)
1	10
2	10
3	15
4	20

### Test Joints:

At the connection of the earth terminal, a test joint should be fitted on each down conductor at a height of 1 m from the ground, except in the case of natural down conductors combined with foundation earth electrode. The purpose of test joint is to measure the earth resistance value. The remaining portion of down conductor (i.e., after the test joint should be mounted inside a plastic pipe of minimum 3 mm thickness.)

### Earth Terminations

Earth mat is most preferable. Where earth mat is not possible, ring earthing is the next best method. Ring earthing must be 1 meter away from the building and 0.5m below the ground level. The resistance of earthing system shall not exceed 10 ohm as per IEC 62305.

Lower earth resistance is more preferable.

For earth termination system, 2 basic types of earth electrode arrangements are applicable. Type A & Type B arrangement.

#### **Type A arrangement:**

Comprises of horizontal or vertical earth electrode installed outside the structure to be protected connected to each down conductor.

In type A arrangement, the total number of earth electrodes shall not be less than two.

Type A arrangement is suitable in places where electronic equipment are not located.

#### **Type B arrangement:**

This type of arrangement comprises either a ring conductor external to the structure to be protected, in contact with the soil for at least 80% of its total length or a foundation earth electrode. Such earth electrodes can also be meshed. For structures with extensive electronic systems or with high risk of fire, type B earthing is most preferable method. Corrosion proofing band has to be used wherever down conductor is connected to earth termination system. Bitumen has to be applied at the point of inter-connection.

In potentially corrosive areas, Stainless steel must be used.

#### **References:**

IS / IEC62305 – PROTECTION AGAINST LIGHTNING:

Part 1: General Principles

Part 2: Risk Management

Part 3: Protection of structures

Part 4: Protection of Electrical & Electronic equipment within structure

IS3043: 1987: Code of practice for Earthing.

#### **TESTING & COMMISSIONING**

The Contractor shall conduct his own inspection and test reports certified by their engineer shall be submitted to the Engineer-in-charge for his approval and submit a request for joint inspection.

Joint inspection shall be carried out by the engineer-in charge or his authorized representative. Test results shall be checked and compared with the report submitted. All equipment, transportation, manpower and other necessary costs for the joint inspection shall be borne by Contractor.

The system shall be tested once in every month intervals for earth resistivity, resistance to earth of the electrodes and electrical continuity of the system. The record of readings / results of these tests shall be maintained by contractor during defect liability period by the Contractor and after that by Engineer-in charge.

The Contractor shall supply one set of portable Air terminal test meter suitable for operation on batteries for maintenance and check of system. The meter should be suitable:

To test the individual charge sensor

To test the individual triggering terminal

To identify the faulty air terminal

To give alarm in case test meter is defective.

The Contractor shall submit a detailed layout drawing showing the positions of testing carry out on site.

**SUB HEAD – 13****UN-INTERRUPTED POWER SUPPLY (UPS)****Introduction**

The UPS systems (True online double conversion VFI type as per IEC 62040-3) will be working in parallel sharing entire load. Battery backup shall be as per data sheet with each UPS Module. The batteries shall be placed in battery room separately. This specification defines the electrical and mechanical characteristics and requirements for a continuous duty, highly reliable, solid state Uninterruptible Power Supply systems. The UPS shall provide high quality AC power for sensitive electronic equipment loads. It should also supply clean power. Under no conditions will the protected system get direct supply from the raw mains unless there is fault in the protected system. All the manufactures have to ensure that their product confirm to the specification set in this documents, failure to do so will result in the disapproval of the product.

**Submission**

All technical submissions shall be approved by the contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of Engineer-in-charge for its review and approval.

**System Description: Design Requirements-UPS Module**

Input power factor & THDi: Input power factor of the UPS shall be as per data sheet enclosed herewith greater than 0.99 lag. & THDi shall be less than 3 % No harmonic filters are to be employed to achieve the parameters mentioned above.

**Mode of Operation**

The UPS shall be designed to operate ONLY as an ON LINE reverse transfer system in the following modes:

**Normal:**

The critical AC load is continuously supplied by the UPS Inverter.

The rectifier / charger derive power from AC Input source and supplies DC power to the Inverter while simultaneously charging power reserve battery.

**Emergency:**

Upon failure of AC Input power, the critical AC load is supplied by the Inverter which without any switching obtains power from the battery. There shall be no interruption in power to the critical load upon failure or restoration of the AC input source.

**Recharge:**

Upon restoration of AC input power during the emergency mode of operation, the rectifier/ charge shall automatically restart, walk – in and gradually assume the inverter and battery recharge loads.

**Bypass:**

If the UPS must be taken out of service for maintenance or repair or should the inverter overload capacity be exceeded, automatic static transfer switch shall perform reverse transfer of the load from the inverter to bypass source with no interruption in the power to the critical AC load in sync mode. The static bypass switch should be bi-directional. The static should also have an overload rating of 14 times of rated load for 10 m sec (1/2 cycles).

A manually operated Maintenance Bypass Switch should be incorporated into UPS cabinet that will connect the load

**Battery Requirements**

Battery should be designed to provide 30 minutes back up. Battery should be sealed maintenance free type. The UPS module shall have the Battery Circuit breaker mounted in the battery Rack. When this breaker is opened no battery voltage should be present in the UPS enclosure. The UPS module should be disconnected automatically when the battery reaches to the minimum discharge voltage level or when signaled by other control functions.

**Product : Materials**

All materials of the UPS shall be new, of current manufacture, high grade and free from all defects and shall not have been in prior service except as required during factory testing. All active electronic devices shall be solid-state. Control logic and fuses shall be physically isolated from power train components to ensure operator safety and protection from heat. All components shall be accessible from the front.

**Construction and Mounting**

The UPS unit comprised of Input Isolator, Rectifier/ Charger, Inverter, Static Transfer switch. Maintenance Bypass switch and static bypass Input switch shall be housed in a free standing steel enclosure with key lockable doors. Front access only shall be required for expedient servicing, adjustments and installation. The enclosure will be built to comply with IP20 when the doors are open. The UPS shall be constructed of replaceable sub- assemblies. Printed circuit assemblies shall be plug-in type.

**Cooling**

Cooling of the UPS shall be by forced air. Low velocity fan shall be used to minimize audible noise. Fan power shall be provided by the UPS output. Temperature shall be monitored by thermal sensors.

**Cable Entry**

Standard cable entry for the UPS module and battery module shall be from BOTTOM/TOP.

**Service Area Requirements**

All serviceable sub -assemblies shall be modular and capable of being replaced from front of the UPS (Front access only). The UPS modules shall require no more than 1.5 meter of front service access room and shall not require rear or side access for service.

## Components

### Rectifier / Charger

**General:** The term rectifier / charger shall denote the solid – state equipment and controls necessary to convert incoming AC power to regulated DC power for input to the controlled, IGBT Bridge with constant voltage / current limiting control circuitry. The input harmonic currents are to be limited to less than 3 % by using DSP based technology.

**Input current Walk – in:** The rectifier / charge shall contain time walk – in circuit that causes the unit to gradually assume the load over a 10 sec time interval after input voltage is applied.

**Fuse Failure protection:** Power semi – conductors in rectifier / charge shall be fused with fast acting fuses so that loss of any power semi – conductor shall not cause cascading failures.

**DC Filter:** The rectifier / charger shall have an output filter to minimize ripple voltage into the battery. Under no conditions shall ripple voltage into the battery exceed 1% RMS. The filter shall be adequate to ensure that the DC output at the rectifier charge will meet the Input requirements of the Inverter. The inverter shall be able to operate from the rectifier charger with the Battery disconnected.

**Battery Recharge:** In addition to supply power for the inverter load, the rectifier/ charger shall be capable of producing battery charging current to recharge the batteries. After the battery is recharged, the rectifier / charge shall maintain the battery at full charge until the next emergency operation.

**Charging** shall be an automatic cycle per DIN 41772 characteristics I-U. Both float and recharge voltage shall be adjustable. Charge voltage can also be manually controlled.

### Inverter

The term inverter shall denote the solid state equipment and controls to convert DC power from the rectifier / charge or battery regulated AC power for supporting the critical load. The inverter shall be IGBT based / Sine Weighted pulse width modulated (PWM) design capable of providing the specified AC output.

**Overload capacity:** Inverter shall be capable of supplying current and voltage for overload exceeding 100% and up-to 150% of full load current for min. of 1 minute. A status indicator and audible alarm shall indicate overload operation. The UPS shall transfer the load to bypass when overload capacity is exceeded.

**Fault clearing and current Limit:** Without bypass supply available, the inverter shall be capable of supplying and overload current of 150% of its full load rating in excess of 60 secs. For greater currents, or longer time duration, the inverter shall have electronic current limiting protection to prevent damage to components. The inverter shall limit the output current to 275% of the nominal current & deliver for minimum 150ms to clear the fault. The inverter shall be self-protecting against any magnitude of connected output overload.

**Output Frequency:** The output frequency of the inverter shall be controlled by an oscillator. The oscillator shall hold the inverter output frequency to +/- 0.1% for state and transient conditions.

The output harmonic shall not be greater than 1% without load and maximum 5% at 100% non linear load.

The UPS shall be capable of handling load of crest factor better than 3:1.

Inverter efficiency shall be greater than 95% at 100% load.

### **Display and Controls**

Monitoring and Control: The UPS shall be provided with a micro – processor based unit status display and controls section designed for convenient and reliable user operation. A system power flow diagram, a percentage load and battery time remaining display shall be provided as part of the monitoring and controls sections, which depicts a single line diagram of the UPS. Illuminated visual indicators shall be of the long – life light – emitting diode (LED) type. All of the operator controls and monitors shall be located on the front of the UPS cabinet. The monitoring functions such as metering, and alarms shall be displayed on an alphanumeric LCD panel. LCD panel shall be provided with following monitoring functions and indicators (each alarm and notice condition shall be accompanied with an audible alarm).

NORMAL: This symbol shall be lit when the UPS is operating in Normal Mode.

BATTERY – This symbol shall be lit when the UPS is operating in battery mode.

BYPASS – This symbol shall lit when the UPS is operating in bypass mode. Warning – this symbol shall lift when the system needs attention. Some notice shall be displayed and shall include.

UPS on Maintenance Bypass

Inverter Unsynchronized

Battery on load

Load on Bypass

Mains Failure

ALARM-This symbol shall lit when a situation requires immediate attention. All alarm shall be accompanied by the Audio alarm. Alarm shall include

Emergency Stop

Inverter Off or Failed

Over temperature

Overload

Rectifier off or failed



Power Status Diagram: A mimic panel shall be provided to depict a single line diagram of the UPS. Indicating lights shall be integrated within the single line diagram to illustrate the status of the UPS. These six LEDs shall indicate the following status.

Input Voltage OK

Bypass Voltage OK

Load on Bypass

Load on Inverter

Battery Voltage OK

Inverter Output OK

Battery Management Systems: The UPS shall contain a battery management system with the following feature.

The battery management system shall provide battery time available, or percentage remaining with operating in battery mode.

The battery management system shall provide the imminent shutdown to signal a low battery condition.

Remote Monitoring: Web enabled remote monitoring is required to monitor all the UPS system.

### **Static Transfer Switch**

General: A static transfer switch and bypass transfer switch shall be provided as an integral part of the UPS. The static switch shall be a Bi-directional naturally commutated high-speed static (SCR type) device rated to carry fully load current continuously. The static transfer switch control logic shall contain an automatic transfer logic circuit that senses the status of the inverter logic signals, and operating and alarm signals. This control circuit shall provide an uninterrupted transfer of the load to an alternate bypass source, without exceeding the transient limits, when an overload or malfunction occurs within the UPS, or bypassing the UPS for maintenance.

Uninterrupted Transfer: The transfer control logic shall automatically turn on the static transfer switch, transferring the critical AC load to the bypass source, after the transfer logic sense any of the following conditions.

Inverter Overload capacity exceeded

Critical AC load over – voltage OR under – voltage

UPS fault conditions

The transfer control logic shall inhibit an automatic transfer of the critical load to the bypass source if any of the following conditions are present.

Bypass frequency out of limits

Bypass out of synchronization range with invert output.

Uninterrupted Retransfer: Retransfer of the critical AC load from the bypass source to Inverter output shall be automatically initiated unless inhibited by manual control. The transfer control logic shall inhibit an automatic retransfer of the critical load to the inverter if one of the following conditions exists.

Bypass out of synchronization range with Inverter output.

Inverter / Bypass voltage difference exceeds the preset limits

UPS faulty conditions presents.

Overload conditions exists in the excess of inverter full load ratings.

### **Maintenance Bypass Isolator**

A manually operated maintenance bypass isolator shall be incorporated into the UPS cabinet to directly connect the critical load to the inverter if one of the following conditions exists.

Bypass out of synchronization range with Inverter output.

Inverter / Bypass voltage difference exceeds the preset limits.

UPS faulty conditions presents.

Overload conditions exists in the excess of inverter full load ratings.

### **Remote Emergency Power Off (REPO)**

Provision shall be available for adding a REPO switch to meet specific site needs. The REPO switch shall be electronically shut down the UPS by turning off the rectifier, inverter static switch.

### **Communications**

#### **RS-485 Interface Card & SNMP CARD**

The UPS shall have internally fitted RS-485 interface card & SNMP Card that will provide real-time status information over a 2 or 4-wire RS-485 connection. The RS-485 interface Card will support Mod Bus RTU and J Bus.

#### **SMS Master (Site Monitoring Software)**

Functions of Site Monitor include:

Easy to install: Site Monitor is designed to operate under Windows, Linux, Solaris, AIX, HP-UX

Operating systems.

Automatic equipment search and configuration, saving the trouble of manual configuration.

Current data query: Current equipment operating data and alarm data can be queried.

Alarm notification: Site Monitor can send email, short message to or phone the user in the event of an alarm.

Remote control: The equipment can be controlled from a remote site through Site Monitor.

Remote adjustment: The equipment parameters can be set from a remote site through Site Monitor.

Convenient report query: Site Monitor provides equipment alarm report, equipment data report and operation log report, and supports report display by page and data export functions.

Powerful user management function: Users can be added, modified, deleted, and given different levels of software operation authorities according to their duties.

Powerful online data backup and recovery: Providing quick system data backup and recovery without affecting other users.

## **Execution**

### **Field Quality Control**

Factory trained field service personnel shall perform the following inspections and test procedures during startup.

#### **Visual inspection**

Inspect equipment for sign of damage

Verify installation as per drawing

Inspect cabinet for foreign object

Verify neutral and ground conductors are properly sized and configured.

Inspect battery cases

Inspect battery for proper polarity

Verify all printed boards are configured properly

#### **Mechanical Inspection**

Check all control wiring connections for tightness

Check all power wiring connections for tightness

Check all terminal screws, nuts, and/or spade lugs for tightness.

#### **Electrical Inspection**

Check all fuses for continuity

Confirm input voltage and phase rotation is correct

Verify control transformer connections are correct for the voltage being used

Assure connections and voltage of the battery strings

### **Documentation**

The manufacturer shall supply minimum 2 sets of an installation manual with installation. Start up trouble shooting guide and operation instruction of the specified system. The manufacturer shall train at least two engineers at their factory free of cost.

### **Installation**

A service engineer fully trained on the UPS by the manufacturer shall install the UPS. The manufacturer will have to conduct load/site study prior to the commissioning of the UPS. A copy of the load/site study report will have to be submitted with required comments.

### **Service capability**

The manufacturer should have the independent service setup with engineers who are fully trained in the UPS. All the service personnel's should have the latest power measurement equipments, which will be required during the process of site study, installation and maintenance. The manufacturer should have ISO 9001 certification to ensure the quality of the service.

All the manufacturers' service engineers should have mobile communication, for instantaneous communication as and when the need arises.

The manufacturer should have the capability to provide consultancy on the aspect of power quality as and when required for which they should have their own power solution. (Product and technology)

The response time to attend the complaint shall be less than one hours in normal working hours. The manufacturer should have the facility to provide night service as and when required.

### **The Criteria to be fulfilled by the Supplier for Quoting against this Enquiry**

<b>S.No.</b>	<b>Criteria</b>	<b>Required</b>
A.	Service Support	<p>Round the clock back-up service support should be available in surroundings (i.e. 24 hrs throughout the year, just a phone call away).</p> <p>(Supplier must submit the document supporting the above requirement.)</p>

B.	Manufacturing Base	The supplier shall have a manufacturer base in India for manufacturing equivalent or higher rating of UPS system.
C.	Performance Track Record	The supplier must have a proven track record of at least 3 years in the country & shall show the reference of the customer base.
D.	Total Quality Management Assurance (Desirable)	The supplier must have TQM recognition in IT equipment manufacturing field from any IT association of India.
E.	Factory Inspection	Will be carried out by Engineer-in-charge/Consultant at the manufacture works.

**SUB HEAD – 14****INVERTER****General**

This specification describes a modular, continuously rated, solid state Inverter .The Inverter utilises VFD topology, with pure sine wave output when the output power supplied is derived directly from the battery through Inverter. The Inverter will be used to operate in conjunction with the existing building supplies and shall provide high quality power for Emergency lighting loads.

**Standards :**

The product shall have CE marking in compliance with the following directives:

Low Voltage Directive 2006/95/EC

EMC Directive 2004/108/EC

The manufacturer shall demonstrate conformity with the Inverter standards and directives EN 62040-1-1 for Safety and EN 62040- 2 for EMC.

The Inverter shall be designed in accordance with the applicable sections of the current revision of the following standards. Where a conflict arises between these documents and statements made herein, the statements in this specification shall govern.

Safety Standard:	EN 62040 -1-1:2003
	EN 60950 -1:2001/A11:2004
	EN 62040-2:2005
	EN 61000 -3-2:2000
Electromagnetic Compatibility Standard (EMC):	EN61000-3-3:1995?A1:2001
Performance Standard :	EN61000-6-2:2001
	EN61000-6-4:2001
	EN 62040 -3:2001

**Submission**

All technical submissions shall be approved by the contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of Engineer-in-charge for its review and approval.

## System Description

The Inverter system shall consist of a single Inverter module. The Inverter shall be located within a fully enclosed, free standing, system cabinet which shall contain communication cables, individual module isolators, input / output power terminals and an integral maintenance bypass switch with options of auto & manual mode of operation.

## Modes of Operation

The Inverter module shall be designed to operate as a true on-line, Voltage and Frequency Dependent (VFD -SS- 112) system. The following modes of operation shall apply :-

Normal - The emergency a.c. load is continuously supplied directly by the Mains / DG. The rectifier / Battery Charger derives power from the utility or generator a.c. source and supplies d.c. power to the batteries. Battery charger shall maintain a ripple free float-charge voltage to the battery.

Battery - Upon failure of the input a.c. power supply the emergency a.c. load is supplied by the inverter, which obtains power from the battery. There shall be no interruption in power to the emergency load upon failure or restoration of the utility or generator a.c. source.

Recharge - Upon restoration of utility or generator a.c. power after a power outage, the battery charger shall recommence recharging the battery. The inverter shall provide a soft start on the return of the utility or generator a.c. power.

Automatic Restart - Upon restoration of utility or generator a.c. power, after an a.c. power outage and after a complete battery discharge, the Inverter should automatically restart and resume supplying power to the connected load together with supplying power to the battery charging.

Static Bypass - The static bypass shall provide an alternate path for power to the connected a.c. load and shall be capable of operating in the following manner:

Automatic - In the event of a Inverter failure or the inverter overload capacity be exceeded the Inverter unit shall perform an automatic transfer of the connected a.c. load from the inverter to the mains / DG source with an alarm and overload indication .

Manual Operation - If the inverter module need to be taken out of service for limited maintenance or repair, manual activation of the bypass shall cause an immediate transfer of the connected a.c. load from the inverter to the mains / DG source.

## Performance Requirements

### AC Input to Inverter:

Voltage configuration 380/220, 400/230 or 415/240 or Vac nominal, three- phase, 4- wire - plus-ground.

Input frequency 45 to 55 Hz, without switching to battery supply

Input current distortion sine wave <3% THDi maximum

**AC Output**

Output Rating	Continuously rated at 0.8 p.f.
Voltage configuration	400/230, 415/240 or 380/220 Vac, three-phase, 4-wire- plus ground.
Voltage tolerance	static $\pm 1\%$
Voltage regulation	dynamic $\pm 4\%$ (zero to 100% to zero load steps)
Voltage Distortion	<3% total harmonic distortion (THD) maximum - 100% linear load
	<7% total harmonic distortion (THD) maximum - 100% non-linear load (EN 62040- 3:2001)
Load power factor range	0.6 lagging to 0.9 leading, without de -rating
Load peak (crest) factor	4:1 minimum
<b>Load unbalance</b>	<b>100%(all 3 inverter phases shall be regulated independently)</b>
Overload capability (inverter)	125% Load - 8 min
	150% Load - 60 sec

If the overload limits or times are exceeded the Inverter will transfer the load to Mains / DG supply (if available). Simultaneously it should give alarm and indication for the same.

Phase Angle Tolerance  $\pm 0$  deg.

Short circuit capability

(rms) Inverter 2 x In for 250ms Mains 10 x In for 10ms

Transient recovery time to steady state output voltage within 100 milliseconds

**Inverter Efficiency**



The overall efficiency shall not be less than 93% at all loads at power factor 0.8.

### Batteries

- A. The battery system shall be sized to support a connected load at 0.8 p.f. for a minimum period of 4 hrs at an ambient temperature of 30 °C.  
The battery system shall consist of gas recombination, valve regulated, lead acid cells (VRLA), compliant to BS6290 Part 4 and BS EN6089- 2.  
The Inverter battery charging circuit shall comprise of a battery charging rectifier. The battery charging voltage shall have zero a.c. (ripple) content.
- B For single Inverter the battery system shall consist of a minimum of 2 parallel strings of multiple cells. Each individual parallel string shall have its own dedicated means of electrical protection.
- C The batteries shall be housed in cabinet/s comprising a floor -standing suitably protected steel enclosure with dimensions and paint finish to match the Inverter cabinet to form a continuous suite when standing immediately adjacent to the inverter. The battery cabinet shall have full width opening doors to permit ease of access for the purposes of maintenance and/or repair of the batteries.
- D Alternatively, the batteries shall be housed on open or cladded racks of a steel construction, having an epoxy powder-coated finish, with adjustable feet for leveling and adequately designed to support the weight of the batteries and permit ease of access for the purposes of maintenance and/or repair of the batteries. If the battery system is located on open stands then all individual battery cell terminals shall be fully shrouded to prevent inadvertent contact.

A fully discharged battery system shall be capable of being recharged to 80% of the Inverter output capacity within a maximum period of 10 times the normal total discharge time period, and to 90% of the Inverter output capacity within a maximum period of 4 hours.

The Inverter d.c. bus voltage shall be variable whereby the number of battery blocks can be adjusted between 40 to 50 (12 Vdc blocks) or 80 to 100 ( 6 Vdc blocks) to enable the battery system to be optimised for size and cost.

### Environmental Conditions

The Inverter system shall be designed to operate continuously at full load without degradation of its reliability, operating characteristics or service life in the following environmental conditions:

Ambient temperature range	0°C to 40°C,
Battery ambient temperature range	20°C to 30°C
Humidity	5 to 95% RH non-condensing

The Inverter system shall be designed for operation in altitudes up to 1000 meters, without the need for derating or reduction of the above environmental operating temperatures.

The audible noise generated by each Inverter during normal operation shall not exceed 55 dBA measured at 1 metre from the surface of the Inverter.

The Inverter system shall be able to withstand a minimum 15kV electrostatic discharge without affecting the emergency load.

To permit access through a standard single doorway opening, either the width or the depth of the Inverter system and battery cabinets shall not exceed 750mm.

The Inverter cabinet shall comprise of a floor standing steel enclosure to house the Inverter, individual module isolators, input/output power terminals and an integral maintenance bypass switch, necessary for the correct operation of the UPS in accordance with the requirement of the specifications. All switchgear and interconnections must be adequately protected to enable an isolated Inverter module to be safely maintained or repaired whilst the remaining system supports the load.

It shall be possible to Inverter module to enable the safe removal, or insertion without risk or disruption to the emergency load.

### **User Documentation**

The specified Inverter system shall be supplied with one (1) user's manual. Manuals shall include:

General arrangement of the Inverter showing dimensions and weight

User operating instructions

Single line schematic diagram with functional description of the equipment

Installation drawing along with recommended cable and protective device sizes

Safety and maintenance guidelines

Type test certificates as per IEC 62040 – 3

Routine test certificates.

### **After Sales Service**

#### **Warranty**

The Inverter manufacturer shall warrant the inverter system, including the batteries, against defects in materials and workmanship for 24 months (for Batteries) from the date of commissioning or 30 months from the date of delivery whichever is later, and 60 months (for Inverter) from the date of commissioning . The warranty shall be provide for free replacement of parts and on-site labour.

Guaranteed Up-time should be Min. 99.99% for the Inverter system.

#### **Extended Warranty**

The Inverter manufacturer shall provide the facility for enhancing or extending the warranty by providing an annual maintenance contract for 5 years after completion of the guarantee period. The maintenance contract shall provide:

Guaranteed response time four preventative maintenance visits per year

24 hour telephone support directly from the Inverter manufacturer free labour, travelling to site and incurred expenses free replacement parts (excluding batteries outside the warranty period)

## **QUALITY ASSURANCE**

### **Inverter Manufacturer Qualifications**

The Inverter manufacturer shall have a minimum 10 years' experience in the design, of manufacture, and testing of static Inverter systems.

### **Factory Testing**

Before shipment, the manufacturer shall fully and comprehensively test the system to assure compliance with the specification. These tests shall include full functional tests at the Inverter rated load and a minimum 24 hour continuous burn in test varying between no load and the Inverter rated load.

Engineer-in-charge reserves the right to get conducted certain type tests on one Inverter of each rating. All routine and acceptance tests shall be conducted on all Inverters at works before dispatch. The Inverters shall not be dispatched unless the dispatch clearance is given by Engineer-in-charge. Engineer-in-charge or his representative shall witness all the tests.

At least four (4) weeks advance notice shall be given for witnessing the tests.

## **PRODUCT :**

### **Fabrication**

### **Construction**

All materials and components making up the Inverter shall be new, of current manufacture, and shall not have been in prior service except as required during factory testing. The Inverter shall be constructed of replaceable sub-assemblies.

### **Wiring**

Wiring practices, materials, and coding shall be in accordance with the requirements of applicable Indian / International codes and standards.

### **Inverter Cabinet**

The Inverter system cabinet shall offer a minimum degree of protection to IP20 grade.

The Inverter cabinet shall be cleaned, primed and painted in RAL 9007. Either the width or the depth of the Inverter system cabinet should not exceed 750mm, to permit access through a standard doorway.

**Battery Cabinet**

The battery cabinet shall offer a minimum degree of protection to the IP20 .

The battery cabinet shall be cleaned, primed and painted to RAL 9007 and should match the Inverter cabinet in appearance and height. Either the width or the depth of the battery cabinet should not exceed 800mm to permit access through a standard doorway.

**Battery Racks**

The battery racks shall be of a steel construction, having an epoxy powder-coated finish, with adjustable feet for leveling. Open racks shall not exceed 2 meters in height to the top tier and should not be more than 2 rows deep if it is not possible to gain rear access, e.g. the rack is placed against a wall.

**Cooling**

The Inverter module shall be forced-air cooled by an internally mounted fan.

**Components****Input Converter**

Incoming a.c. power shall be converted to a regulated d.c. output by the input converter for supplying d.c. power to the batteries. 6 pulse rectifier and / or filter devices will not be accepted if they have a detrimental effect on the overall Inverter efficiency.

**AC Input Current Limit :**

The input converter shall be provided with a.c. input over current protection.

**Input Protection :**

The Inverter shall have built-in protection against under voltage, over current, and overvoltage conditions, including low-energy surges introduced on the primary a.c. source. The Inverter cabinet shall not contain an input circuit breaker. The Contractor shall supply an input circuit breaker/fuse sized to supply the rated load and to recharge the battery at the same time.

**Battery Recharge:**

To prolong battery life, the Inverter shall have the facility for automatically adjusting the battery charging voltage according to the environmental temperature of the batteries.

The battery charger shall be ripple-free avoiding premature battery ageing.

**Inverter****General:**

The inverter shall convert d.c. power from the battery, into precise regulated sinusoidal wave a.c. power for supporting the emergency a.c. load.

**Overload:**

The inverter shall be capable of supplying current and voltage for overloads exceeding 100% and up to 150% of full load current. A visual indicator and audible alarm shall indicate overload operation. The load shall be immediately transferred to bypass when the load current exceeds this level of overload.

The inverter shall have electronic current-limiting protection to prevent damage to internal components. The inverter shall be self-protecting against any magnitude of connected output overload and the inverter control logic shall sense and disconnect the inverter from the emergency a.c. load within 200 mS.

**Output Frequency:**

The output frequency of the inverter shall be controlled by an oscillator. The oscillator shall hold the inverter output frequency to  $\pm 0.1\%$  for steady state and transient conditions.

**Battery over Deep Discharge Protection:**

To prevent battery damage from deep discharging, the Inverter control logic shall monitor the discharge voltage and shut the Inverter down at a pre-set minimum dc voltage. This level is dependent on the rate of discharge and battery autonomy and shall be adjusted at the time of commissioning the Inverter. Under any circumstances it should not be set to less than 1.67V per cell.

**Automatic Battery Test**

The INVERTER shall initiate an automatic battery testing sequence periodically (default setting once a month), at a programmed day and time of day, selectable by the end user. It shall be possible for the user to disable the automatic battery test.

**Display and Controls****General:**

Each INVERTER module shall have its own discrete status/alarm panel located on the front door of the system cabinet. The status/alarm panel shall consist of multiple status LEDs, switches, and an alphanumeric LCD display for additional alarm/configuration information. During normal operation (on-line), all mimic display LEDs shall be green in colour and indicate the following: Line 1 (a.c. Input )

Battery (Load supplied from the battery)

On Inverter (Load supplied from the inverter)

On Bypass (Load supplied from the Mains)

An INVERTER fault shall be identified via additional indicators and audible alarms to notify the user that a

INVERTER fault condition has occurred. During mains failure the colour of the LED's shall be as follows:

Line 1	(a.c. Input rectifier)	red
Battery	(Load supplied from the battery)	green
On Bypass	(Load supplied from the Mains)	amber

In addition to a visual fault signal (alarm), the INVERTER shall also record fault occurrences in a rolling event log. The user shall have access to the event log through the LCD display. Every alarm and/or event recorded in the event log will contain a time and date stamp.

#### **Audible Alarms:**

The volume of all audible alarms shall be at least 65 dBA at a distance of one meter. An audible alarm shall be used in conjunction with the LED/LCD display to indicate a change in INVERTER status.

The audible alarms shall warn loss of mains or generator supply, low battery (whilst on battery), and all other alarm conditions. For all audible alarm conditions, the display shall identify the cause of error/alarm. All alarm tones shall be a continual tone until the condition rectifies itself or the alarm is silenced. Once silenced, the audible alarm shall not sound until a new alarm condition is present, but the LED indication shall continue to identify the alarm condition.

#### **Alarm Silence Button:**

The display panel shall include an audible alarm 'Reset' switch. If the alarm mute (Reset) switch is pressed for one second, all current audible alarms shall be disabled. If a new alarm occurs, or a cancelled alarm condition disappears and then re-appears, the audible alarm is re-enabled.

#### **LCD Display:**

The LCD display shall be used to provide the following information to the user and INVERTER service engineer:

The LCD display shall be used to provide the following information to the user and INVERTER service engineer:

Phase Voltages	Input to converter
	INVERTER output
Battery	DC Voltage (voltage to/from battery)
Current	INVERTER output (line current)
	Battery charging / discharging
Frequency	INVERTER Input
	INVERTER output

Autonomy	Remaining back -up time (minutes)
	Battery capacity (%)
Others	INVERTER output active power (kW)
	INVERTER output reactive power (Kvar)
	INVERTER output apparent power (kVA)
	INVERTER load (% per phase

### SUB HEAD – 15

#### LT BUS DUCT & RISING MAINS: 415 VOLTS, 3-PHASE, 4-WIRE

##### LT BUS DUCT –Sandwich type

##### Scope:

The specification covers design, manufacturing, supply, installation, testing and commissioning of Sandwich type busbar trunking for use as feeder busbars for interconnection between separate electrical equipment / load centers, and for use as plug in busbar risers.

##### System details:

The busbar shall be suitable for operation in a 1000V system with insulation voltage of 1000V and frequency of 50 Hz having 100% neutral and 50% integral earth. The bus duct shall conform to seismic protection certification (Zone-4 as specified in NBC/CBC). Product and its manufacturing process should be in compliance with ASTA and CPRI certification. Degree of ingress protection (IP rating) shall also be tested at any reputed independent laboratory. This test shall be for IP54 for indoor application and IP65 for outdoor application for sandwiched busbars.

##### Manufacturer:

The manufacturer must have ISO 9001 certification for design, manufacture and testing of busbar systems. It should be noted that cast resin should not be considered for primary insulation as it is prohibited as per IEC 60364 chapter 5.523.6.

### Design & Construction requirements – Sandwich busbars

General: The busbars shall be of sandwich construction, non-ventilated design. It shall be possible to mount the busbar system in any orientation, without affecting the current rating.

The bus duct shall consist of three phases and neutral bus bar permanently positioned dust and vermin proof and the degree of enclosure protection shall be IP54 for indoor installation and shall be IP-65 for outdoor installation as per schedule of quantities.

Busbars: The busbars shall of high conductivity Aluminum, as specified in the tender and should conform electrolyte grade of 91E. Where an earth conductor is required, it shall be a integral earth conductor, of the same high conductivity material and should be 50% as of phase conductors,

Insulation: The busbars shall be insulated throughout their length by Mylar. The insulation material used shall be of Class F. The insulation must comply to UL 94 V-O. It shall be Halogen Free.

Housing: The housing shall be made of extruded Aluminum (1.5 mm thick) case duly enameled/ electro-galvanized sheet steel, with an epoxy powder coated paint finish. The housing shall be profiled, to provide higher strength and efficient heat dissipation. The temperature rise at any point of the busbar shall not exceed 55 degree C rise above ambient temperature (40 degreeC ) when operation at rated current. The width of the housing shall preferably be the same for all ratings of busbars, in order to provide interchangeability of tap off boxes. The housing of busduct should conform to IEC62262.

Installation: Bus ducts running along the wall shall be supported at intervals not exceeding 1.5 m. In case of branching, there shall be support on all branches at a distance of 300 mm from the point of branching. Support shall not be less than 40 x 40 x 6 mm MS angle secured in an approved manner. Supports may also be provided in the form of brackets fixed to walls where the duct runs along the wall. In case of ceiling suspended bus ducts, supports made out of 40x40x6 mm MS angle iron shall be provided. The horizontal distance between two such supports shall not be more than 1200 mm. The ducts supports shall be suspended from suitable approved suspension devices provided in the ceiling. Fire barrier shall be provided at each floor/wall crossing as per relevant IS code.

1000-hour salt test. Type Test should be as per IEC 60439-6.

### TESTS

Following tests shall be carried out at site and test results recorded.

- i. Insulation resistance test with 500 volts megger. The insulation resistance shall be not less than 100 mega-ohms. The testing shall be done as per IS 8084 - 1976 with upto date amendments.
- ii. Earth continuity test.
- iii. Heat run test.

### **RISING MAINS : 415 VOLTS, 3-PHASE, 4-WIRE**

#### **GENERAL**

#### Description



This section specifies the supply, installation, testing, commissioning and setting to work of a totally enclosed housing of non-ventilated and low impedance insulated rising mains system.

Rising mains shall be of totally enclosed with independent earth bar, low impedance having minimum rating as indicated in the Drawings and Specification with all necessary fittings, tap-off units, supporting devices and accessories as per manufacturer recommendation to complete the installation as a whole.

Ratings and the indicative routings of rising mains shall be as indicated on the drawings. It is contractor's sole responsibility to forward coordinated drawings, after carrying out site survey, checking of the location and making necessary corrections / modifications, for Engineer's approval.

### **Standards**

The rising mains shall be low impedance solid rectangular bus bars/ Trunking made of totally enclosed extruded aluminium housing with electro-tin plated hard drawn high-conductivity Copper/ Aluminium to BS 1433 to BS 1432/ IS 5082.

Material and installation shall comply with BS7671, SEB regulations and any other recommended practices, Standards of ANSI, IEEE, NEMA and UL.

BS: 381C/BS4800 - Specification for colours for identifications, coding & special Purpose

BS: 1432 - Specification for Copper/ Aluminium for electrical purposes, High conductivity Copper/ Aluminium rectangular conductors with drawn or rolled edges.

BS: 2757 -Methods for determining the thermal classification of electrical insulation.

IEC: 60529/EN60529 -Specification for degrees of Protection Provided by enclosure (IP code)

IEC: 60439/EN60439 Part: 1 Section for low voltage switchgear & control gear assembled. Specification for type tested & partially type tested assemblies.

IEC: 60947/EN 60947- 1-2, 3-4 Specification for low voltage switchgear & control gear etc. Technical & installation Requirements.

The rising mains and associated equipment shall be certified for the category of duty specified hereafter in particular with regards to fault conditions and temperature rise limits.

The manufacture of various components and accessories including the plug-in units shall be done as per rising mains manufacturer recommendations to ensure compatibility of the components.

The rising mains shall be of SEB approved type. The Contractor shall forward a copy of the Projects reference list for Engineer's review.

### **Submission**

All technical submissions shall be approved by the contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.

As a minimum requirement, the submission shall include the following:

Equipment submission with manufacturer's data such as resistance per metre, reactance per metre, mV/A/m, contact resistance per joint, etc.;

Test certificate for short circuit capacity and IP rating;

Shop drawings for construction details of rising mains arrangements, spring hangers, wall flanges, floor flanges, plug-in boxes, etc.;

Rising mains routing drawings showing the co-ordinated routing of the rising mains, setting out lines of the rising mains relative to building grids, locations of rising mains joints, suspension and fixing units, etc.;

Weight of equipment

Builder's works requirement.

## **PRODUCTS**

### **General**

Rising mains shall be factory fabricated epoxy insulated totally enclosed dust, vermin and insect proof non-ventilated type suitable for three phase four wire system with full sized Bus bar for phases and neutral.

Rising mains complete with plug-in units shall be type-tested to National Electrical Manufacturer's Association (NEMA) Standard and shall be able to withstand a short circuit condition equivalent to 50 kA 1 sec or not less than the type-tested short circuit capacity of the corresponding switchboards.

Rising mains shall be insulated to Class B i.e. 85°C temperature rise above ambient temperature of 45°C but maximum operation temperature should not exceed 95°C.

Eddy current heating shall be taken into account while designing the enclosure.

A complete rising mains assembly shall comprise the following:

Cable and box

Hangers

Plug-in / Feeder Bus bar

Plug-in / Tap-off box

Elbow

Off set

Transposing unit

End cap

Fire barrier

Expansion joints

Integral earth

Fire resistance rising mains shall be insulated with double layers of mica and silicone rubber on the bus bars. All jointing parts shall be protected with fire protective enclosure. Test certificate for fire resistant rising mains shall be submitted to the Engineer for approval. Fire resistance rising mains shall be provided for all circuit incoming and outgoing from the Emergency Main Switch Board.

All rising mains and the associated fittings shall be minimum IP44 rating within Electrical room and Electrical riser. At car park, outdoor or plant room areas shall be weatherproof type to IP 65 in accordance to IEC 529. Weatherproof rising mains shall incorporate gaskets; drain holes, etc. suitable for outdoor use. All the plug-in, joint and accessories shall be special box-up to manufacturer detail to the same IP rating as the bus way.

Minimum 2 nos. of hanger/support shall be provided for every 2m run of rising mains. Extra number of hangers will be required for joints. The rising mains shall be so supported that no visible stress shall be apparent from either unbalanced plug-in units. Vertical floor support shall be complete with spring hanger.

All joints shall be the one-bolt removable/isolating type with through-bolts that can be checked for tightness without de-energizing the system. It shall be possible to make up a joint from one side in the event the rising mains is installed against the wall or ceiling. The joint shall be so manufactured so as to allow removal of any length without disturbing adjacent lengths. Belleville spring shall be provided to give positive pressure over complete contact area. Plug-in feeder shall use identical parts.

The rising mains system shall be capable of being mounted in any position without de-rating. Plug in and feeder sections shall be interchangeable without the use of special adapter joint covers.

The complete rising mains system shall be capable of withstanding the short circuit capacity of the electrical installation without damaging by the electrical, mechanical and thermal stress under fault condition of a service voltage of 440V 50Hz.

Rising mains shall have rated insulation voltage and rated operating voltage of 650V respectively.

### **Rising Mains**

As per BS-1432 for the rising mains copper / Aluminium conductor (99.999 Purity) adequately rated shall be supported by non-tracking moulded insulator spaced at suitable intervals. The complete assembly shall be capable to withstand the maximum mechanical stresses under fault conditions.

The bus bar connections shall be constructed in accordance with the requirement of IEC- 60439-1 or EN-60439-1 forgoing Part of switchboards & on current carrying capacity & limits of temperature rise.

The current density of bus bars shall be considered as 0.8 Amps/ Sq.mm for Aluminium conductor and 1.0 Amps/ sq.mm for Copper Conductor.

The clearances between phase and neutral shall be as per BS 162. Bus bars shall be separated & supported with appropriate clearances in air in addition to the requirements of providing full insulation. The material for phase identification shall be non-colour fading and adhesive label shall not be used.

The rising mains shall be provided with three phase or three phases and neutral.

Non-deteriorating neoprene type gaskets shall be provided. The gaskets used for outdoor portion of the rising mains shall be non-deteriorating due to hostile climate conditions and direct exposure to sunlight.

Bus bar supports shall be made of high quality insulating material such as FRP / DMC, SMC / Fibre glass araldite etc. The insulating material shall be treated against fungus. Surface of insulators shall be highly glazed and treated to minimize accumulation of dust.

Flanged ends shall be provided to facilitate connection of rising mains both at the transformer and switch gear end & switch gear to switchgear end. All hardware such as bolts, nuts, spring and plain washers shall be supplied along with rising mains to connect it at both ends.

Reinforcement / stiffeners shall be provided for the covers from inside on which supporting lugs are provided.

Flexible connectors shall be provided at the end terminations, both at transformer end and switch gear end and at intermediate places depending upon length and configuration of the rising mains. The connectors shall preferably be laminated to cater for linear expansion of bus bars. The material of flexible shall be same as bus bars. If different materials are used care shall be taken to prevent bimetallic corrosion.

Earth bus of size made of Copper/ Aluminium as mentioned in B.O.Q shall be fitted outside the rising mains throughout the length of the rising mains Two Nos. of terminals shall be brought out at ends of the earth bus to facilitate connection of earthing lead externally.

A cross over chamber with sufficient number of links and supports shall be provided in accordance with system required. The cross over chamber shall effect change of phase sequences to match with respective phase sequences in the end equipment. The links, insulators and fasteners shall be located such that across the replacement/ tightening is available for all parts.

Suitable fabricated adapter box with flexible links shall be provided wherever specified to interface with the termination arrangement on the end equipment connection. Bidder shall design the adapter box to suit exact requirements of the end equipment with adequate clearance and accessibility for end connections. All necessary links, supports, fasteners and washers shall be included in the scope of supply.

The rising mains shall be provided with wall straps for fixing the duct along wall at 1 meter interval regularly.

Fire barrier shall be provided at every floor and should be able to with stand fire hazard for 2 hours.

The length of the rising mains shall be as per floor to floor height. For this purpose measurement shall be taken from site.

The rising mains enclosure shall be fabricated for CRCA sheet steel of minimum size of 2.0 mm.

Bus bars and insulating supports shall withstand successfully thermal and dynamic stresses resulting from the circuit currents mentioned in the Data Sheets for the duration, so specified. Rising mains shall be able to withstand short circuit level of 50 KA for 1 sec.

The rising mains assembly enclosure shall be dust and vermin proof with IP-44 protection & IP-65 for outdoor installation. Adequate access shall be available for inspection/ replacement/ Tightening of bus bars and their support/fish plate etc.

## **EXECUTION – TESTING & COMMISSIONING**

### **General**

Store rising mains in clean dry area. Rising mains shall not be delivered or installed until building is enclosed and dry.

Clean conducting surfaces and install bus in accordance with manufacturer's installation instructions.

Torque all connections. Adjust spring hangers to equally distribute load.

Provide 10 cm high concrete curb around rising mains floor penetrations.

Provide a spring suspension hanger at each floor and not more than every 4 vertical meters.

Provide expansion fittings in accordance with manufacturer's recommendations.

Provide listed fire stop fittings at floor and wall penetrations.

### **Drawings and Documents**

Fully, dimensioned, scale drawing showing general arrangement, assembly, installation, configuration, clearance, creep age distances and interfacing details at both ends shall be submitted for approval.

Calculations for bus bar capacity to carry rated current with specified maximum operating temperature.

Short time thermal and dynamic withstand capacity under specified fault level, Heat loss calculations & Voltage drop calculations.

### **Test**

The rising mains shall be tested and inspected at fabrication stage in accordance with the relevant IS/ BS requirement for type and routine tests.

After installation the following tests shall be performed before energising the rising mains.

High voltage withstand test for 1 min.

Megger test

Inspection

The Purchaser reserves the right to witness all routine tests at manufacturer's works prior to dispatch to prove compliance with Specification. All expenses for conducting these tests shall be borne by the Bidder. Metering/testing equipment of approved range and accuracy class shall be arranged by the Vendor.

### **Basis of measurement**

The rising mains unit rate shall be based on per meter length basis measured along the longitudinal axis from flange to flange (centre line measurement} irrespective of horizontal/ vertical runs, bends, crossover chamber and adapter panel. The per meter rates shall be inclusive of bend, crossover box and adapter box flexible end coupler etc.

### **Quality Assurance**

Quality Assurance shall follow the requirements of Owner documents as applicable. QA involvement will commence at enquiry and follow through to completion and acceptance thus ensuring total conformity to Purchaser's requirement.

### **Deviations**

Deviation from specifications must be stated in writing at the quotation stage.

In the absence of such a statement, it will be assumed that the requirements of the specifications are met without exception.

## EXTERNAL LIGHTING

### Work Description

The scope of work includes the external lighting with LED lamp light fittings. The actual position of all fittings, the wiring details and cable routes shall be coordinated with other trades at site and submitted for the approval of the Engineer-in-charge. All time and cost required for adjusting the layout or complete installation to suit site requirement is included.

To determine the exact positioning of External lighting points due consideration shall be given, for selection of the most accessible routes for wiring, convenience of switching and operational requirement of the installation.

For the purpose of specification and related drawing, each lighting circuit shall be coded with a prefix to indicate the corresponding distribution board number.

The electrical equipment/system may develop sudden changes due to low frequency/or direct electric current components such as fluorescent lamps, contactors, etc. shall be fitted with radio and television interference suppression components suitable to meet the levels specified in BS 800 “Limits of Radio Interference”.

### Standards

The complete wiring installation shall be engineered according to manufacturer data and constructed in accordance with the latest revision of the IS and the appropriate BS/IEC

In the adoption of standards and requirements, the Contractor shall take the following precedence:

Engineer’s decision

Local codes of practice

Drawings

Specification

International standards and requirements

### Submission

All technical submissions shall be approved by the contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of Engineer-in-charge for its review and approval.

The submission shall include the following as a minimum requirement,

Equipment catalogues submission with manufacturer’s data

Sample submission include all wiring accessories

Shop Drawings of the lighting, circuit numbers, cable routings, switching arrangement, mounting height, etc. The positions and mounting heights shall be coordinated with other services. Fixing details of all wiring accessories shall also be included.

Drawings showing the installation details

Labeling system

Builder's works requirement.

### **DECORATIVE STREET LIGHTING POLES:**

Decorative street lighting pole of the following standard shall be used on work

#### **Design & Construction:**

Ornamental cast aluminum pole BCIP- 01 made out of cast aluminum as per requirements of IS: 202-1993 or equivalent. Casting of all pole sections should be accurately done from permanent moulds and cores of the design submitted to achieve uniformity in all design aspects in internal and external shape of the unit. All sections should be free from defects like blow holes, porosity, hard spots, cracks, hot tears, cold shuts, distortion, sand and slag inclusion and other harmful defects. All the casted sections used in the pole should be free from welding of any kind used to repair it. The casted sections should be machined from all the locations used to insert the pieces into one another using either threading or socket method accuracy of all machined parts should be maintained throughout a lot for random replacements of sections if and when required. All the threaded joints should be mechanically tightened and sealed using industrial tools to make the entire unit vandal resistant.

#### **Aesthetic Appearance:**

All the grooves and carvings of the pole unit should be free from any kind of distortion for a pleasing aesthetic appearance

#### **Material:**

Cast aluminum material used for casting pole unit should be of grade FG-220 type, as described in IS: 202 and should have minimum tensile strength of the order of 200 N/sq. mm.

#### **Pretreatment:**

Each and every casted piece should be subject to sand blasting at a pressure of 10-15 Kgf to remove all external dirt and sand remains etc

#### **Painting & Finishing:**

Entire unit should be given an extensive three stage treatment with PU based two pack Zn-Ph primer and paint prescribed for CI surfaces to make it absolutely rust and corrosion proof, as well as giving it a pleasing appearance. PU based paint should be MRF make or equivalent.

#### **Thickness of the coating:**



A minimum of 80 microns of coating thickness should be achieved on the final piece.

#### **Installation:**

Pole unit should be grouted using 4nos. anchor bolts of size M-16x450mm confirming to 6.8 Gr. As per IS: 2062. Pole unit should be grouted in a Foundation made out of 1:3:6 cement concrete after excavating the earth with proper cable sleeves etc. laid in the foundation itself.

Manufacturer standard installation drawing shall be followed for installation of poles.

#### **OCTAGONAL STREET LIGHTING POLES:**

Octagonal G.I. street lighting poles of the following specification shall be used for work.

The Octagonal Poles shall be designed to withstand the maximum wind speed as per IS 875. The top loading i.e. area and the weight of fixtures are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BS: 5649 Part VI1982.

The pole shaft shall have octagonal cross section and shall be continuously tapered with single longitudinal welding. There shall not be any circumferential welding. The welding of pole shaft shall be done by Submerged Arc Welding (SAW) process.

All octagonal pole shafts shall be provided with the rigid flange plate of suitable thickness with provision for fixing 4 foundation bolts. This base plate shall be fillet welded to the pole shaft at two locations i.e. from inside and outside. The welding shall be done as per qualified MVAW process approved by third party inspection agency. The octagonal Poles shall have door of approximate 500 mm length at the elevation of 500 mm from the Base plate. The door shall be vandal resistance and shall be weather proof to ensure safety of inside connections. The door shall be flush with the exterior surface and shall have suitable locking arrangement. There shall also be suitable arrangement for the purpose of earthing.

The pole shall be adequately strengthened at the location of the door to compensate for the loss in section.

Welding shall be carried out confirming to approved procedures duly qualified by third party Inspection agency. The welders shall also be qualified for welding the octagonal shafts. The Octagonal Poles shall be in single section (upto 11 mtr). There shall not be any circumferential weld joint. The poles shall be hot dip galvanized as per IS-2629/IS-2633/IS-4759 standards with average coating thickness of 70 micron. The galvanizing shall be done in single dipping.

The Octagonal Poles shall be bolted on a pre-cast foundation with a set of four foundation bolts for greater rigidity.

Top Mounting; the galvanized mounting bracket shall be part of supply along with the Octagonal Poles for Installation of the luminaries. Installation of poles shall be carried out as per manufacturer's standards.

**The Lux level for lighting shall be considered as per IS standards and on the following area requirement.**

Public Parking	40-50
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Internal Roads (10mtrs)	18-20
Main Approach Roads (12mtrs)	20-25
Piazza Lights	38-40
Security lights	20

**HIGHMAST :****Struture:**

The High mast shall be of continuously tapered, polygonal cross section, 20 sided, presenting a good and pleasing appearance and shall be based on proven In-Tension design conforming to the standards referred to above to give an assured performance and reliable service. The dimensions of the mast and other details are as per the enclosed data sheet.

**Construction:**

The mast shaft shall be manufactured from high tensile steel plates confirming to BS EN 10025 having minimum yield strength of 355N/Sq. mm. Each mast shaft section shall have only one/multiple longitudinal weld depending on the bottom A/F dimension of mast and without any circumferential weld joint. Sections with more than one longitudinal weld shall not be accepted. The mast base flange shall be free from any lamination or incursion and provided with supplementary gussets between the bolt-holes to ensure elimination of helical stress concentration.

The minimum A/F dimension of top shall be 150 mm and bottom as per the design and data sheet enclosed. The minimum section length except for the top section shall be 10.98 m and top shall depend on the length required to make the specified height. The masts sections shall be joined at site by slip-stress-fit method and minimum overlap distance shall be 1.5 times the diameter at penetration.

A door reinforced with welded steel section, vandal resistant, weather proof with Allen bolts and pad locking facility of minimum dimension 1200 mm x 250 mm shall be provided at a height 2 times the width of door from the base of mast to provide clear access to base compartment equipments winch, motor, cable, connector etc;

For the environmental protection of the mast, the entire fabricated mast shall be hot dip galvanised internally and externally in single dip having a uniform average thickness of 86 microns for plates more than 5 mm and 70 microns for 5 mm or less thickness.

**Dynamic Loading for the Mast:**

The mast structure shall be suitable to sustain an assumed maximum reaction arising from a wind speed as per IS 875 (three second gust), and shall be measured at a height of 10 metres above ground level. The design life of the mast shall be 25 years. The force co-efficient taken for design of the polygonal structure is to be established from the wind tunnel test data.

**Luminaries Carriage:**

Hot dip galvanized Luminaries carriage designed to install luminaries as specified in data sheet or as per illumination design, its control gear boxes and junction box. The same is to be fabricated from ERW tubes in two halves and flanges joined at site with stainless steel bolts and nyloc nuts. Holes are to be provided in the bottom side of tubes to act as conduit for wiring cable. PVC buffer is to be provided in the inner side of carriage to avoid metal contact with mast surface.

Cast Aluminium weather proof junction box shall be provided on the Carriage Assembly for terminating the trailing cable and power cable to luminaries.

**Raising and lowering mechanism:****Winch:**

The double drum winch shall be completely self sustaining without the need for brake shoe, springs or clutches and self-lubricating type by means of an oil bath. The worm gear ratio shall be 53:1 and safe working load as per the data sheet. The drums are to be grooved to provide perfect seat for stable and tidy rope lay and arrangement for distortion free rope end termination

The winch shall have provision to operate manually by a handle or electrically through power tool. The capacity, operating speed, safe working load, recommended lubrication and serial number of the winch shall be marked on each winch.

The winch shall be type tested through reputed institutions like IIT as consultants and the type test report shall be submitted along with offer. A test certificate is to be submitted along with supplies.

**Head Frame:**

The hot dip galvanized head frame is to be designed as a capping unit of the mast is of welded steel construction and provided with guides and separators between the ropes and cable. The LM6 Aluminium pulley's with bush bearing mounted through stainless steel shaft shall be suitable to accommodate wire ropes and multi core trailing cable. The head frame shall be provided with guides and stops with PVC buffer for the docking of luminary's carriage. The pulley assembly shall be covered by a hot dip galvanized canopy.

**Stainless Steel Wire Ropes:**

The stainless steel wire ropes shall be in AISI 316 grade, 7/19 construction with central core in the same material of diameter as per data sheet. The breaking load of each rope shall give a safety of over 5 for the system at full load as per the TR-7. The end construction of rope for the winch drum shall be fitted with talurit and for two continuous ropes the end termination in luminary's carriage shall be with stainless steel thimble and copper splicing and for others with stainless steel thimble and bull dog grips.

**Electrical System, Cable and Cable Connections:**

The multi core trailing cable from base compartment to junction box at luminaries carriage shall be 1.1 KV grade EPR insulated, PCP sheathed copper conductor with male female connectors of minimum 5core x 2.5 sq. mm or above depending on luminaries load. Wiring from junction box to luminaries is to be done using 3 core 1.5 sq. mm PVC/XLPE insulated, PVC sheathed, copper conductor flexible cable.

Suitable arrangement is to be provided in the base compartment to receive and terminate incoming power cable and MCB in a box for isolation of incoming power supply.

#### **Power Tool for the Winch:**

Three phase, single speed, 6 pole high-powered motor of rating suitable to lift the load mounted on adjustable plate to adjust the length of winch motor coupling chain is to be provided in base compartment.

Mechanical torque limiter is to be mounted on motor shaft to stop transmission of motion from motor to winch in case of excess load and thus prevent the damage to winch and breakage of rope.

#### **Lightning Finial**

One number heavy duty 1.2 m long hot dip galvanised lighting finial shall be provided for each mast on the head frame to get a direct conducting path to the earth through the mast.

#### **Aviation Obstruction Lights:**

Two number Low intensity LED Aviation Obstruction Lights shall be provided on luminaries carriage.

#### **Earthing Terminals:**

Earth terminal using 12 mm diameter hot dip galvanized bolts shall be provided on the door stiffener of the mast for lightning and electrical earthing of the mast.

#### **Feeder Pillar**

Each mast shall be provided with a feeder pillar housing 63A TPN MCB incomer, single dial time switch and 45A contactor for automatic switching on and off luminaries, 9A two contactors and raise lower push buttons for motor operation, incoming terminals of 50 sq. m and out-going terminals of 16 sq. mm for power cable and 2.5 sq. mm for motor.

#### **Incoming Power Cable**

1.1 KV grade, PVC insulated, PVC sheathed, Aluminium conductor, armoured cable for power supply shall be provided from feeder pillar to the base compartment of the high mast. Cable shall be taken to the base compartment of the high mast through the provision made in the foundation. Power cable of suitable size up to the feeder pillar from supply point shall be provided by purchaser.

#### **Luminaries**

The flood light luminaries shall be grey epoxy powder coated die-cast aluminium housing with frame, heat resistant clear toughened glass fixed to the frame with silicon gasket with electrochemically brightened, polished and anodised aluminium reflector with cast aluminium control gear box, and LED Lamps.

**SUB HEAD – 17****HT PANEL BOARDS****Work Description**

This specification covers the ‘General Requirements’ for the design, manufacture, supply performance, inspection, testing and commissioning including supply of indoor type high voltage switch boards up to 11 KV including necessary termination, cabling and bus work required for satisfactory operation .

All factories built assemblies subject to rain or wet conditions or located outside electrical switch room shall be weatherproof constructed to IP-65, able to withstand high impact strength of 60KN/m<sup>2</sup> (min.), temperature resistant, flame retardant and corrosion resistant.

Specific requirements shall be in accordance with single line diagram/specification

The technical parameters of switchgear equipments, transformers etc. shall be referred.

**Standards**

All equipment, material and components shall comply with the requirements of the latest editions of Indian Standards with updated amendments. Standards and Regulations applicable in the area where equipment is to be installed shall also be followed.

The equipment offered complying with other standards, these standards shall be equal to or superior to those specified and full details of the differences shall be furnished along with the tender.

The Panel boards shall be engineered and constructed in accordance with the latest revision of the following Indian and British standards:

- |     |          |  |
|-----|----------|--|
| 1.  | IS:13947 | A.C. Circuit Breakers  |
| 2.  | IS:3427  | Metal enclosed Switchgear & Control Gear   |
| 3.  | BS:162   | Safety Clearances  |
| 4.  | IS:2705  | Current Transformers   |
| 5.  | IS:3156  | Voltage Transformers   |
| 6.  | IS:3202  | Code of Practice for climate proofing of electrical equipment                          |
| 7.  | IS:375   | Marking & Arrangement for Switch gear Bus-Bars, main connections and auxiliary wiring. |
| 8.  | IS:14697 | A.C. Electric Meters   |
| 9.  | IS:1248  | Direct acting Electrical Indicating Instruments  |
| 10. | IS:3231  | Electrical Relays for Power System Protection  |

- |     |                  |  |
|-----|------------------|--|
| 11. | IS:2544          | Epoxy Cast Resin Insulators  |
| 12. | IS:5082          | Electrolytic Copper/ Aluminium   |
| 13. | IS:5792          | High Voltage HRC fuses   |
| 14. | BS:88            | Cartridge fuses for voltages up to and including 1000V, AC and 1500V DC.   |
| 15. | BS:89            | Direct acting electrical indicating analogue electrical measuring instruments and their accessories.                                 |
| 16. | BS:142           | Electrical protective relays   |
| 17. | BS:159           | Bus bar and Bus bar connection   |
| 18. | BS:1433          | Copper for electrical purposes. Rods and bars  |
| 19. | BS EN: 60898     | Circuit-breakers for over current protection for household and similar installations   |
| 20. | BS:3938          | : Current transformers   |
| 21. | BS:5419          | : Air-break switches, air-break disconnections, and fuse combination units for voltages up to and including 1000V, AC and 1200V, DC. |
| 22. | BS:5992          | : Electrical relays  |
| 23. | BS:6004          | : PVC insulated cables, (non-armoured), for electric power and lighting.   |
| 24. | BS:6231          | : PVC insulated cables for switchgear and control gear wiring.   |
| 25. | IS:3043/ BS:7430 | : Earthing   |

BS/IEC or IS not mentioned above but are applicable to this installation shall also apply.

### **General Construction**

Separately earthed compartments shall be provided for circuit breakers, bus bars, relay & instruments, CT & PT and cable boxes, fully and effectively segregating those from one another so that the fault in any one component do not cause damage to equipment in other compartment.

### **General Design Aspects**

The HV panel board shall be designed such that the switchgear, instrument, relays, bus bars, small wiring etc are arranged and mounted with due consideration for the followings:

Facility for inspection, maintenance and repairs of testing terminals and terminal boards for ease of external connection.

Minimum noise and Vibration

Risk of accidental short circuits and open circuits.

Secured and vibration proof connections for power and control circuits

Risk of accidental contact and danger to personnel due to live connections.

Mountings at approachable heights.

### **Submission**

All technical submissions shall be approved by the contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of Engineer-in-charge for its review and approval.

Such drawings shall show the proposed method of construction of the cubicles, method of supporting equipment and Bus-bar, full details of Bus-bar layout, method of support, electrical control wiring diagrams, equipment weight, colors, and surface treatment.

The drawings shall also incorporate a full list of proposed materials. The construction shall not commence until the drawings are approved for construction.

Pre delivery inspection of materials at manufacturer's works, pre commissioning test at site and preparation of report in formats are included.

Coordination of Protection system in drawings/tables for complete equipment.

Submission of Routine test certificate and testing procedure details prior to pre delivery inspection at works.

Providing procedures detail for pre commissioning of equipments installed and testing at site.

Preparation of as built drawings for the services rendered by the contractor.

Any other work / activity which is not listed and is necessary for completeness of electrical system

## **PRODUCTS**

### **Panel Board**

The switch boards shall be cubicle type, suitable for indoor installation, floor mounting and free standing. The design shall be totally enclosed, dust tight, damp-proof and vermin proof offering degree of protection not less than IP-4X.



Separate segregated compartments shall be provided for circuit breakers, bus bars, cable box, voltage transformers, wire ways, relays, and instrument and control devices. Switchgear cubicles/ modules shall be provided with hinged doors in front with facility for padlocking door handles.

Vent openings shall be covered with grills and chicken wire mesh so arranged to discharge the hot gases.

In a manner that it does not injure the operating personnel. These vent openings shall be vermin proof.

All panels shall be of same height, width and depth. Panels shall be bolted together to form a continuous flush front switch board, suitable for front operation. The back panels shall remain closed during normal operation. Easy opening arrangements shall be provided for opening of these panels in case of emergency.

The switchgear cubicles shall be rigid and robust in design and construction, fabricated out of CRCA sheet steel. Cubicles shall be made from rigid welded structural frames made of structural steel sections or of pressed/formed sheet steel of not less than 3mm thickness. The frames shall be enclosed by sheet steel of at least 2mm thickness, smoothly finished, leveled and free from flaws. Stiffeners shall be provided wherever necessary.

All doors, panels, removable covers shall be provided with non deteriorating (neoprene) gaskets all around the perimeter.

All doors shall be removable and supported by concealed type hinges. The hinges shall be strong and braced to ensure freedom from sagging, bending and general distortion of panel or hinged part.

Floor mounted cubicles shall be provided with a 75mm x 75mm x 3mm high channel base frame. The total height of the cubicle shall not exceed 2400mm FFL including base channel.

### **Bus Bars & Bus Bar Chamber**

Three phase bus bars shall be of high conductivity electrolytic Copper.

Air insulated encapsulated bus bars housed in a separate compartment, segregated from all other compartments shall provided.

Bus bars & bus bar connections shall be of uniform cross section, suitable for carrying rated current continuously and short circuit current for specified duration without overheating.

All bus bar joints and bus lap joints shall be silver or tin plated. Joints shall be bolted type and insulated.

Spring/Lock washers shall be provided to ensure good contact on the joints.

Direct access of contact with the bus bars and primary connections shall be avoided by providing shrouds. All apertures and slots shall be protected by barriers to prevent accidental shorting of bus bars. To provide a tight seal between cubicles, bushings or insulating panels shall be provided for bus bars crossing from one cubicle into another.

All insulating materials used shall be non-hygroscopic and shall be treated for preventing fungus growth. Surface of insulators shall be highly glazed and treated with silicone compounds to minimize accumulation of dust, condensation and tracking.

All bus bars shall be color coded as per IS: 375.

### **Circuit Breakers (Class P-2 Duty)**

The circuit breakers shall be vacuum type.

The circuit breakers shall be of horizontal isolation, horizontal draw out pattern. The circuit breaker carriage shall be fabricated from steel, providing a sturdy vehicle for the circuit breaker and its operating and tripping mechanism the carriage shall be mounted on wheels, moving on guides, design to align correctly and allow easy movement of the circuit breaker and for removing the carriage for inspection and maintenance purpose.

Vacuum interrupters shall be hermetically sealed and shall be designed for minimum contact erosion, fast recovery of dielectric strength, maintenance free vacuum interrupters, suitable for auto-reclosing.

The drive mechanism shall preferably provided with facility for pad locking at any position namely, “Service”, “Test”, and “Fully Isolated”. It should be possible for testing the circuit breaker for its operation without energizing the power circuit in the “Testing” position.

The contacts shall be made only after the breaker is inserted into service position. Interlocking should prevent contacts from being disconnected if circuit breaker is tried to be moved from service position.

Operating mechanism shall be one of the following as specified:

Manually operated spring charged / motor wound spring charged with both mechanical and electrical release for closing. The operating mechanism shall be trip free.

External auxiliary supply shall be made available for charging motors and heating operation

Circuit breaker panel shall be complete with the followings:

Racking in / Racking out mechanism

Isolation plug and sockets

Mechanical interlocks and safety shutters

Mechanical ON /OFF indicator

Minimum of 4 NO and 4 NC auxiliary contacts directly operated by the circuit breaker. Additional NO & NC contacts can be provided with auxiliary contactors

Anti condensation space heaters suitable for operation on 240 V, 1 phase 50 cycles A.C. for each panel wherever specified

Suitable tripping arrangement

Mechanical counter to assess the total number of operations of the breaker.

### **Current Transformers (CT'S)**

Accommodation shall be provided in the circuit breaker panel to mount one set of three number dual core ratio CT's for metering and protection purposes. Access to the CTs for cleaning, testing or changing shall be from front, back or top of the panel.

Current transformers ratings shall be dual core and dual ratio CTs of suitable burden (but not less than 15 VA) shall be preferred with 5 Amp secondary.

Secondary terminals of CT shall be brought out suitably to a terminal block which will be easily accessible for testing and terminal connections.

The protection CTs shall be of accuracy class 5 P 10 of IS 2705 – Part – III -1992.

The Metering CTs shall conform to the metering ratio and accuracy class 0.5 of IS 2705 – 1992

### **Potential Transformers (PT'S)**

Potential Transformers shall conform to latest edition of relevant standards.

Potential transformers shall be dry, cast epoxy resin type. The PTs shall be of single phase construction.

The PT'S shall be capable of operating continuously at 110% of the rated voltage without any damage. When star - star connection is required in non-effectively or ungrounded system, the PT'S shall be suitable for continuous operation with a persistent phase to ground fault.

Maximum temperature rise of the transformer at rated burden and with rated primary voltage and frequency shall not exceed 40 Deg's above an ambient of 45 Deg's.

Voltage transformer of burden not less than 100 VA and of the proper ratio and of proper ratio as specified shall be provided at the incoming panel. The accuracy class for the VT shall be class 0.5 as per IS 3156 Part-I to III for incomer and class 1 for outgoing panels.

The transformer shall be of cast epoxy resin construction. It shall be fixed/ withdraw able type. HRC fuses/MCBs shall be provided on both HV & LV side. It shall be possible to replace PT fuses easily without having to de-energies the main bus bars. Prospective interrupting current rating of the fuses shall be same as the system fault level.

### **Protective Relays**

Relays type and numbers shall be in accordance with the protective scheme specified or as per drawings.

Relays shall be microprocessor based numerical relays with O/L, E/F, and S/C protection.

Over current Relays shall have adjustable setting for current from 50 % to 200% and earth fault from 10% to 40% or 20% to 80%. These should be manual reset type. All relays shall have a LED indicator which will indicate for each function. It shall be possible to reset it only by manual operation. The number and type of relay shall be as specified

Tripping relay shall be used for tripping signal to the shunt trip coil of the Circuit Breaker operating on 24V/30V DC supply / Power pack /110V VT supply.

Relays conform to relevant standards in all respects.

Relays shall be provided with minimum two pairs of self or hand reset type contacts as specified. Auxiliary relays shall have the number of NO and NC contacts as specified in data sheet.

### **Safety/ Protection & Interlocks/Features**

Following interlocks and features shall be incorporated for equipment protection and personnel safety under mal-operation. No deviations on these interlocks and safety features are allowed. These interlocks and safety features shall be fail-safe, positive and full-proof.

It shall not be possible to plug-in or isolate a closed circuit breaker. An attempt to do so shall trip the breaker. (In case of breakers with vertical isolation, this will apply to raising and lowering). There shall be a positive locking facility to prevent closing of circuit unless it is in Service or Test position.

Closing and opening operations shall be possible only in discrete, well defined Test and Service positions and not in any position midway. An extension adapter cable with plugs and sockets shall be preferably be provided so that the closing and opening operation of the circuit breaker can be done in fully withdrawn position outside the cable.

Slow operation of circuit breakers shall be possible only in the circuit breaker in Test or Isolated position.

Isolating switches if provided shall be interlocked with respective circuit breakers to prevent them making or breaking the current.

1No. bus earthing truck shall be supplied with each panel to earth the outgoing cable of the VCB breaker.

Automatic safety shutters for all openings which will lead to access to the live parts of the switchgear upon withdrawal or any operation the switchgear components/parts shall be provided, preferably with a padlocking facility.

Spring of motor operated spring charged mechanism shall not discharge until they are fully charged and charging means are fully disconnected.

Where key interlocking is employed, tripping of a closed circuit breaker shall not occur if any attempt is made to remove the trapped key from the mechanism.

Any other interlocks which manufacturer may deem to be required for safety and specifically specified separately required for the system shall be included.

All terminals, connections which may be live and exposed for accidental contact shall be adequately shrouded.

Components within cubicles shall be properly labeled to facilitate testing.

### **Earthing**

The switch board shall be provided at the bottom throughout its entire length with an earth bus of copper of adequate size to carry the fault current for the duration same as short time rating of the circuit breaker. Earth bus shall have two earthing connection facility at its both ends of earthing conductor.

All non-current carrying metal parts, frames and equipment mounted in the switch board shall be bonded to earth bus.

Earthing of moving carriage of draw out equipment shall be achieved by scraping earthing device. The earthing device shall maintain positive earth continuity in all Service Test and Isolated positions.

It shall be possible to connect each circuit or set of three phase bus bars to earth either through earthing trucks or through the circuit breakers.

One earthing trolley suitable for earthing of cables & bus bars for all circuit breakers of the same type/rating shall be provided.

### **Instrument & Meters**

A voltmeter of class 1.5 accuracy as per IS-1248 at each incomer panel, with selector switch. The instrument shall be calibrated for the ranges specified.

Energy meter of class 1.0 conforming to IS 722 (Part IX) and power factor meter of class of accuracy of 2 shall be provided.

Ammeter of specified ranges of class 1.0 accuracy as per IS -1248 shall be provided at both incomer and outgoing panels along with necessary selector switch.

The panel assembly shall also take care of the following requirements:

- a. Lamp identification shall be provided to indicate ON/OFF (by red /green respectively) of switch gear.
- b. Panel illuminating lamps
- c. Mechanical indication for spring charged status. If possible an indication lamp could be provided.
- d. Lamp indicating tripping at fault status
- e. Healthy trip supply shall be indicated by clear lamp
- f. Separate fuses / MCB's shall be provided for lamps, heaters, voltmeter and other instrumentation etc. on each panel.
- g. Anti-condensation space heaters shall be provided, and shall be suitable for operation on 240V, 1 Phase, 50HZ, AC for each panel .Where there is more than one incomer and bus sections, these shall be castle key interlocked as per interlocking scheme as specified.

### **Control Wiring**

The small wiring for control, protection, alarm and indicating circuits on all equipment shall be carried out with minimum 1.5 Sqmm FRLS / HFFR insulated copper conductor cables.

CT wiring shall be done with minimum 2.5 Sqmm wires with color code RYB, Grey for auxiliary DC circuits and Black for auxiliary AC circuits

All wiring shall be securely fixed and neatly arranged to enable easy tracing of wires. Identification tags shall be fitted to all wire terminals to render identification easy and to facilitate checking in accordance with IS -375 .Necessary terminal block shall and cable entries shall be provided for RTD relay wiring, power supply etc.

All wiring shall be taken to terminal blocks without joints or tees in their run.

All wiring for external connections shall be brought out to individual terminals on a readily accessible terminal block.

All unused auxiliary contacts of the circuit breaker and relays shall be wired up to terminal block.

### **Fittings and Accessories**

#### **Indicating Lamps**

LED type indicating lamps shall be provided everywhere except where low voltage filament type with series resistor called for.

Lamp covers shall be provided with interchangeable colored lenses of Perspex or equivalent unbreakable material. The lenses shall not discolor in course of time due to heat of the lamp.

Bulbs and lenses shall be interchangeable and replaceable from the front.

Following colors shall be used for the function indicated:

Red	- Circuit Breaker 'ON'
Green	- Circuit Breaker 'OFF'
White	Continuous trip supply - supervision
Amber	- Auto trip
Blue	- Spring charged
R.Y.B	- Potential indication

#### **Push Buttons**

All push buttons shall be push to actuate the contact type.

Start & Stop push buttons shall be colored green and red respectively. Reset push buttons shall be yellow in color and test push buttons shall be blue in color. All other push buttons shall be black in color.

Emergency stop push buttons shall be lockable in the operated position, i.e. push to operate and key to release type. Push buttons for emergency stop shall be recessed/shrouded type to avoid accidental operation.

### **Control & Selector Switches**

Control and Selector switches shall be of rotary type, having enclosed contacts accessible only after removal of cover.

All control and selector switches for circuit breakers and instruments shall be mounted on the front of the panel. Control switches for space heater/s and control supplies shall be mounted inside the panel.

Circuit Breaker control switches shall be provided with pistol grip handles. Selector switches shall be provided with round, knurled handles. All handles shall be black in color. Properly designated escutcheon plates clearly marked to show the operating positions shall be provided on all switches.

Circuit breaker control switches shall normally have three positions CLOSE-NORMAL-TRIP with spring return to normal position. Switch operating mechanism shall prevent the switch from being operated twice successively in the same direction. Circuit breaker control switch shall have one NO-NC contact along with other contacts as required.

All other instruments and selector switches shall have stay put contacts.

Contacts of all control and selector switches shall be rated for 10 Amps at 240V AC or 20 Amps at 220V DC (inductive break). Switch for space heater supply and control voltage supply shall normally be two pole rated for 25A A.C.

### **Control Terminal Blocks**

Box - clamp type, 650V grade line up terminals of minimum 2.5 Sqmm size shall be provided. Connection to terminals shall be from front.

Not more than one wire on each side shall be connected on any terminal. Where duplication of terminals block/s is necessary, suitable solid bonding links shall be incorporated.

Terminal blocks at different voltage shall be segregated into groups and distinctly labeled.

Current transformer secondary leads shall be brought to terminal blocks having facility for short circuiting and grounding the secondary.

Terminals shall be numbered for identification and grouped according to function. Engraved back on white PVC labels shall be provided on the terminal blocks describing the function of the circuit.

Separate terminal stems shall be provided for internal and external wiring.

Control terminal blocks shall be so located that control cables are fully segregated from power cables. Suitable insulated or earthed metal race ways shall be provided for control wiring. Separate unrolled removable gland plate shall be provided for the control cables at the bottom of each panel.

Minimum 10% of total number spare terminals shall be provided for future use.

### **Name Plates and Labels**

One Name plate giving designation of the MV switchboard shall be affixed prominently on top of the switch board. Details of designation will be specified.

Labels giving following details shall be affixed on each feeder panel:

Feeder No.

Equipment reference no. & Description

Rating (HP/kW/kVA/Amp.)

All components whether mounted inside or on the door shall be permanently and clearly labeled with reference number/letter or their function. Rating of fuse shall be part of fuse designation. Paper labels, stickers or labels fixed with adhesives are not acceptable. All labels shall be properly fixed by screws with provision to prevent distortion due to expansion.

All labels shall be non-corroding, preferably laminated plastic or rear engraved Perspex with white letters on black background.

Labels for feeder panel designation fixed on front side shall be fitted with chrome plated, self tapping, and counter sunk head screws. These labels shall be of identical size to permit interchange.

### **Space Heaters**

Adequately rated anti-condensation space heaters shall be provided in each cubicle.

Space heater/s shall be trip type, rated with operation voltage of 240V, 50 Hz. AC supply.

Each space heater shall be complete with a 2P, MCB, 10KA and a control thermostat.

The space heater shall be rated for maintaining the panel inside temperature 10°C above outside ambient temperature.

### **Cubicle Lighting**

Each cubicle shall be provided with interior lighting by means of CFL/LED light fixture. An ON/OFF switch/door switch shall be provided. The lighting fixture shall be suitable for operation from a 240V single phase, 50 Hz. A.C. supplies.

### **Auxiliary Supply**

Auxiliary supply for control, indication, space heater etc. shall be made available at one point on the switch board. Vendor shall provide suitable auxiliary supply in the switch board.

### **Fuses**



Fuses shall be HRC cartridge link type (DZ Fuses are not acceptable) and shall be provided with operation indicator which shall be visible without removal of fuses from service.

Fuses shall be pressure fitted type and shall preferably have ribs on the contact blades to ensure good line contact.

It shall be possible to handle fuses during off load conditions with full voltage available on the terminals. Wherever required fuse pullers shall be provide. The fuse bases shall be so located in the modules to permit insertion of fuse pullers and removal of fuse links without any problems.

Mounting of fuse fitting shall ensure adequate dissipation of heat generated and shall facilitate inspection and easy replacement of fuse.

### **Contactors**

The contactors shall be vacuum break type, equipped with three main contacts and minimum 2NO + 2NC auxiliary contacts. The main contacts of a particular contactor shall have AC 3 ratings for unidirectional motors & AC 4 for reversible motors.

The auxiliary contacts shall be rated for minimum 5 Amps at 240V AC and 1.3 Amps at 110V DC (Inductive load).

Unless specified otherwise, the coil of the contactor shall be suitable for operation on 240V, +10% and – 15% 1PH, AC supply. The contactor drop off voltage shall be “between” 15% to 65% of the rated coil voltage.

### **Single Phasing Preventer (SPP)**

Unless specified otherwise SPP'S shall be provided in all motor starter modules with contactor rating of 200Amps and above. The SPP shall be of the current operated type and shall operate on the principle of sensing negative sequence component of current.

In case of single phasing, the SPP shall operate after a time delay of 2 to 3 seconds. The relay shall be of the hand reset type and visual indication of the relay operation shall be available.

The SPP shall be suitable for protection of the non-reversible and reversible motors. The relay operation shall be independent of the loading and RPM of the motor prior to the occurrence of single phasing.

### **Cable Termination**

The switch board panel shall be complete with suitable cable end termination for XLPE insulated cables.

Cable and sealing box shall preferably be situated in a compartment at the rear / side of housing as specified. For XLPE cables adequate space and clearances shall be made for heat shrinkable termination e.g. Raychem or cold flowing stress grading joints.

Cable entry: provision for top (bus ducts preferred for top entry) / bottom or such other side entry shall be made as per requirement with sufficient head room for cable termination. 3mm thick removable gland plate shall be provided for cable termination.

The earthing of the breaker body and moving portion shall be so arranged that the earthing of the non – current carrying structure to the frame each bar is completed well before the main circuit breaker plugs enter the fixed house socket.

Entire panel shall have a common tinned copper earth bar of suitable section with two earth terminals for effectively earthing metallic portion of the Panels

## **EXECUTION**

### **Testing and Commissioning**

All panel boards shall be inspected & tested in the presence of Engineer-in-charge's representative and certified by the installation Engineer that it is safe before supply is energized, and that all the equipment comply with the requirements of the Specification.

Generally such tests in the factory and repeated at site are as follows:

All routine tests specified in relevant Indian/British Standards shall be carried out on all circuit breakers.

Procedure for testing and commissioning of relay shall be in general accordance with good practice.

Checking of all small wiring connections

Relays calibration and setting by secondary injection method and Primary injection method. Primary injection test will be preferred for operation of relay through CTs.

Checks and test shall include following:

Operation checks and lubrication of all moving parts

Interlock function check

Continuity check of wiring, fuses etc. as required

Insulation tests

The complete Panel shall be tested with 5000 Volts megger for insulation between Poles and Poles to earth. Insulation test of secondary of CTs and VT to earth shall be conducted using 5000V megger.

Triplicate sets of all principal test records and test certificates are to be supplied for all the tests carried out in accordance with the Specification to the Engineer for approval before dispatch from the factory.

All costs, materials, equipment, labour, etc. necessary for the execution of the testing shall be included in this portion of work. For detail refer O&M Contract conditions

### **Drawings and Information**

The Vendor shall furnish following drawings/documents in accordance with enclosed requirements:

General Arrangement drawing of the switchboard, showing front view, plan, foundation plan, floor cut-outs/trenches for external cables and elevations, transport sections and weights.

Sectional drawings of the circuit breaker panels, showing general constructional features, mounting details of various devices, bus bars, current transformers, cable boxes, terminal boxes for control cables etc.

Schematic and control wiring diagram for circuit breaker and protection including indicating devices, metering instruments, alarms, space heaters etc.

Terminal plans showing terminal numbers, ferrules markings, device terminal numbers, function etc.

Relay wiring diagrams.

Equipment List.

Vendor shall furnish required number of copies of above drawings for Purchaser's review, fabrication of switch boards shall start only after Purchaser's clearance for the same. After final review, required number of copies and reproducible shall be furnished as final certified drawings.

The information furnished shall include the following:

Technical literature giving complete information of the equipment.

Erection, Operation and Maintenance Manual complete with all relevant information, drawings and literature for auxiliary equipment and accessories, characteristics curves for relays etc.

A comprehensive spare parts catalogue.

### **Tools**

One complete set of all special or non-standard tools required for installation, operation and maintenance of the switch board shall be provided. The manufacturer shall provide a list of such tools individually priced with his quotation.

### **Spares**

The manufacturer/tendered shall also supply a complete list of commissioning spares and tools. The same shall be included in the bid price. No extra payment shall be made on account of non-availability of spares during commissioning.

### **Transportation**

Panel boards are not allowed to be delivered to site until the electrical room or switch room is in a clean and acceptable condition with lockable doors.

Panel boards, transported to site shall be fully covered with weatherproof covers and transportation eye bolts shall be provided for handling at site.

Panel boards, which are poorly packed and result in signs of corrosion, will be rejected.

All necessary measures to cover and protect the panel boards at site shall be provided. Such measures shall include a complete PVC blanket over the whole panel boards.

### **Rejection of Panel Boards**

Deviation from specification must be stated in writing at the quotation stage.

In absence of such statement, it will be assumed that the requirements of the specifications are met without expectation.

If any of the above tests fail to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site, the Engineer may reject the item or defective component thereof, whichever is considered necessary, and after adjustment or modification as directed by the Engineer, the Contractor shall submit that item for further inspection and/or test. In the event of the defective item being of such nature that the requirements of this Specification cannot be fulfilled by adjustment or modification, such item is to be replaced by the Contractor at his own expense, to the entire satisfaction of the Engineer. Delivery of panel boards on site without significant cable connection (Say 80%) shall not entitle progress payment certified for material delivery on site.

## **SUB HEAD – 18**

### **SOLAR PV SYSTEM**

#### **Work Description**

This specification covers the 'General Requirements' for the design, manufacture, supply performance, inspection, testing and commissioning of required rating of KWp as per GRIHA-3 star requirement.

It is proposed that power for lights, raw power etc. shall be supplied through solar PV. These loads shall get two supplies. One from normal panel and other from solar PV. The total capacity of solar power has been considered at required rating of KWp as per requirement of GRIHA. The solar panels shall be installed in the terrace area.

#### **System Description (Grid Connected System)**

The Photovoltaic (PV) Grid connects system consists of having mainly of 3 components: The Crystalline Silicon PV array, Module Mounting Structure and the Power conditioning Unit (PCU). The C-Si module will generate the DC voltage and to increase the voltage to make it suitable for the PCU rating.

The Solar Photovoltaic (PV) modules convert solar radiation from the sun into electrical energy in the form of direct current (DC). The Solar Charge Controller (SCC) part of PCU then maximizes the use of this electrical energy to charge the battery bank and at the same time it prevents over charging of the battery bank.

The PCU is nothing but converting the DC Power into AC power and feeding into the grid. It is designed with a high efficiency >98% with IGBT technology. It is delivering the max. Power generated through solar modules in to grid due to its inbuilt feature of MPPT operations. The PCU is having internal self

protection in case of any fault in the grid. Also the PCU has inbuilt contactors/breakers with fuses for self protections.

The PCU is having inbuilt microprocessor based controls before starting it's monitor the grid voltage, frequency of the grid if it is within set value then it senses the array voltage and current then it's start feeding the power in the grid if all parameters are within range. In case of power gets fail the PCU will stop working automatically. During the morning the PCU starts on its own when the power generation start from the solar module and stops automatically when the sun set and array is not generating any power.

Each PCU is having a remote and local data monitoring system with which one can monitor all the parameters and current energy generation & past generation for the given period. Outputs of PCU's are connected to Distribution boards and grid supply will be brought to distribution boards for synchronization with the PCU.

The power generated from the PV Modules will be supplied to the load through solar inverter unit (part of PCU), which converts DC power to pure 440V/230V AC sine wave power. The inverter unit will power the dedicated loads either from the solar array or battery bank in that order of preference. The inverter is designed for catering the power needs of the load.

### **Submission**

All technical submissions shall be approved by the contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of Engineer-in-charge for its review and approval.

Such drawings shall show the proposed method of construction of the Solar PV systems

The drawings shall also incorporate a full list of proposed materials. The construction shall not commence until the drawings are approved for Engineer-in-charge.

Pre delivery inspection of materials at manufacturer's works, pre commissioning test at site and preparation of report in formats are included.

Submission of test certificate and testing procedure details prior to pre delivery inspection at works. Providing procedures detail for pre commissioning of equipments installed and testing at site.

Preparation of as built drawings for the services rendered by the contractor.

Any other work / activity which is not listed and is necessary for completeness of electrical system

### **PRODUCTS**

#### **Electrical Features of Crystalline silicon solar photovoltaic module**

Modules array consists of high efficiency Solar Modules utilizing crystalline high power silicon Solar Photovoltaic cells.

Solar module has laminated using lamination technology using established polymer (EVA) and Tedlar / Polyester laminate.

320Wp solar modules consists of crystalline silicon photovoltaic cells.

Solar Modules has made with High Quality, High Transmission 3.2mm tempered Solar Glass.

The efficiency of Solar Photovoltaic module is greater than 13%. It has made of high transmissivity glass front surface giving high encapsulation gain and hot butyl rubber edge sealant for module protection and mechanical support.

All materials used in manufacturing of module have a proven history of reliable and stable operation in external outdoor applications

Solar module has designed to operate and perform in relative humidity up to 100% with temperatures between -10 Deg C and +85 Deg C and withstand gust up to 200km/h from back side of the panel.

New screw type anodized Aluminum frame design using double sided tape for framing.

Solar Modules have IEC and UL approved, IP 65 rated junction box assembly using USE cable and UL approved connectors. Three Scotty bypass diodes used for preventing any damage due to shading Degradation of power generated will not exceeding 20% of the min. Rated power over the 25 year period. Efficiency of solar PV system is to 90% for above 12 years & 80% for above 25 years.

The solar modules have suitable encapsulation and sealing arrangements to protect the silicon cells from the environment. The arrangement and the material of encapsulation are compatible with the thermal expansion properties of the Silicon cells and the module framing arrangement/material.

Multilayered Back sheet giving weather-able barrier for modules and high performance in rugged environments around the world, high dielectric performance, superior partial discharge and electrical insulation properties.

Solar modules have Tedlar /Polyester tr laminate back surface

## **SYSTEM CONFIGURATION**

### **PV MODULES**

A Photovoltaic module is a packaged interconnected assembly of Photovoltaic cells, which converts sunlight into Electrical Power. The Solar Modules are multi crystalline type, made of High Transmissivity front glass giving high encapsulation gain and silicon rubber edge sealant for module protection, mechanical support and moisture proofing.

### **MOUNTING STRUCTURE**

The Solar Module Mounting Structure (MMS) is designed for holding suitable number of modules. Modules will be mounted on Mild Steel, hot dipped galvanized with 120micron coating, support structures suitable for site conditions, which are tilted according to the Site Locations to maximize annual energy output. Support Structure design and foundation or fixation mounting arrangements shall withstand minimum horizontal wind speed relevant to site conditions.

## **TECHNICAL SPECIFICATION OF PV MODULE MOUNTING STRUCTURE**

Parameters	Specifications
Type	Roof Mounted
Configuration	Designed to suit site requirements
Material	Mild Steel, hot dipped galvanized, 120micron thickness
Tilt angle	Suitable to site
Fasteners	SS 304
Design Wind Speed	120 ph

### PVC CU. CABLES

Sizes of cables between array interconnections, array to junction boxes, junction boxes to Inverter etc. shall be so selected to keep the voltage drop (power loss) of the entire power plant to the minimum. Cables are flexible and are used with annealed electrolytic grade copper conductors. They are suitable for outdoor and for 1000VDC application

### TECHNICAL SPECIFICATION OF PV CABLES

Parameters	Specifications
Type	PVC insulated and Sheathed
Material	Copper
Working voltage	Up to 1100 V
Test voltage	1.1Kv
Color	To suit Red, Black, Blue
Temperature	-15 Deg C to +70 Deg C

### SOLAR ON- GRID INVERTER

The PCU consists of in-built charge controller and bi-directional inverter to supply continuous power to the dedicated load with support to the load coming either from the solar array, battery bank, Grid Power in order of preference. The Grid-Tie of required rating of KWp as per GRIHA-4 star rating requirement is considered for this project. The sine wave inverter generates a sinusoidal AC voltage with an exceptionally precise voltage and stabilized frequency. The inverter is protected against overload and short circuit.

### JUNCTION BOX

In the Junction boxes, individual module strings are bundled and safely routed to the inverter. It is a combination of an exact, well-organized string monitoring system and a safety concept adapted to the PV technology.

These junction boxes are weather proof outdoor suitable and are IP 65 rated, making it ideal for long-term use in PV systems. In addition, the direct connection between the strings and the spring clamp connectors ensures a durable and safe installation.

## **EARTHING PROTECTION**

**Earthing:** The array structure of the PV yard will be grounded properly using adequate number of earthing kits. All metal casing / shielding of the plant shall be thoroughly grounded to ensure safety of the power plant.

**Lightning:** The SPV Power Plant shall be provided with lightning & over voltage protection. The main aim in this protection shall be to reduce the over voltage to a tolerable value before it reaches the PV or other sub system components. The source of over voltage can be lightning, atmosphere disturbances etc. Metal Oxide visitors shall be provided inside the Array Junction Boxes. In addition suitable MOV's also shall be provided in the Inverter to protect the inverter from over voltage.



**SUB HEAD – 19****LIGHTING FIXTURES****FOLLOWING TECHNICAL PARAMETERS SHALL BE FOLLOWED IN SELECTION OF LIGHT FIXTURES:**

1. Efficacy of the fixture must be minimum 100 lumen/Watt.
2. Service Life of the fixture including driver/control gear should be minimum 50,000 burning hours.
3. The CRI of the fixture should be minimum 80 for indoor applications and 70 for outdoor applications.
4. The THD should be less than 10%.
5. The housing of the indoor fixtures should be extruded aluminium.
6. For outdoor fixtures the housing shall be of high pressure die cast aluminium.
7. The IP category should be IP20 or higher for indoor applications and IP65 or higher for outdoor applications.
8. The Surge Protection to be provided conforming to relevant IS standards/IEC 61643-II Class-2 & EN 61643-II Type-2.
9. The manufacturer's name/logo should be engraved/ embossed on the housing/body or Name/Logo on aluminium plate labels or Name/logo printed on housing/body.
10. The warranty period on complete luminaire including driver/control gear, LED, all accessories should be 5 years from the actual date of completion of work.
11. The Power factor should be 0.95 or higher.
12. The total power consumption of the fitting should not be more than 110% of rated capacity of LED light.
13. The light fixtures/driver shall be BIS certified as per latest Government norms.
14. Before execution, the contractor should get light level calculations from the supplier after selection of fixtures.
15. The light fixtures shall be selected as per Reflected Ceiling Plan.

**SYSTEM HARDWARE****GENERAL**

All equipment and materials for permanent installation shall be the products of recognized manufacturers and shall be new. The Bidder shall supply the latest made available at the time of bidding of each piece of equipment. If a newer version becomes available within thirty (30) days of the issuance of a purchase order by Engineer-in-charge or if a new technology becomes available that offers an alternative to selected equipment or software, the Bidder shall offer to substitute such new equipment or software for selected equipment and software. The Engineer-in-charge shall decide whether or not such substitutions are appropriate and prices shall be adjusted to reflect increases or decreases in cost to Engineer-in-charge. The cost of any changes to infrastructure cabling or physical plant design due to such changes will be included in the cost revision presented to the Engineer-in-charge acceptance.

**Lux Levels**

Lux levels to be followed as per NBC - 2016. The following are some basic Lux Levels:.

S.N.	Area	Recommended Lamp	Lux Level.
1	Offices	LED	300 – 500
2	Waiting Areas	LED	200-300
3	Basement	LED	50-100
4	Service Area	LED	200 – 300
5	Staircases	LED	100-150
6	Toilets	LED	1 50-200
7	Corridors	LED	1 50-250
8	External	LED	10-30-50

**INSTALLATION:**

The light fixtures and fittings shall be assembled and installed in position complete and ready for service, in accordance with details, drawings, manufacturer's instructions and to the satisfaction of the Construction manager /Consultants. Pendent fixtures specified with overall stem lengths are subject to change and shall be checked with conditions on the job and installed as directed. All suspended fixtures shall be mounted rigid and fixed in position in accordance with drawings, instructions and to the approval of the Construction manager/Consultants. Fixtures shall be suspended true to alignment, plumb level and capable of resisting all lateral and vertical force and shall be fixed as required.

All suspended light fixtures, fans etc, shall be provided with concealed suspension arrangement in the concrete slab/roof members. It is the duty of the Contractor to make these provisions at the appropriate stage of construction. Exhaust fans shall be fixed at location shown on drawings. They shall be wired to a plug socket outlet at a convenient location near the fan. All switch and outlet boxes, for fans and light fittings shall be bonded to earth. The recessed type fixtures shall not be supported into the false ceiling frame work. This shall have independent support from the socket of ceiling using conduit down rods/steel chain with provision for adjusting the level of fitting. Wires shall be connected to all fixtures through connector blocks. Wires brought out from junction boxes shall be encased in flexible pipes for connecting to fixtures concealed in suspended ceiling. The flexible pipes shall be check-nuted to the junction box with a brass bush. Double check-nut at the fixture and flexible pipes, wherever used shall be of make and quality approved by the Construction manager/Consultants

**SUB HEAD – 20****INTEGRATED BUILDING MANAGEMENT SYSTEM****GENERAL**

## DESCRIPTION

The scope of works for all integrated building Management and security systems comprises engineering, supply, delivery, installation, testing and commissioning, handover, training, maintenance and warranty all as described or reasonably implied in the Contract. The Contractor is obliged to provide fully functioning works and systems in conformance with the requirements of the Contract. In the event certain items are not fully described or indicated in the Contract, but deemed essential by the Engineer (in all reasonableness) for the performance of the works and systems then the provision of such items shall form part of the Contractors scope of works at no additional cost to the Employer.

The Contractor shall be responsible to co-ordinate the equipment and services and shall produce properly coordinated shop drawings to demonstrate the installation comply with the performance requirement with shop drawing, calculations and details.

Shop drawings shall take into account actual measurement and setting out dimensions/levels obtained and determined by the Contractor on site, actual equipment/material used, actual routing of services, co-ordination with all installation, and site conditions/constraints.

## SCOPE OF WORKS FOR BMS INSTALLATION

The Building Management installation shall generally include the following:

A completely dedicated Building Management Systems (BMS) and associated automatic control and monitoring works of the following systems:

Complete operational control and monitoring of chilled water distribution system including chillers, primary and secondary pumps, variable speed drive, pressurization unit, and associated accessories units including modulation of valves serving air handling units, fan coil as per the requirement.

All operational control and monitoring of mechanical ventilation and pressurization systems including fans, ductwork, and associated accessories serving the toilets, plant rooms, staircases, service/fire lift lobbies, and other areas that are not air-conditioned.

Complete operational control and monitoring of mechanical ventilation for car park area (including carbon monoxide detection system) and smoke control system. (WHERE EVER APPLICABLE).

All associated water treatment works (If specified).

All associated electrical works, like light management, D.G set operation, metering, etc.

All associated operations and controls of the fire protection system as specified.

All associated interfacing works with other trades including electrical, fire protection, plumbing and sanitary, gas supply and detection, etc.

The complete operation and control of security systems such access control, Car Park Management, etc. as specified in the subsequent sections and schedule of equipment.

Other works as shown on the Drawings and described in the Contract documents.

## **QUALITY ASSURANCE**

Comply with the current applicable codes, ordinances, and regulations of the authority or authorities having jurisdiction, the rules, regulations and requirements of the utility companies/ authorities serving the project and the Engineer-in-charge's insurance underwriter.

Drawings, specifications, codes and standards are minimum requirements. Where requirements differ, the more stringent apply.

The Engineer reserves the right to inspect and reject any part of the Works not complying. The Contractor shall replace such rejected works without cost variation and delay to the Contract.

Approval or acceptance by the Engineer-in-charge shall not relieve the Contractor of his responsibilities under the Contract for the quality of materials and the standard of workmanship in the Works.

No work shall be covered up or put out of view without the agreement of the Engineer-in-charge. The Contractor shall provide/allow the Engineer-in-charge full opportunity for the examination and measurement of any work which is about to be covered or put out of view. Upon request by the Engineer-in-charge, the Contractor shall expose their Works and allow/provide access him to inspect any part of the Works during the course of the manufacturing or site installation/erection.

When requested by the Engineer-in-charge, the Contractor shall submit evidence including written certificates and full testing reports from approved/recognized testing organization certifying that his proposed equipment or material has been tested and conform with the specified standard.

## **ABBREVIATIONS AND DEFINITIONS**

### **A. Abbreviations:**

1. ADA American with Disabilities Acts
2. ACMV Air Conducting and Mechanical Ventilation
3. AMCA Air Moving and Conditioning Association (USA)
4. ANSI American National Standards Institute
5. ARI American Refrigeration Institute
6. ASHRAE American Society of Heating, Refrigerating and Air-conditioning Engineers (USA)
7. ASME American Society of Mechanical Engineers (USA)
8. ASTA Association of Short-circuit Testing Authorities

- |     |        |  |
|-----|--------|--|
| 9.  | ASTM   | American Society for Testing and Materials (USA)     |
| 10. | BMS    | Building Management System                           |
| 11. | BS/BSS | British Standard or British Standard Specification   |
| 12. | CAD    | Computer Aided Drafting                              |
| 13. | ELV    | Extra Low Voltage                                    |
| 14. | ETL    | Electrical Testing Laboratories                      |
|     |        |  |
| 15. | LPC    | Lost Prevention Council (UK)                         |
|     |        |  |
| 16. | HVCA   | Heating and Ventilation Contractors Association (UK) |
| 17. | ICAO   | International Civil Aviation Organisation            |
| 18. | IEC    | International Electro technical Committee            |
| 19. | IEE    | Institute of Electrical Engineers (UK)               |
| 20. | IEEE   | Institute of Electrical and Electronic Engineers     |
| 21. | IES    | Illuminating Engineering Society                     |
| 22. | IP     | Index of Protection                                  |
| 23. | IPCEA  | International Power Cable Engineers Association      |
| 24. | ISO    | International Standardization Organisation           |
| 25. | ETL    | Electrical Testing Laboratories                      |
| 26. | LPC    | Lost Prevention Council (UK)                         |
|     |        |  |
| 27. | HVCA   | Heating and Ventilation Contractors Association (UK) |
| 28. | ICAO   | International Civil Aviation Organisation            |
| 29. | IEC    | International Electro technical Committee            |
| 30. | IEE    | Institute of Electrical Engineers (UK)               |
| 31. | IEEE   | Institute of Electrical and Electronic Engineers     |
| 32. | IES    | Illuminating Engineering Society                     |

33.	IP	Index of Protection
34.	IPCEA	International Power Cable Engineers Association
35.	ISO	International Standardization Organisation
36.	M & E	Mechanical and Electrical
37.	NC	Noise Criteria
38.	NEC	National Electrical Code
39.	NR	Noise Rating
40.	NEMA	National Electrical Manufacturers' Association (USA)
41.	NFPA	National Fire Protection Association (USA)
42.	SMACNA	Sheet Metal and Air Conditioning contractors National Association Inc. (USA)
43.	SPL	Sound Pressure Level
44.	SPW	Sound Power Level
45.	UL	Underwriters Laboratories Inc.

All other notations and symbols used shall have their internally/normally accepted/used meaning.

### **CLIMATE CONDITIONS**

The Contractor shall warrant that all materials and equipment are suitable for continuous use and operation in the climatic conditions encountered on site.

All equipment and materials shall be suitable for use in the peculiar local climate and operating conditions. All equipment/system shall be suitable for operation with outdoor dry bulb temperature of at least up to 50°C and relative humidity of up to 100%.

### **Project Location: Jaipur (Rajasthan)**

#### **SYSTEM DESIGN:**

It is proposed to install a comprehensive integrated Microprocessor based “Distributed Digital Control” and “Building Management System (BMS)”.

The BMS shall use series of Dedicated and multilevel controllers located in different parts of the building to perform their following functions:

Control and Monitor the High side HVAC equipment's.

Control and Monitor Toilet Ventilation Blowers.

Control and Monitor all water services.

Monitor the Fire Pumps.

Control and Monitor Fire Doors etc.

It shall also be used to monitor the major electrical equipment.

The various controllers shall be connected to a PC in a control room. The PC shall have software dynamic graphics to display the status of various services, beside capacity to write programmer logics and loading them to the sub-controller.

## **SYSTEM INTEGRATION**

All the above systems shall be integrated together on a common Bus duct, so as to display data on a single monitor of the Master PC.

The data of other Services shall be used by the BMS to take necessary corrective steps to reduce danger to the occupants and buildings. Some of these are:

Display the zone having fire.

Opening up the Magnetic locks on Fire escape doors.

Display phone numbers of the Fire department, Building in charge etc.

Monitoring the starting of Fire Pumps and raising alarm for non-functioning.

## **PRODUCTS**

### **EQUIPMENT AND MATERIALS**

Provide products and materials that are new, clean, free of defects, and free of damage and corrosion.

Products and materials shall not contain asbestos, PCB, or any other material which is considered hazardous by the authority having jurisdiction.

Replace materials of less than specified quality and relocate work incorrectly installed as directed by the Engineer-in-charge.

Provide name/data plates on major components of equipment with manufacturer's name. Model number, serial number, capacity data and electrical characteristics attached in a conspicuous place.

Install materials and equipment with qualified trade people.

Maintain uniformity of manufacturer for equipment used in similar application and sizes.

Follow manufacturer's instructions for installing, connecting, and adjusting equipment. Provide a copy of such instructions at the equipment during installation.

Equipment capacities, ratings, etc, are scheduled or specified for job site operating conditions. Equipment sensitive to altitude shall be de-rated with the method of de-rating identified on the submittals.

Energy consuming equipment shall meet local energy ordinances and by-laws.

### **EQUIPMENT INSTALLED AT OUTDOOR LOCATION**

For equipment and services intended to be installed at outdoor locations or exposed to external weather conditions, the Contractor shall ensure that these equipment and services are properly protected by weatherproof external casing or cladding. All associated motors, terminal, and electrical components shall be weatherproof type and suitable for outdoor installation, IP 55 or greater. Weather protection shield shall also be provided for all moving parts of the equipment and associated accessories external to the weatherproof equipment casing.

All external equipment included sensors, etc used for BMS and security purpose, etc. shall be specially graded against corrosive environment.

This outdoor weatherproof requirement shall also apply to services installed in close proximity of external openings and louvres.

### **PANEL AT EXPOSED LOCATIONS**

For all Mechanical and Electrical panels or controllers outside plant rooms and at exposed locations such as car park, services area, public space, etc. shall be provided with a lockable front door with viewing glass panel.

### **EQUIPMENT SELECTION**

The capacities of all plant and equipment described in the Contract are minimum capacities and the Contractor shall take into account of the offered equipment capacities to meet the performance requirement in the Contract and actual installation requirements as specified in the subsequent sections.

Physical sizes of all BMS Room and equipment shall suit the space allocated, taking into account the requirement for access and proper maintenance.

Any proposal to deviate from the Specification and Drawings is subject to the Engineer-in-charge's approval at his sole discretion. Upon approval, any necessary changes to the engineering and installation as a result of these deviations shall be the responsibility of the Contractor.

Proposed equipment technical detail shall be submitted for approval by the Engineer-in-charge before ordering is placed. All necessary information requested by the Engineer-in-charge for the review of the proposal shall be submitted.

### **EXECUTION**

### **COORDINATION OF WORK**



Contract documents establish scope, materials and quality but are not detailed installation instruction.

Coordinate work with related trades and furnish, in writing, any information necessary to permit the work of related trades to be installed satisfactorily and with the least possible conflict or delay.

The drawings show the general arrangement of equipment and appurtenances. Follow these drawings as closely as the actual construction and the work of other divisions will permit. Provide off-sets, fittings, and accessories which may be required but not shown on the drawings. Investigate the site, and review drawings of other divisions to determine conditions affecting the work, and provide such work and accessories as may be required to accommodate such conditions.

The locations of thermostats, switches, panels and other equipment indicated on the drawings are approximately correct. Exercise particular caution with reference to the location of panels, thermostats, switches, etc., and have the precise and definite locations accepted by the Engineer-in-charge before proceeding with the installation.

The drawings show only the schematic drawings of services and approximate location of equipment, outlets, panels, etc. Any significant changes in location of equipment, outlets, panels, etc., necessary in order to meet field conditions shall be brought to the determine attention of the Engineer-in-charge for review before such alterations are made. Modifications shall be made at no additional cost to the Contract.

Carefully check space requirements with other division works to ensure that equipment can be installed in the space allotted.

Wherever work interconnects with work amongst different installation, coordinate with other trades to insure that they have the information necessary so that the Contractor may properly install the necessary connections and equipment. Identify items requiring access in order that the Ceiling Trade will know where to install access doors and panels.

Consult amongst installation so that, wherever possible, motor controls and distribution equipment are of the same manufacturer.

Furnish and set sleeves for passage of risers through structural masonry and concrete walls and floors and elsewhere as required for the proper protection of each riser passing through building surfaces.

Provide required supports and hangers for equipment suitably so as not to exceed allowable loading of structures.

Wherever the work is of sufficient complexity, prepare additional detail drawings to scale to coordinate the work with the work of other trades. Detailed work shall be clearly identified on the drawings as to the area to which it applies. Submit these drawings to the Engineer-in-charge for review. At completion include a set of these drawings with each set of record drawings.

Coordinate with the local utility companies/authorities for their requirements for service connections and provide all necessary provisions, grounding, materials, equipment, labor, testing, and appurtenances.

Before commencing works, examine adjoining works on which this work is in any way affected and report conditions which prevent performance of the works. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.

The Contractor is responsible to any modifications required due to service not properly coordinated.

### **EXAMINATION OF SITE**

Prior to the submitting of bids, visit the project site and become familiar with all conditions affecting the proposed installation and make provisions as to the cost thereof.

The Contract Documents do not make representations regarding the character or extent of the sub-soils, water levels, existing structural, mechanical and electrical installations, above or below ground, or other sub-surface conditions which may be encountered during the work, based on examination of the site or other information. Failure to examine the drawings or other information does not relieve the Contractor of responsibility for satisfactory completion of the work.

### **CUTTING AND PATCHING**

Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finish plaster, woodwork, metalwork, etc., using skilled trade people of the trades required at no additional cost to the Contract.

Provide prior information with marking to the sub - contractor for the required slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required.

### **MOUNTING HEIGHTS**

Verify exact locations and mounting heights with the Engineer-in-charge before installation.

### **SUPPORTS**

Support work in accordance with the best industry practice. Provide supports, hangers, auxiliary structural members and supplemental hardware required for support of the work.

Provide supporting frames or racks extending from floor slab to ceiling slab for work indicated as being supported from walls where the walls are incapable of supporting the weight. In particular, provide such frames or racks in electric closets and equipment room.

Provide supporting frames or racks for equipment which is installed in a free standing position.

Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members, rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workmanlike arrangement of all equipment mounted on them.

Adequate support of equipment (including outlet, pull and junction boxes and fittings) shall not depend on ducts, pipe, electric conduits, raceways, or cables for support.

Equipment shall not rest on or depend for support on suspended ceiling media (tiles, lath, plaster, as well as splines, runners, bars and the like in the plane of the ceiling). Provide independent support of equipment.

Provide required supports and hangers for equipment so that loading will not exceed allowable loading of structure. Equipment and supports shall not come in contact with work of other trades.

### **FASTENINGS**

Fasten equipment to building in accordance with the best industry practice.

Where weight applied to the attachment points is 45 kg or less, conform to the following as a minimum:

1. Concrete and solid masonry : Bolts and expansion shields
2. Solid metal : Machine screws in tapped holes or with welded studs

Where weight applied to the building attachment points exceeds 45 kg, but is 135 kg or less, conform to the following as a minimum:

At concrete slabs provide 60 cm x 60 cm x 13 cm steel fishplates on top with through bolts. Fishplate assemblies shall be chased in and grouted flush with the top slabs screed line, where no fill is to be applied.

At steel decking or sub-floor for all fastenings, provide through bolts and threaded rods. The tops of bolts and rods shall be set at least one inch below the top fill screed line and grouted in. Suitable washers shall be used under bolt heads or nuts. In cases where the decking or sub-floor manufacturer produces specialty hangers to work with his decking or sub-floor such hangers shall be provided.

Where weight applied to building attachment points exceeds 135 kg, coordinate with and obtain the approval of Engineer-in-charge and conform to the following as a minimum:

Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall suitably have welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.

For items which are shown as being ceiling mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.

Wall mounted equipment may be directly secured to wall by means of steel bolts. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars.

## **IDENTIFICATION**

Identify equipment with permanently attached black phenolic nameplates with 13 mm high white engraved lettering. Identification shall include equipment name or load served as appropriate. Nameplates shall be attached with cadmium plated screws; peel and stick tape or glue on type nameplates are unacceptable.

Services runs shall be properly identified as per the requirements in the Contract.

See individual section for additional identification requirements.

## **PROHIBITED LABELS AND IDENTIFICATIONS**

In all public areas, tenant areas, and similar locations within the project, the inclusion or installation of any equipment or assembly which bears on any surface any name, trademark, or other insignia which is intended to identify the manufacturer, the vendor, or other source(s) from which such object has been obtained, is prohibited.

Required test lab certification labels shall not be removed nor shall identification specifically required under the various technical sections of the Specifications be removed.

## **EQUIPMENT PADS AND ANCHOR BOLTS**

Provide concrete pads under all floor mounted electrical equipment. Equipment pads shall conform to the shape of the piece of equipment it serves with a minimum 25 mm margin around the equipment 28 day, 175 kgs/square cm concrete reinforced with 15 cm x 15 cm welded wire mesh. Trowel tops and sides of pad to smooth finishes, equal to those of the floors, with all external corners bull nose to a 20 mm radius. Shop drawings stamped UNALTERED shall be used for dimensional guidance in sizing pads.

Provide galvanized anchor bolts for all equipment placed on concrete equipment pads, inertia blocks, or on concrete slabs. Provide bolts of the size and number recommended by the manufacturer of the equipment and locate by means of suitable templates. Equipment installed on vibration isolators shall be secured to the isolator. Secure the isolator to the floor, pad, or support as recommended by the vibration isolation manufacturer.

Where equipment is mounted on gypsum board partitions, the mounting screws shall pass through the gypsum board and securely attach to the partition studs. As an attached to 15 cm square, galvanized metal back plates which are attached to the gypsum board with an approved non-flammable adhesive. Toggle bolts installed in gypsum board partitions are not acceptable.

## **DELIVERY, DRYAGE AND HAULING**

Provide drayage, hauling, hoisting, shoring and placement in the building of equipment specified and be responsible for the timely delivery and installation of equipment as required by the construction schedule. If any item of equipment is received prior to the time it is required, the Contractor shall be responsible for its proper storage and protection until the time it is required. Pay for all costs of demurrage or storage.

If equipment is not delivered or installed at the project site in a timely manner as required by the project construction schedule, the Contractor shall be responsible for resulting disassembly, re-assembly, manufacturer's supervision, shoring, general construction modification, delays, overtime cost, etc., at no additional cost to the Contract.

## **TESTING OF SYSTEMS**

Comply with the project construction schedule for the date of final performance and acceptance testing, and complete work sufficiently in advance of the Contract completion date to permit the execution of the testing prior to occupancy and Contract closeout. Complete any adjustments and/or alterations which the final acceptance tests indicate as necessary for the proper functioning of all equipment prior to the completion date.

Provide a detailed schedule of completion indicating when each system is to be completed and outlining when field testing will be performed. Submit completion schedule for review within ONE MONTH after the notice to proceed by Engineer-in-charge has been given. Update this schedule periodically as the project progresses.

## **ELECTRICAL POWER SUPPLY INTERFACES**

The Contractor shall provide power supply points/isolators at certain designated locations within the development for all mechanical and electrical installations as indicated on the drawings. It is the responsibility of the Contractor to coordinate and make sure that the connections to these power supply points/isolators and to provide all the necessary 'down-stream' power supply distribution board/network to the mechanical system's control panels, equipment, sensors, field devices, etc.

## **BUILDING MANAGEMENT SYSTEM AND INTERFACES**

The Contractor shall co-ordinate the mechanical system and equipment to interface with the Building Management System in accordance with the point schedules specified on the drawings or DBR and specified in subsequent Sections. All necessary interfacing works shall be included in the Contract.

## **INTEGRATED CONTROL CONSOLE**

The Contractor shall include the supply and installation of a custom-built control console of proprietary make in the Fire Command Centre and each building component's Security Room to integrate all control panels, mimic panels, and central equipment of the following systems:

Building Management system

Security systems

Fire Alarm and Detection system (Where ever specified)

Ventilation Control Panel for all emergency operation fans/systems

Lift system

Escalator system

Fireman Intercom system

Fire Protection Pumps Control Panel

Fireman's Override Control Panel (Where ever specified)

Public Address and Emergency Evacuation Announcement systems (Where ever specified)

All other systems to be housed inside the Fire Command Centre (Where ever specified)

The proposed manufacturer detail of the Integrated Control Console shall be submitted to the Engineer-in-charge for approval before manufacturing commences. All necessary interfacing works with other mechanical and electrical systems shall be included.

### **SPARE PARTS AND TOOLS**

The tenderer is obliged to provide, with his tender, a written guarantee that the spare parts for the Works or other equal and approved spare parts will be available for a period of fifteen (15) years beyond the issue date of Taking Over Certificate for the Works (At the extra Cost and if specified). Failure to provide the guarantee may, at the sole discretion of the Employer, result in the Tender being rejected.

The Contractor to submit with his Tender his recommended lists of spares parts for FIVE years' operation and maintenance covering all systems and sub-systems of the specification. This list should be priced and the price fixed so that the Employer can, at his discretion, order these spare parts in part or in whole at any time up to the issue of the Performance Certificate without any increase in price.

The Contractor is obliged to provide and store spare parts in India-Delhi to cover his obligations during the Defects Notification Period.

The Contractor shall also include in the Contract to procure and hand-over the following required quantity of spare parts. The spare parts shall be new and similar to the equipment/material being installed.

### **SAMPLES**

Installation techniques, quality and workmanship of component parts, compatibility of accessories shall be submitted for approval, upon request by the Engineer-in-charge.

## **WARRANTIES**

The Contractor shall warrant that the capacity, rating or duty of all equipment used in the installation shall not be less than the performance specified on the Drawing or in the Specification when operating under the specified conditions and in accordance with the equipment manufacturer's instructions. Any equipment/system not meeting this requirement shall be rejected.

## **PROTECTION OF MATERIALS, PERSONNEL AND PROPERTY**

All material and goods shall be delivered to the site in new condition, properly packed and protected against damage due to handling, adverse weather or other circumstances, and be kept in packing case or under protective covering until required for use.

Any items suffering damage in transit or on site shall be rejected and replaced without extra cost and time to the Contract.

In the case of equipment and materials which originate from other countries and/or different climatic conditions, all such equipment and material shall be adequately and securely packed for safe transportation with due regard to the climatic conditions encountered in transit and arrival.

The Contractor shall be entirely responsible for all apparatus, equipment and materials furnished by him in connection with his works, and special care shall be taken to protect all parts thereof in such a manner as may be necessary or as directed.

Protection shall include covers, crating, sheds, stores or other means to protect the apparatus, equipment and materials from the weather, water damage, corrosion and to prevent dirt, grit, plaster or other foreign substances from entering the working parts of machinery or equipment. Special care shall be taken to keep all opening of pipes, ducts, etc. closed while in storage or during the course of delivery and erection/installation.

The Contractor shall take precautions to avoid unnecessary damage among the IBMS installation.

All precautions shall be taken for the safety of personnel on site. The Contractor shall also conform with the general regulations governing personnel on the site and must keep to the working space allocated for their use.

## **INTERFACING WITH ALL SERVICES AND SYSTEMS**

### **General**

The Contractor shall coordinate with the other services contractor and ensure that all necessary provisions for interfacing amongst installation, services, and equipment has been provided. All necessary sensors, current/voltage transformers, voltage-free contacts, relays, auxiliary contacts, terminals, transducers, etc. for interfacing works shall be provided by the Contractor.

All control/monitoring wiring from sensors, equipment, and components for the interfacing shall be terminated at a separate interfacing compartment located at the respective equipment/system's switchboard or control panel. The interfacing compartment shall be completed with all necessary

connectors, terminals, and with proper identifications to allow interfacing works to be easily carried out. The compartment shall clearly indicate “Extra Low Voltage Cable Only. No Power Cable Connection”. Where there is no equipment/system switchboard or control panel involved, the Contractor shall provide separate interfacing panels with provisions same as the interfacing compartment as described above. The locations of the switchboard/control panels and the interfacing panels shall be properly coordinated.

For every control panel and each module of the switchboard, at least five (5) spare terminals shall be provided for future interfacing works.

Wiring and cables for interfacing with the fire alarm system and other fire protection and life safety systems shall be fire rated to comply with fire regulations.

Unless otherwise specified or shown on the Drawings, interfacing wiring from Fire Alarm and Building Management/Automation systems shall be provided and terminated at the terminals of the interfacing compartments or panels by the Fire Alarm System and Building Management/Automation System installation respectively. The Contractor shall co-ordinate the current and voltage requirements for the interfacing works/provisions. The type of provisions for interfacing signals shall be as follows, unless otherwise specified:

Digital inputs and outputs	voltage-free dry contact
Analog inputs and outputs	4 – 20 mA or 0 – 10 mV

All the interface provisions shall be DC operated and rated not more than 50 mA.

For interfacing works between Fire Alarm System and Building Management/Automation System, the Contractor shall provide the Fire alarm installation with interface wiring and terminate them at the Building Management/Automation System’s interfacing compartments or panels.

The Contractor shall provide and make all power cable connections from mechanical equipment, local control panels, and distribution boards to the electrical isolators or power points (including cable termination) provided under Division 16 works. Location of power supply isolators and power points shall be properly coordinated.

In addition to the interfacing requirements shown on the Drawings, interfacing provisions as described below shall also be provided and included in the Contract.

### **Electrical Installation:**

The contractor shall ensure that the following point has been followed:

- The Electrical Installation shall provide the following:
  - Isolators and power points (fused spur units) for all mechanical equipment and systems. Where shown on the Drawings, the Electrical installation shall include direct power cable connections to the mechanical system’s main motor control centers.



- Earthing terminal in the Fire Command Centre and all other plant rooms for supplementary equipotential bonding of mechanical equipment and systems.
- Power failure signal to the Lift System (including wiring terminations into the Lift interfacing panel in the Lift Motor Room), Fire Alarm System and the Building Management/Automation System.
- Electrical bonding of all roof equipment and external metal cladding including provisions and connection of bonding cables.
- Fuel main storage tank and day tank High/Low level alarm signals to the Building Management/Automation System.
- Emergency power supplies to Building Management/Automation System (including all field panels), Fire Alarm System, car parking system, and all security systems.
- Emergency power supplies to all fire shutters, smoke shutters/curtains, and automatic doors.

ACMV Installation: The contractor shall also provide the automatic control of the following:

The ACMV Installation shall provide the following:

Smoke signal from the air-handling unit return air smoke detector to the Fire Alarm System.

On/Off control and status indications at the Fire Command Centre's including switches and indication lights for the following equipment and systems:

Entire smoke extraction system including individual fans (and associated motorized dampers), smoke shutters/curtains, smoke damper, etc

Staircase pressurization fans

Smoke Lobby ventilation fans

Basement car park ventilation fans

All automatic fire/smoke dampers

Other emergency fans for fire and life safety operations

High level interface between the chiller control panels and the Building Management/Automation system.

Shut down control of air-handling units by the Fire Alarm System on floor-by-floor basis.

High/Low level signals to the Building Management/Automation System for all water tanks including feed and expansion tanks.

**Fire Alarm Installation:**

The contractor shall also provide the automatic control of the following:

The Fire Alarm Installation shall provide the following:

All control and monitoring modules for interfacing with all other mechanical and electrical systems.

Control signals and modules for all fire shutters, smoke shutters/curtains, automatic doors and all emergency ventilation systems.

High level interface with the Building Management/Automation system

Signal to the Lift Motor Room for lift homing operation.

Signal to all electronic security systems.

Signal to shut down air-handling units on floor-by-floor basis and all gas supply systems.

Building Management/Automation System (BMS) Installation:

The BMS Installation shall provide the following:

All control and monitoring modules for interfacing with other mechanical and electrical systems (with the exception of those for interfacing with the Fire Alarm System).

High level interface with the Fire Alarm System and the chiller control panels.

## **PAINTING**

All equipment, enclosures, housings, air ducts, piping, trunking, cable trays, conduits, etc. which are exposed to view (including those in plant rooms) shall be provided with colour paint finishes.

Generally, all metal surfaces requiring painting shall be provided with two (2) coats of asphalt aluminum paint, primer coated, and two (2) coats of finished paint.

No painting shall be done on damp surfaces.

The Contractor shall submit colour scheme for the entire Works for co-ordination and submission for approval by the Engineer-in-charge.

Painting requirements as stated in codes and regulations or generally required by local authorities shall also be provided.

## **SAFETY EQUIPMENT AND NOTICES**

The Contractor shall supply and install the following safety equipment and notices for each switchboard/control panel in the respective switch rooms and BMS rooms: -

Solid rubber insulated mats complying with relevant IS standard in front of and extending the full length of the control panel/switchboards.

Copies of all statutory safety notices, regulations and instructions for resuscitation and treatment after electrical shock.

Danger signs on the switchboards/control panels and elsewhere to the requirements of the Power Supply Authority.

A copy of the main single line diagram, varnished and mounted on suitable hard backing and framed (in glass panel), showing clearly the full details of the electrical and mechanical systems as supplied and installed.

Any other Notices as required by all local Authorities.

### **QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)**

The Contractor, prior to the commencement of the Works, shall submit for the Engineer-in-charge's approval comprehensive QA/QC programme for the installation which shall include, but not be limited to the following: -

QA/QC programme of the manufacturing process of equipment;

Method statement of all site erection/installation works;

Method of protection for material/equipment during delivery, and stored on and off the site; and

Testing and commissioning programmes, procedures, etc.

The QA/QC programme and procedures shall generally be in conformance with the guidelines of ISO 9000.

All equipment, material and items incorporated in the Works under this Contract are to be new and of top class quality.

Equipment/material of non-reputable make may not be accepted solely at the discretion of the Engineer-in-charge.

The use of electrically dissimilar metals in contact with each other shall be avoided. If this is not possible, the contact surfaces of the two (2) metals shall be insulated from each other by an approved method.

All work under this Contract shall be performed in a skillful and workmanlike manner and in accordance with best workshop practice.

All components shall be easily accessible for maintenance/replacement.

All instrumentation and equipment required for inspection, testing and commissioning shall be calibrated and maintained by the Contractor. The Contractor shall submit all valid calibration records from manufacturer and/or recognised laboratories and testing authorities before the use of such instrumentation and equipment.

**PROGRESSIVE RECORD/AS-BUILT DRAWINGS**

During the course of the Contract, the Contractor shall keep progressive record drawings of all installation works.

As-built drawings shall be developed and produced during the course of the installation and, when requested by the Engineer-in-charge, for substantiating of monthly progress claims.

As-built drawings shall be submitted prior to the issue of Taking Over Certificate by the Engineer-in-charge.

As-fitted schematic system diagrams, properly framed, shall also be provided and mounted on the wall inside each plant room.

Submission of approved “as-built” or “as manufactured” drawings shall be in the following manner:

One (1) set of special quality plastic film transparency for all drawings;

Two (2) sets of computer soft copy in CD ROM;

Five (5) bound sets of paper prints for all drawings; and

Additional set of as-built drawings in addition to the above as specified in the Contract Preliminaries and reasonably requested by the Engineer-in-charge shall also be provided.

**AS-BUILT DRAWINGS SUBMISSIONS**

As-built drawings shall be provided as required by the Engineer-in-charge.

The Contractor shall ensure that the submissions are made properly and in a timely fashion and will not delay the inspections and testings by the authorities. All as-built drawings shall be produced based on the latest architectural plans.

**TESTING AND COMMISSIONING**

The Contractor shall be responsible for obtaining all necessary licenses where ever necessary and as required by all relevant authorities before operation of any equipment/system.

All testing and commissioning to enable proper operation of the Works shall be completed to the satisfaction of the Engineer-in-charge in accordance with the construction programme or before the issuance of Taking Over Certificate, whichever is earlier.

All final adjustments and final balancing of the equipment/system operation shall be completed before the Date of Taking Over Certificate.

The complete testing and commissioning are deemed to be concluded successfully only when the installation operated properly within the specified limits of its rating continuously without failure of any kind.

The Contractor shall establish the dates by which permanent utilities shall be available for testing and commissioning of equipment and take this into account in his programme, or make suitable arrangements to test and commission with temporary power based on programme.

The Contractor shall arrange for all submissions to Authorities and pay the cost of statutory inspections and certificates.

### **ATTENDANCE TO OCCUPATION PERMIT APPLICATION**

The Contractor shall provide the complete organisational structure involved during the job completion stage and also all necessary daily attendance to inspections by the Engineer-in-charge and authorities during any stage of work, whenever asked.

### **OPERATION AND MAINTENANCE INSTRUCTIONS MANUAL**

The Operation and Maintenance Instruction manual shall be in A4 size paper and be bound in rigid covers covered and engraved with lettering giving the Employer's name, project name, Engineer-in-charge's name.

Final draft manuals must be submitted for the Engineer-in-charge's review before Taking Over Certificate is issued. After acceptance, the Contractor shall submit five (5) sets and a soft copy of this manual for record before Taking Over certificate is issued.

In general, each manual shall consist, but not be limited to the following section:

#### **General**

This section shall include the purpose of the manual and brief description of the manual directory.

#### **System Description**

This section shall include the following as a minimum: -

Description of the overall system.

General operation of plant, starting up and shutting down procedures, location of each equipment, normal and emergency operation of systems/equipment, control settings and tolerances.

Normal sequence of equipment and plant operation and alternative sequence to maintain operation of part of the total facilities during abnormal circumstances.

Time scheduling of the operation of various equipment operation as per program and interfacing with each other if required.

#### **Technical Specification**

This section shall include the technical descriptions and functions of all equipment and components and shall generally include:

Schedules of equipment showing quantities, locations, types, operating duties.

Technical description of all systems and equipment, including circuit diagrams of each printed circuit board and component layout diagram for each printed circuit board installed for this project.

**Wiring diagrams.**

**Manufacturer's drawings.**

Equipment list, stating the make, model, serial number, accepted settings (after commissioning).

Catalogues, certificates and performance data sheets for all equipment.

**Maintenance**

This section shall include the required operating and maintenance procedures of all the equipment. This shall include the following as a minimum: -

Inspection manual for all system/equipment;

Operation manual for all system/equipment;

Procedure of changing components of equipment requiring regular replacement;

Maintenance instructions, calibration procedures and fault finding instructions for all systems;

Precautions when carrying out operation and maintenance procedures;

Storage and inventory systems; and

Procedures for system fault finding.

**Safety**

This section shall include the following as a minimum: -

Proper procedure of equipment operation;

General description of plant hazards, where ever appropriate, including the following: -

Protection against electrical hazards;

Protection against mechanical and physical hazards;

Protection against fire and explosion hazards;

Protection against chemical hazards;

Protection during fuel and chemical handling; and

First aid and accident reporting.

**Directory of Suppliers**

This section shall list the name of suppliers and agents of each type of equipment, materials and accessories. Correspondence address, telephone number, fax number, mobile number, and E-mail address shall be included.

### **List of Spares**

This section shall list all the spares, consumable materials, and maintenance tools that will be maintained and kept to ensure continued satisfactory operation of the equipment and systems.

### **Organisation of Maintenance Team**

This section shall include detailed organisation of the Maintenance team deployed for the Defect Notification Period with names and CV's, of all key staff. Contact telephone or mobile numbers for emergency and/or twenty-four (24) hour call shall also be included.

### **List of As-Built Drawings**

This section shall contain a full list of all "as-built" and "as-manufactured" drawings.

## **TAKING COVER PROCEDURE**

The Contractor shall adhere to the sequence of handover described below:

The Contractor shall submit the arrangement of the commissioning to the satisfaction of the Engineer-in-charge. The Engineer-in-charge reserves the right to reject any person.

The installation shall be 'practically complete' following satisfactory commissioning and the submission of final commissioning data prior to the issuance of Taking Over Certificate by the Engineer-in-charge. It is solely the Contractor's responsibility to ensure that all plant/equipment shall have their respective warranty by the respective equipment/plant supplier directly.

A joint inspection shall be held among the Employer, Engineer-in-charge and Contractor to establish an outstanding works and defects list. All outstanding works/defects, shall be completed within one month from the date when the Taking Over Certificate was issued.

If, at the end of the one month's period from the date of issuing the Taking Over Certificate, any defects/outstanding works mentioned in the list still exist, the Engineer-in-charge is empowered to appoint a body to rectify all defects/outstanding works.

The Contractor shall also refer to other requirements in the relevant clauses of the Contract.

Before the Taking Over Certificate is issued, the following must be completed:

Operation and Maintenance Instructions Manual, test data and "as-built" drawings must be submitted. Computer "soft" copies of these manuals and drawings shall also be submitted.

The Employer or his representative must be fully instructed in the operation of the system. A written acknowledgment from the Employer shall be required.

All tools and spares shall be handed over. A written acknowledgment from the Employer shall be required.

Written confirmation from the Contractor to indicate the installation is completed according to Performance Requirement.

Submit and obtain approval by the Engineer-in-charge. Maintenance schedule for the installation during the Maintenance and Defect Notification Period.

### **AS-NEW CONDITIONS**

At the time of handover of the Works after the Taking Over Certificate, the whole installation shall be in 'as-new' conditions. The Contractor shall, during the course of the Contract, protect all plant and equipment and shall restore/repaint as necessary before handover of the installation.

### **DEFECT NOTIFICATION PERIOD**

Notwithstanding the decennial liability of the Contractor in terms of the Defects Notification Period for IBMS systems shall be 24 months. The period commencing on the date of issue of the Taking Over Certificate. During the Defect Notification Period, the Contractor shall provide a 24-hour 'call-out' service to repair any equipment that has broken down.

Immediately answering the breakdown calls, the Contractor shall attend to such calls within a maximum time limit of 2 hours during night and 1 hour during daytime of receiving such calls.

During the Defect Notification Period, the Contractor shall at his own cost remedy and make good with all faults or defects in the Works, which in the opinion of Engineer-in-charge, is due to faulty materials, workmanship. The Contractor shall indemnify the employer and/or the General Contractor against any damage or injury to the Building contents and/or occupants arising from such faults or defects.

If the Contractor fails to remedy such faults or defects within a reasonable time, the Employer may proceed to do so at the expense of the Contractor and without prejudice to such other rights as the Employer may have under the Contract.

The Contractor shall also refer to other requirements in the relevant clauses of the contract.

### **TUITION/TRAINING**

#### **THE TENDERER SHALL PROVIDE THE FOLLOWING NECESSARY TRAINING.**

The Tenderer shall submit a schedule in the Tender submission list all works and systems for which the Contractor has to provide training. The Schedule should have information include list of recommended training courses within each works/systems, location of the training courses. Trainers details (from the manufacturers premises where applicable), Courses duration, unit rate of the training in per head basis.



The Contractor shall provide sufficient and proper instructions to the trainees nominated by Employer in the commissioning, operation, maintenance, servicing and trouble-shooting of the various plant and systems.

The Contractor shall provide training facilities and training courses and ensure that the trainees nominated by Employer will acquire full knowledge and appreciation of all aspects of the day to day operation, breakdown and routine maintenance, and fault diagnosis of all plant, equipment, and system installed under this Contract. Detailed syllabus and the timing of the training courses shall be submitted.

Trainees nominated by Employer will attend the training courses, and the Contractor shall allow them reasonable access to technical information and documentation required for proper operation and maintenance. The Contractor shall also explain this information and documentation to allow the trainees to become fully conversant with all aspects of the systems.

When training is required to be held in overseas facilities, all necessary costs for airfare, hotel accommodation, local transportation, food, etc. shall be included.

#### **VERMIN PROOFING AND CLEANING**

On completion of the installation, the Contractor shall check and ensure that all cable entries, openings, core holes, etc. are properly sealed with fire rated material and rendered vermin proof and water tight. The floors, trenches and surroundings shall be cleaned, mopped, and left in a clean, dust free state on completion. Building works and paint work of equipment damaged during the installation works shall be made good to the satisfaction of the Engineer-in-charge.

All costs involved in the above shall be deemed to be included in each installation.

#### **POWER SYSTEM HARMONICS**

For the purpose of this provision, “PCC” means the point of common coupling being the terminals of the mechanical equipment power interfacing units at the point where they connect to the electrical distribution system. The Contractor shall demonstrate the installation will be carry out to complying with current international and European Community electrical immunity and emission standards. In order to continue an interference free service to others’ installation, the Contractor must comply with each of the following:

The Contractor shall provide adequate measures including active harmonic filters to limit the total harmonic distortion at the PCC to 5% for voltage and less than 12% for current for all phases, in accordance with the requirements of the Institution of Electrical and Electronic Engineers Standard IEEE 519. The Contractor shall take particular care in the selection of equipment that may produce harmonics including without limitation electronic ballasts, UPS, soft starters and variable speed drives, to ensure that these limits are met at all times.

The Contractor shall ensure that the power factor at the PCC is equal to or better than 0.85 lagging.

#### **ELECTROMAGNETIC COMPATIBILITY (EMC)**

The Contractor shall demonstrate the installation will be carry out in the way to ensuring that all equipment supplied conforms with the requirements of relevant international standards in terms of their electromagnetic compatibility with the environment and with all equipment to be installed in the Project. All equipment used shall comply with the prevailing generic EMC requirements and EMC requirements applicable to general, scientific and industrial equipment specified but not limited to the following standards, or their equivalents:

IEC	–	International Electrotechnical Commission standards
CISPR	–	International Special Committee on Radio Interference Document
EN	–	European Standard
BSI	–	British Standard Institution
VDE	–	Verband Deutscher Electrotechniker

All signal and control cabling installed shall be correctly screened and earth to prevent noise and electric shock. Operation of all equipment shall not be adversely affected by radiated energy from hand held communication equipment.

All equipment that is likely to be touched by personnel and contains sensitive electronic equipment shall be protected against electrostatic discharge.

The Contractor shall ensure that any static or alternating magnetic fields, generated in the environment, do no adversely affect the operation of the equipment.

Bonding shall be provided for all exposed metallic parts of the equipment and connecting them to the earthing network for meeting safety requirements and minimize noise voltage due to potential differences.

Equipment provided by the Contractor shall have minimum radio interference in the frequency range 0.15 MHz to 30 MHz by means of suppression at source.

All equipment supplies, prefabricated and installed shall be, manufactured and installed to fully comply with the European Electromagnetic Compatibility Directive 89/996/EEC, the CE marking directive 93/68/EEC and the United Kingdom's Electromagnetic Compatibility regulations 1992 and 1994 and all subsequent amendments.

All equipment supplied to the site shall be either electromagnetically benign or carry the "EC" mark and be provided with copies of the relevant test certificates.

#### **CONTRACTOR'S OBLIGATIONS FOR THE PRODUCTION OF SHOP DRAWINGS**

The Contractor's obligations for the production of Shop Drawings shall, in addition to other requirements specified elsewhere in the Contract Documents, include the following:

Adjustments and enhancement of services as a result of space co-ordination to provide sufficient installation and maintenance access to facilitate easy future operation and maintenance

Re-routing and re-organization of services to achieve the clear headroom/ceiling height

Adjustments and enhancements to suit the construction works on site but must provide the desired results.

Adjustments and enhancements to suit equipment/systems offered.

Adjustments and enhancements to suit public utility connections.

Adjustments and enhancements to suit existing public utilities locations for avoiding diversions of these existing utilities

Adjustments and enhancements due to coordination and interfacing with other trades (e.g. power supply, water supply, electro-magnetic compatibility, etc.)

Changes required as a result of certain construction sequence and methods

Adjustments and modifications of the installation arrangement to suit the specified phased completion and early hand-over areas.

Adjustments and/or enhancements to correct or clarify any discrepancies in the Contract Documents, Working Drawings, Specification and other performance requirement subject to the approval of the Engineer-in-charge.

The Contractor shall be responsible and liable for the preparation of all Shop Drawings necessary or required under the Specifications and/or for the construction of the Works. The Shop Drawings prepared by the Contractor shall be based on the Contract Document. These Shop Drawings shall be subject to the approval of the Engineer-in-charge.

During the course of the Contract, the Contractor shall produce and commence submission of detailed shop drawings sufficiently early for the Engineer-in-charge's review. These shop drawings shall be submitted progressively in accordance with the construction programme. Clearance or approval of any such drawings shall not relieve the Contractor from any specified performance or material requirements, nor nullify right to reject unsatisfactory works on the site. A minimum period of fifteen (15) days shall generally be allowed for the review of each shop drawing submission by the Engineer-in-charge. The Contractor is deemed to have allowed for this 15-day review period for each submittal in his Construction Schedule.

Installation works carried out by the Contractor before the relevant shop drawings submitted and approved by the Engineer-in-charge are at the Contractor's own risk.

Shop drawings shall show at least the following general categories of information:

- Penetrations through floors, walls, and other structural members;
- Equipment positions and operating weights;
- Entry positions, access routes, weight of equipment or components during delivery to site;

- Services access openings;
- Location, details of concealed/buried conduits, inserts, and pipes;
- Temporary openings in floors/walls;
- Detailed workshop and manufacturing drawings;
- Equipment schedules;
- Electrical wiring and control diagram;
- General layout plans and sections (1:50 scale for plans and 1:20 scale for sections);
- Schematic diagram;
- Support and mounting details;
- Material/Component specifications;
- Setting out dimensions and level; and
- Interfacing details and co-ordination with Architectural, structural and all installation Works.

In preparing the Shop Drawings, the Contractor shall provide all construction-related engineering input and undertake construction co-ordination, inter-facing, cross-checking, sequencing and construction detailing subject to the absolute approval of the Engineer.

Shop drawings shall be constantly updated to reflect modifications and changes agreed/accepted by the Engineer and to reflect changes issued by Engineer's instructions.

Shop drawings produced shall be properly co-ordinated with the works of all installation. Where required for proper co-ordination and to achieve required headroom, the Contractor shall make modification of services layout/routing, etc. and reflect all these on the shop drawings for the Engineer's approval.

The Contractor shall co-ordinate and provides on time the details of builders works required to be incorporated into the construction works. For builder's work information has already been given on the Drawings or the Contract drawings, such information are to be checked by the Contractor to ensure suitability and sufficiency for his works.

Engineer's comments and corrections made on shop drawings shall not relieve the Contractor of his contractual responsibilities to comply with requirements of the Specification and Drawings.

Shop drawings shall be updated progressively to reflect "as-built" conditions.

In preparing the Shop Drawings, the Contractor shall co-ordinate the information in the Contract, engineering the installation and demonstrates the installation adequacy, practicality, suitability, compliance of any statutory requirements and integrity of other information in the Contract

Documents. The Contractor shall not be entitled to any increase whatsoever to the Contract Sum for the Works or any extension of time to complete the Works.

### **BUILDING MANAGEMENT SYSTEM AND INTERFACES**

All necessary interfacing works amongst all installation shall be included in the Contract.

### **SCHEDULE OF ACCEPTABLE MANUFACTURERS FOR MECHANICAL EQUIPMENT**

The attached list schedule indicates the acceptable manufacturer for mechanical and electrical equipment.

The Contractor shall also ensure that the only those makes which can satisfy the specification fully as given in this document shall be entertained. In case out of the below makes, if no makes of any particular equipment can comply the specification, then the contractor shall reserve the right to select any other makes after the prior approval with Engineer-in-charge.

### **TESTING**

#### **SUBMITTAL REQUIREMENTS**

A. Submit the following information to the Engineer:

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 Engineer-in-charge reserves the right to request an independent test and balance Specialist or Agency to be engaged by the 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, Contractor and Owner references with telephone numbers and contact persons.

#### **WORK INCLUDED**

Comply with - General Requirements and all documents referred to therein.

Provide all labour, materials, products, equipment and services to test, adjust and all HVAC and other M&E services systems as specified to verify conformance to specified quantities and to the design intent of the concern services and system.

Provide system report.

## **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 Engineer showing dates and method of calibration.

Verify and match the performance of all permanently installed IBMS devices by calculation and calibration, or by independent measurement of the same flowing medium with calibrated devices.

### **PREPARATION WORK**

Before starting final testing, the Contractor shall make sure that each operation listed below, whichever is applicable, has been satisfactorily completed.

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 has already been performed.

Coordinate and 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 and effectively balancing and for efficient system and equipment operation.

Examine terminal units such as AHU's, FCU's, VAV's, etc to verify they are accessible and their controls are connected and functioning.

Examine control valves for proper installation and for their intended function.

Examine equipment for installation and for properly operation safety interlocks and controls.

Report deficiencies discovered before and during testing and balancing procedures.

Equipment is in operable condition, with all accessories installed.

Temperature control systems are installed complete and operable.

Control valves and dampers are in proper working order and have been positioned for full flow through equipment.

Prepare procedures for of testing for all systems.

### **TESTING REQUIREMENTS**

#### **General**

Carry out all 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 commissioning codes, local Government requirements, and this Specification.

At least one month's prior to testing or commissioning any system, furnish the following information for each system or process to the Engineer for review.

Testing procedure and details as well as the relevant report forms to the Engineer for approval.

Type of instruments to be used

Manufacturer of instruments

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 Contractor.

All instruments shall have been recalibrated within six months of the start of 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 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 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.

**Site Testing:**

**Execution of Tests:**

The plant performance shall be inspected and tested during and after installation on site as set out below for compliance with the performances, and ratings as specified.

All tests shall be witnessed by Engineer's representative at site with at least seven days' notice given prior to any test.

All tests shall be executed and the desired results as obtained by the manual test shall be obtained, if not satisfactory, repeated to the satisfaction of the Engineer at no extra cost.

**Preliminary Commissioning Check:**

Ensure that all equipment included under this Contract is thoroughly cleaned, lubricated and checked for serviceability immediately before setting to work.

All automatic controls and safety devices shall be inspected and checked for serviceability before the working fluid or electricity is applied to the system.

**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, humidistat and pressure stats, set the modulating range and set points on all automatic valves and dampers as required to ensure that operating conditions are correct. The time and control sequence shall also be tested and verified.

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, humidity shall be measured to ensure design conditions are achieved. Measuring instruments shall be located 1500 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.

**Final Adjustments and Commissioning:**

When the entire installation works are completed and all the above checking and testing have been properly carried out, the Contractor shall set to work, regulate and calibrate the entire installation. Particular attention shall be paid to the following:

All AHU's shall operate properly and produces the desired results as per HVAC requirements. The contractor shall ensure that all valves shall be able to be shut off totally at the maximum anticipated system working pressure.



All instruments are correctly calibrated and read accurately.

All control systems are functioning correctly and are properly sequenced, interlocked, and interfaced with other services.

All security and Car park management system is fully and satisfactorily operational as desired by the Engineer-in-charge.

All equipment to be fully installed 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.

**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 Engineer, the plant shall be finally commissioned and Installation prior to handover to the Employer. Four sets of 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.

**REPORTS**

Submit fortnightly progress reports during the work upon Engineer's request. Include preliminary recommendations, and advise Engineer of any situation which may adversely affect end result of test.

Submit four copies of the final typewritten 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, Contractor name(s).

Testing company, address, name of testing technician(s), 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, motor type, kW, voltage, phase, frequency and FLA.

Status of chilled water temperature in Supply and return line, pressure readings across filter bank, of each air handling system, showing calculated readings by the BMS and the actual measurement done manually. The difference in error shall not be in any case be more than +/- 1%.

Status of Temperatures of outside air, return air, mixed air, air off cooling coils and terminal supply air for each air handling system.

Rated and actual motor current, in amperes, of every motor at full load conditions.

Schematics for all systems with all terminals identified.

Provide separate test forms for each M&E services and other services.

Submit with the report, a summary listing of recommendations for Engineer's review.

Certify all reports by the Balancing Engineer and balancing technician before submitting for Engineer's review.

### **SCOPE OF WORK & SYSTEM OVERVIEW**

It is the intent of this specification to integrate the various M&E equipment and Fire Alarm System through software & hardware interface to achieve the following minimum features

A common database for all the system

Same set of graphics and same methods for issuing commands to be used for all Systems

Consistent alarm management across systems

Consolidated historical data and reports

In an emergency, all of the building systems respond in a co-ordinated manner

Information is entered in to one system

### **SYSTEM REQUIREMENT**

The integrated system shall be linked to each other or run on an Industry Standard EIA-485 Signalling/ BACnet MS/TP or approved equal Open Communication Protocol.

It is the intention that the Building Management System (BMS) be an open system operating on ASHRAE Approved BACnet Protocol. It is the intention to develop automation applications, which interact with data from the BMS. To facilitate this, the following scope is included in this contract.

The provision of industry standard open middleware interfaces to Building automation applications has to be implemented. Systems on proprietary Protocol for communication are not acceptable

either in the Field Level, Integration level or on the Management Level of the Building Automation Architecture, restricting the application of Interoperability & seamless Integration

Each of the BMS Workstations shall be able to function as an information broker to an office automation application and shall provide the open industry standard middleware interfaces. BMS Workstation minimum shall provide the following functions: -

- i) Enable / disable change-of-state reporting for a point.
- ii) Set / change alarm parameters such as alarm limits and differential.
- iii) Read current point value.
- iv) Override current point value for data points and output points.
- v) Begin / end Trend Log data collection.
- vi) Read all or part of an on-line or archived Point Profile data file
- vii) Internal process (loop) Speed of 100 milliseconds for DDC's
- viii) Subscribe to receive change-of-state messages.
- ix) Read / add / delete weekly or temporary schedules.
- x) Read all or part of an on-line or archived Totalisation record file.
- xi) Delete an archived tantalization record file
- xii) Read all or part of an on-line or archived Trend Log data file.
- xiii) Delete an archived Trend Log data file.
- xiv) Write to point parameters.

## SYSTEM ARCHITECTURE

The architecture of the Building Management System shall consist of four levels of intelligence or layers:

- i) Information Management Level
- ii) Integration Level/Automation Level
- iii) Field Controller Level
- iv) Sensor/Actuator Level

As a preferred primary technical requirement, the Information Management Level, the Integration Level & the Field Controller Level shall include BACnet Devices (DDC/ IBC, Interoperable BACnet Controller) communicating on BACnet Protocol, making the entire system to perform on Native BACnet Platform. The system shall support Modbus Device Integration on both Field Level as well as Integration/ Automation Level. The System shall be completely based on ANSI/ASHRAE standard 135-2001, BACnet. The tenderer shall submit during the tender stage complete write-up of the entire system compliance statement of the specifications and all technical literature of the components that are offered for this project.

Note: System Architecture is Typical & Vendor shall submit Project Specific System Architecture inline to the above architecture during submission of There Techno-Commercial offer.

## INFORMATION MANAGEMENT LEVEL

**GENERAL**

The Information Management Layer shall consist of a distributed network of BMS Workstations including Web Servers for remote access.

The function of the BMS Workstation is to provide a user-friendly operator interface and to provide data archiving facilities. For system reliability, the BMS Workstations shall not necessarily be required to perform any of the BMS Features. Updates & Changes shall be possible with Operator Terminal used in the BACnet MS/TP Network in case of BMS Workstation Failure.

**HARDWARE**

The hardware platform for the BMS Workstations shall minimum meet the following specification:

Intel Pentium

Intel® Core™ i5 or higher

Ports:

(6) High speed USB 2.0 (2 side/4 rear)

i. Side audio ports: headphone and microphone

(2) PS/2 ports 2 Serial2

Integrated display port VGA-in

RJ-45 AC-in

2 Serial ports (RS485) & 1 Parallel Port

4 USB Ports (2 in front & 2 in back) DVD Recordable, 4GB memory Bluetooth

80 GB of hard disk space or more

1.4 MB FDD or More.

21" LED monitor

USB Optical Wheel Mouse USB Key Board Latest Windows Operating System with license

Each BMS Workstation shall be provided with two colour Laser printers. One printer shall be alarm printer and the other for system alarms. All the alarms / reports generated shall be stored on separate files /

Directories of Operator Works Station for future reference or records.

**SOFTWARE****GRAPHICAL USER INTERFACE**

The system shall be capable of supporting an unlimited number of users using a standard Web browser such as Internet Explorer™ or Netscape Navigator™. Systems requiring additional software (to enable a standard Web browser) to be resident on the DDC / client machine, or manufacture-specific browsers shall not be acceptable. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser.

The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

The Web browser client shall support at a minimum, the following functions:

User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.

Graphical screens developed for the GUI shall be the same screens used for the Web browser client.

HTML programming shall not be required to display system graphics or data on a Web page.

HTML editing of the Web page shall be allowed if the user desires a specific look or format.

Storage of the graphical screens (Static) shall be stored in DDC directly and should not depend on any other hardware.

The Web page shall get automatically refreshed without any user intervention.

Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:

Modify common application objects, such as schedules, calendars, and set points in a graphical manner. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator and set holidays

View logs and charts

View and acknowledge alarms

The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to adjust their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.

Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

## **SYSTEM DESCRIPTION & INPUT OUTPUT SUMMARY**

The proposed system shall be a Direct Distributed Digital Control (DDC) system. It shall be a PC based system and shall combine latest state of the art technology with simple operating techniques. The entire Monitoring of Building Management System (BMS) shall be comprise of a network of interoperable, stand-alone digital controllers communicating on an open protocol communication network to a host computer within the facility and communicating via the Internet to a host computer in a remote location. The BMS shall communicate to third party systems such as Chillers, VAVs, Energy meters, UPS, DG, Lifts, VFDs & HT/LT circuit breakers, access control systems, fire-life safety systems and other building management related devices with open, interoperable communication capabilities.

The BMS framework shall utilize built-in Internet connectivity to a broad range of distribution partners in the building automation, energy services, power/utility, and industrial sectors. The Framework shall bring together the ongoing computerization of control applications under single integrated system architecture.

The features shall be distributed both physically and functionally over the field controllers. Microprocessor based Direct Digital Distributed Controllers (DDC) shall interface with sensors, actuators and environmental control systems (i.e. HVAC units, chillers, pumps, fans, lighting etc.) and carry out followings functions:

Individual input/output point scanning, processing and control.

Centralized operation of the plant (remote control).

Static / Dynamic graphic details of plant and building.

Energy Management through optimization of all connected electrical and mechanical plants.

Alarm Detection and early recognition of faults.

Time, event and holiday scheduling as well as temporary scheduling.

Prevention of unauthorized or unwanted access.

Communication interface and control.

Suggestive preventive maintenance for all equipment as well as own error diagnosis.

Report generation.

Optimum support of personnel.

Data Visualization Tool

These Controllers shall be capable of functioning on a stand-alone mode i.e. in case of loss of communication with the central control station / Server, these shall function independently. DDC shall have microprocessors built-in as standard, which control the respective operation centers based on the required logic and also offer fast communication of data via the network communication system. The local access to these shall be either through an in-built display with

keypad for each outstation or through a portable operator's terminal. The controllers shall be capable of executing advanced control algorithms like Optimum Start stop, PID control, auto PID tuning and schedule management. They shall also execute logic functions based on time and/or event. Totalization and averaging functions shall be an inherent feature of the controller.

Each stand-alone intelligent DDC Controller shall have a single 32 bit processor, on board Ethernet connectivity. These shall also control any other operations on the floor and shall be sized to suit the operation centres or system requirement. This shall help in reducing the site electrical installation.

The number of controllers for central plant room equipment's shall be decided by the contractor. Overall, the system shall be provided with 15% spare capacity, with spare of at least 15% points on each controller.

There shall be one BMS control station located in Control Room. The Operator Station should use a simple Web Browser in conjunction with the BMS Server software. The Computer shall be sized to cover the graphic display memory, planning information, software & data storage requirement. The display shall be in the form of dynamic color graphics and text format with menu driven pop-up windows and help facility.

The following software packages shall be loaded into the system as minimum standard:-

Complete system operational software

Site specific data manipulation software

Graphics software

Alarm indication software

Internet Enabled Remote Monitoring Package.

#### **Network Area Controller:**

The functions of the Network Controller Unit are to host automation features for a minimum of 60 DDC's (BACnet Devices) connected to its BACnet MS/TP LAN or approved equal communication protocol. Automation Feature for supervisory control and management shall include, but not limited to:-

Active Point Data Base.

Alarm Management.

Control Processes

Demand Limiting / Duty Cycling.

Message Management

Password

Point Profile

Scheduling

Totalisation

Trend Log

Each Network Control Unit (NETWORK AREA CONTROLLER) shall operate as a stand-alone controller capable of performing its specified responsibilities independently of other NETWORK AREA CONTROLLER controllers in the network. The intent is that the failure of any one NETWORK AREA CONTROLLER, shall not in any way impact the availability of the complete suite of BMS.

## **HARDWARE**

**The Network Unit Controller shall comply with the following reference standard:**

American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).

ANSI/ASHRAE Standard 135-2001, BACnet.

UL 916 Underwriters Laboratories Standard for Energy Management Equipment Canada and the National Electrical Code (NEC).

EMC Directive 89/336/EEC (European CE Mark)

The Network Control Unit (NETWORK AREA CONTROLLER) shall be BACnet Compliant and shall be capable of providing control strategies for the system based on information from any or all connected inputs. The program implementing these strategies shall be completely flexible and user definable. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site via simple download are not acceptable. Changing global strategies via firmware changes is also unacceptable.

Preferred Programming type shall be object-oriented using control program blocks. Each NETWORK AREA CONTROLLER's shall support a minimum of 1000 Analogue Values & 1000 Binary Values. Programming tool shall be provided with system and shall be the same tool that is used to program the Building Controller. All flowcharts shall be generated and automatically downloaded to controller. No re-entry of database information shall be necessary. Feature to graphically view inputs and outputs to each program block in real-time as program is executing shall be provided. This function may be performed via the operator's terminal or field computer.

The NETWORK AREA CONTROLLER shall be designed to be mounted in a mechanical room environment with a rated operating temperature range of 0°C to 55°C and 0% to 95% RH non-condensing. If the proposed BMS Controller is not rated to 55°C, a separate enclosure to be provided for each NETWORK AREA CONTROLLER and each enclosure shall be equipped with a button fan for ventilation.



Each NETWORK AREA CONTROLLER shall have minimum of 32 MB RAM, 32 Bit Processor with 8 MB of flash RAM to provide fast reliable platform to run DDC's programming and global automation routines.

Each NETWORK AREA CONTROLLER shall support independent Field Level Controller Layer Communication Network (BACnet MS/TP LAN or approved equal communication protocol). The Communication Networks are considered independent if communication traffic on one network does not impact the other network.

NETWORK AREA CONTROLLER's shall be with onboard Ethernet Network Interface Card (NIC) supporting 10 Mbps or 100 Mbps Ethernet Connections and one BACnet MS/TP Network. In addition, controller shall include BACnet PTP connection port & shall also support BACnet/IP Communication for integration on enterprise or Wide Area Networks if required by client in later dates.

The NETWORK AREA CONTROLLER shall have onboard Real Time Clock to support schedule operations, trend logs and timed DDC functions. Each NETWORK AREA CONTROLLER shall support a minimum of 320 trend logs, 320 Alarm setups, 80 Schedules & 80 Calendars to store data point histories for analysis. Controller shall periodically upload trended data to system server for long term archiving if desired.

The power supply of the NETWORK AREA CONTROLLER Controllers shall be designed to withstand environmental condition of 0-55 deg.C & 0-95% humidity non-condensing. It shall be UL Listed with CE mark.

## **SOFTWARE**

It is the intention to distribute the database and software features to multiple BMS Controllers (DDC's, NETWORK AREA CONTROLLER's etc.) so that the system is scalable, it can be increased in size without performance bottlenecks and so that the system is fault tolerant, there is no single point of failure. The Software Features of the BMS Controllers shall be designed to work in this type of distributed processing environment.

The Software capability of the Network Control Unit (NETWORK AREA CONTROLLER) shall maintain synchronization of "global" data across multiple BMS Controllers (DDC's, Integrators, any BACnet Devices connected in the BACnet MS/TP LAN/standard EIA-485 or approved equal. Examples of "global" data include password and holiday definitions. Updating an element of the "global" database in NETWORK AREA CONTROLLER shall cause the update to be broadcast to all Field Level Controllers/BACnet Devices Network.

The NETWORK AREA CONTROLLER shall adopt the client-server paradigm whereby the BMS Controllers hides the distributed nature of the processing platform to create a "virtual server". Client applications resident in the BMS Workstations shall be to interact with the BMS data and features of the All Layer/Levels as if they were stored in a single central location, a "virtual server"

The NETWORK AREA CONTROLLER shall have the following operating features: -

It shall be capable of true real-time operation.

It shall be multi-tasking as each of the features in the NETWORK AREA CONTROLLER's run in parallel.

It shall be multi-user so that multiple users can access the NETWORK AREA CONTROLLER's Controller NETWORK AREA CONTROLLER warranty.

### **Active Point Data Base**

The Active Point Data Base includes the following items: -

Physical points connected to the BACnet Devices/DDC Controllers.

Data points resident in the BACnet Devices/DDC Controllers.

The Active Point Data Base shall include information about each point such as the name, description, units, etc.

The NETWORK AREA CONTROLLER of the Integration Level & BMS Workstation in the Management Level interact with the Active Point Data Base. The Active Point Data Base shall co-ordinate actions of the software features based on a set of priorities. Safety features such as the maximum number of on-off cycles, minimum on times and minimum off-times for binary output points shall be provided by the Active Point Data Base.

### **Alarm Management**

All items in the Active Point Data Base, physical points, data points and mapped points, are compared to pre-programmed "normal" conditions and any exceptions are used to create a message. Messages are handled by the Message Management Feature in the NETWORK AREA CONTROLLER.

For each analog input point and each analog data point in the Active Point Data Base, it shall be possible to uniquely define:

High Alarm Limit

High Warning Limit

Low Alarm Limit

Low Warning Limit

Differential

These parameters are part of the Active Point Data Base for analog data points and analog input points.

When an analog point goes outside the High Warning or Low Warning Limit for more than one minute, a warning message shall be generated and distributed by the Message Management Feature.

When an analog point goes outside the High alarm or Low Alarm Limit, or when a binary point is in an abnormal state, an alarm message shall be generated and distributed by the Message Management Feature.

When a point returns to normal, the event shall create a message that shall be distributed by the Message Management Feature.

To eliminate nuisance alarms it shall be possible to lock out alarm reporting on a point.

To force a point to remain in its current state, it shall be possible to lock out control for any point.

### **Control Process**

Control sequences which are too complex to be accommodated at the Field Level Controller Layer or control sequences which combine information from multiple locations shall be implemented in the NETWORK AREA CONTROLLER as Control Processes. Once the control processes have been developed, simulated, tested and debugged, they shall be downloaded.

It is the intention that the client be able to program their own NETWORK AREA CONTROLLER Controllers without assistance from the supplier or manufacturer. It is intended to use the BMS Workstation in the Management Level as the platform for this programming.

### **Demand Limiting / Duty Cycling**

For each meter, the future utility consumption level shall be calculated using a predictive algorithm. If the predicted future consumption level exceeds a user defined “demand limit”, selected equipment shall be temporarily turned off (shed) to avoid a peak and the associated charges from the utility provider. When the risk of exceeding the “demand limit” has passed, the equipment shall be turned on (restored).

Utility consumption is reduced by regularly turning off equipment for short periods. Since most equipment has been oversized to accommodate worst case conditions, Duty Cycling is an effective way of reducing consumption when at non-peak conditions. For example, a fan may be turned off for ten minutes out of each hour without affecting comfort conditions. Any binary output or binary data point shall be able to be assigned to a meter at one of four priority levels for prioritized shedding of loads. Within a priority level, a rotational shedding algorithm shall be used.

At the end of the minimum off time, a comfort parameter, such as a temperature, shall be sampled. If the comfort parameter is in alarm, the point being shed by Demand Limiting or Duty Cycling shall be restored.

The information necessary to create a Utility Profile Report shall be stored at the NETWORK AREA CONTROLLER. This information includes real-time information from the current billing

period, which is in progress, and historical information from the most recently completed billing period.

### **Message Management**

The Message Management feature shall receive messages and files from other software features and distributes the messages to the Management Layer of the Building Automation System.

Message which shall be distributed by the Message Management feature include: -

Alarm message such as temperature exceeding alarm high alarm limit.

Warning message such as temperature exceeding high warning limit.

Override event message initiated when a point is overridden

Return-to-normal event message initiated when a point is no longer in alarm.

Off-line message initiated when communications with a point or a controller fails.

On-line message initiated when communications with a point or a controller is restored.

Advisory message initiated when current demand greater than target demand.

Advisory message initiated when Demand Limiting feature anticipates than target demand will be soon be exceeded.

Advisory message initiated when Duty Cycling feature is unable to achieve target energy reduction.

Totalization message initiated when totalization limit is reached.

Files which shall be distributed by the Message Management feature include: -

Point Profile data files.

Totalization record files.

Trend Log data files.

Destinations for the Message Management feature shall include: -

BMS Workstation File (destination for message and files).

BMS Workstation Software (destination for message only).

Printer (destination for message only).

It is the intention that the Message Management feature be capable of distributing message to multiple BMS Workstations NETWORK AREA CONTROLLER currently. If the proposed Message Management feature can only direct message to one BMS Workstation, then each BMS

Workstation shall be equipped with a mirroring hard disk of 800 Megabytes. The intention is that the crash of a hard disk shall never result in the loss of archive data.

### **Point Profile**

For every analog point in the Active Point Data Base, 30 historical samples shall be maintained at the NETWORK AREA CONTROLLER. A sample shall be taken every 30 minutes or whenever a change-of-state, such as an alarm or off-line, occurs & for every binary point in the Active Point Data Base, a record of the last 10 change-of-status / change-of-states shall be maintained NETWORK AREA CONTROLLER currently at NETWORK AREA CONTROLLER. Profile data for selected points shall be passed to the Message Management Feature.

### **Scheduling**

The following commands shall be able to be time scheduled to be issued at a later day and time: -

Start or stop a point.

Change alarm limits, warning limits or set point.

Lock/unlock point reporting or point control

Demand Limit target setting

Duty Cycling rolling target setting.

Trend Log point enable / disable for a point

Totalization enable / disable for a point.

Commands shall be able to issued repeatedly on specified days of the weeks at specified times.

Separate schedules shall be stored for regular days, special days and holidays.

The system shall accept one time schedules to accommodate overtime usage.

After recovery from a power failure, the system shall determine any time-scheduled commands, which should have been issued during the period that the power was off. These commands shall automatically be issued.

The system shall allow holidays to be scheduled a minimum of one year in advance.

### **Totalization**

There shall be three types of Totalization, which may be assigned to a point: -

Run-time records operating hours of equipment.

Consumption: records total consumption from a flow input.

Event records number of occurrences of an event such as on / off or alarm.

Totalization records shall be maintained as follows: -

Cumulative since the feature was enabled.

Hourly Totalization record, plus cumulative for the current hour.

Daily Totalization records, plus cumulative for the current day.

Weekly Totalization records, plus cumulative for the current week.

Monthly Totalization records, plus cumulative for the current month.

Totalization records shall be passed to the Message Management Feature. When the value of a Totalization record reaches an operator defined limit, and advisory message shall be passed to the Message Management feature.

#### Trend Log

The operator shall be able to select points for which Trend Log samples are taken on a pre-defined interval from once per minute to once every two hours. Trend Log samples shall be passed to the Message Management Feature. A minimum of 300 trend logs to store data point histories for analysis shall be able to be stored at each NETWORK AREA CONTROLLER.

### **INTEGRATION LEVEL NETWORK COMMUNICATION**

The Integration Level Layer Network which forms a distributive network of NETWORK AREA CONTROLLER Controllers shall support BACnet Ethernet, operating at 10Mbps or 100 Mbps, BACnet/IP & atleast one BACnet MS/TP Network per NETWORK AREA CONTROLLER's. The intention to have a BACnet MS/TP Network is to have BACnet MS/TP/Standard EIA-485 Signalling protocol from Integration Level to Field Controller Level, making the entire network from top-to bottom & vice versa operating on BACnet Protocol. This feature allows having a complete open/Inter-Operable Native BACnet Platform.

To maintain compatibility with the client's equipment, the IP method of addressing shall be used. The client will permanently assign IP addresses to the BMS nodes.

To simplify potential future integration the protocol details used on the Integration Level Layer Network shall be released to the client, without restriction of how the protocol is to be used. Any Integration to M & E equipments releasing information on BACnet/IP shall be seamless, without a use of any integrators/ Gateways. The protocol document shall contain sufficient information to allow M & E Services to connect their devices (If not on BACnet/IP) to the Integration Level Layer Network and provide the following functionality: -

Read point data (analog, binary and data points)

Write point data (analog, binary and data points)

Receive critical reports from the Message Management feature of the NETWORK AREA CONTROLLER's

The tenderer shall include with their tender submission a letter from the BMS system manufacturer confirming their willingness to release the protocol as specified.

### **Direct Digital CONTROLLERS**

#### **DIRECT DIGITAL CONTROLLER (DDC) HARDWARE REQUIREMENT:**

- 1) DDC controllers shall be capable of fully “stand- alone” operation i.e. In the event of loss of communication with other DDC’s or Control Station, they shall be able to function on their own. DDC working on 230V AC are preferred.
- 2) The controllers shall consist of single 32 bit double microprocessors based standalone working on TCP/IP, with EEPROM based operating system on BACNET.
- 3) The controllers shall be minimum 32 bit Double microprocessor based standalone working on TCP/IP on Bacnet IP with integral web browser, calendar function complete with day, month, week, year etc.
- 4) DDC Controller with I/O module, expandable controller. RAM memory size should be 128 MB and Flash Memory size 64 MB
- 5) The memory available to the controller board should serve as working space and there should not be any limitation of using particular function block other than the memory.
- 6) The controllers shall be UL listed or conforming to CE.
- 7) The controller shall have support programs built in RAM for minimum of 120 hours in the event of a power failure and it shall be possible to fit any battery thus expanding the time limit to 5 years. An alarm shall be generated on low battery voltage. The battery shall not be required to supply power to actuators, valves, dampers etc.
- 8) DDC shall have embedded TCP/IP connectivity so that it can be hooked into the Local Area Network (LAN) provided by the client / can be on dedicated network created by the vendor. Each DDC can be accessed from the Graphical User Interface (GUI) or from a standard Web browser (WBI) by connecting to the server.
- 9) Controller shall have capability to communicate with other controllers for any interlock or data sharing using peer to peer technology. The Controller which route the messages or data sharing through the system or any intermediate hard ware / controller shall not be acceptable. Vendor to demonstrate this capability during the commissioning time and the same shall be verified at the time of handing over.
- 10) Each controller shall have RS485 port built on to it so that any trouble shooting required at field level can be carried out without removing the controller from the network (LAN).

- 11) All controllers shall accept 230V, 50Hz Uninterrupted power supply, provided by end user, directly so that the in between hardware such as transformers and SMPS are avoided.
- 12) All controllers shall have capability to provide 24V DC auxiliary power supply for the sensor which requires power, however the same shall not be required to high power consuming devices / equipment's such as actuators, dampers etc.

Vendors to provide details on the same at the time of offer.

- 13) The Controllers shall have proportional control, Proportional + Integral (PI) Control, Proportional plus Integral Plus Derivative (PID) Control, Two Position Control and Time Proportioning Control and algorithms etc, all in its memory and all available for use by the user, i.e. all the control modes shall be software selectable at any time and in any combination. The analog output of Proportional Control, PI Control, and PID Control shall continuously be updated and output by the program shall be provided. Between cycles the analog output shall retain its last value. Enhanced integral action in lieu of Derivative function shall not be acceptable.  
Automatic loop tuning facility should be available to tune the loop at regular interval and adjust the gain or the integral / derivative time.
- 14) The controllers shall have a resident real time clock for providing time of day, day of week, date, month and year. These shall be capable of being synchronized with system / time master clocks in the network. Upon power restoration all clocks shall be automatically synchronized to the time master controller which will be set during the commissioning phase
- 15) The microprocessor based DDC's shall be provided with power supply, A/D and D/A converters, memory and capacity to accommodate a maximum of 192 input/output (I/O) hardware points (with or without an expansion board).
- 16) If the controllers provided by the contractor have the configurable plug in function cards, then the following minimum specifications shall have to be met :
  - i) The cards shall provide for analog or digital, input or output, hardwired connections to the installed plant.
  - ii) The quantity and combination of these cards shall be determined by the requirements of the plant in that location with the concurrence of the Engineer-in-charge
- 17) The DDC's shall have 15-20 % spare capacity for each type of point (digital/analog input/ output) to give flexibility for future expansion.
- 18) All DDC controllers shall have 10 / 12 bit A/D resolution and be capable of handling voltage, milli-ampere, resistance or open and closed contacts inputs in any mix, if required. Analog inputs/outputs of the following minimum types shall be supported:
  - i) 4-20 mA.



- ii) 0-10 volts.
  - iii) 2-10 volts.
  - iv) Resistance Signals (either PTC or NTC such as PT 100, PT 1000, PT 3000, NTC20K)
- Digital input/output types to be supported shall be, but not limited to the following:

- i) Normally-open contacts.
- ii) Normally-closed contacts.
- iii) Pulse inputs

Modulating outputs shall be true proportional outputs and not floating control type.

- 19) It shall be possible to change the analog inputs to accept any of the above depending upon the site condition or system requirement using a jumper. The DDC which is configured using software trigger / switch shall not be acceptable.
- 20) Controller's packaging shall be such that, complete installation and check out of field wiring can be done prior to the installation of electronic boards.
- 21) All board terminations shall be made via plug-in connectors to facilitate trouble-shooting, repair and replacement. Soldering of connections shall not be permitted.
- 22) Controllers shall preferably be equipped with diagnostic LED indicators with at least indication for Power up Test OK, Watch dog and Bus Error. All LED's shall be visible without opening the DDC cover.
- 23) It shall be possible for the controllers to accept regulated uninterrupted power supply to maintain full operation of the controller functions (control, logging, monitoring and communications) in the event of a localized mains failure.
- 24) Controllers requiring fan cooling are not acceptable.
- 25) There shall be the facility for accessing controller data information locally, via a portable plug-in color LCD display which will be common to all controllers and normally removed to prevent unauthorized tampering. In either case, access to the system thus provided shall be restricted by passwords in the same way as at the main operator terminal.
- 26) In case the Portable operator Terminals (POT) are required to programmed the controllers, sockets shall be provided for same. Attachment of POT shall not interrupt or disable normal panel operation or bus connection in any way.
- 27) The controllers shall be housed in vandal proof boxes to protect them from tampering by any unauthorized personnel. All DDC controllers used in plant room spaces and external application shall be housed IP66/IP54 rating enclosures.
- 28) It shall be possible to add new controllers to the system without taking any part of the system off-line.

- 29) All DDC should have XML web service option which can be enabled in later stage for any higher interface with IT infrastructure or any other service.
- 30) Individual DDC should be BTL (BACnet Testing Lab) tested.

#### **COMMUNICATION BETWEEN EACH DDC-FIELD CONTROLLER LEVEL**

1. The Controllers shall have a self-analysis feature and shall transmit any malfunction messages to the Control Station. For any failed chip the diagnostic tests, printout shall include identification of each and every chip on the board with the chip number/location and whether the chip “Passed” or “Failed” the diagnostic test. This is a desired requirement as it would facilitate trouble-shooting and ensure the shortest possible down time of any failed controller. Controllers without such safety feature shall be provided with custom software diagnostic resident in the EEPROM. The tenderer shall confirm in writing that all controllers are provided with this diagnostic requirement.
- 2) Operating system (O.S.) software for controllers shall be EPROM resident. Controllers shall have resident in its memory and available to the programs, a relevant library of algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences.
- 3) In the event of failure of communication between the controllers and/or Control Station terminal, alarms, reports and logs shall be stored at the controllers and transmitted to the terminal on restoration of communication.
- 4) In the event of memory loss of a Controller or the expiration of back-up power, on start-up of the unit the necessary data-base shall be downloaded manually so that the logic built are verified by the user. However, controllers requiring a manual intervention for the re-boot of software are not desired.
- 5) Where information is required to be transmitted between controllers for the sharing of data such as outside air temperature, it shall be possible for global points to be allocated such that information may be transmitted either on change of incremental value or at specific time intervals.
- 6) Controllers must be able to perform the following energy management functions as a minimum, Time & Event programs

Holiday Scheduling

Maximum and Distributed power demand

Optimum start and stop program

Night purge

Load reset

Zero energy band

Duty cycle

Enthalpy analysis and control

Run Time Totalization

Sequencing and Optimization

Exception scheduling

Detailed description of software features and operating sequence of all available energy management software shall be submitted with the tender for evaluation by the Engineer-in-charge.

- 7) The DDC Controllers shall have Adaptive Control capability whereby the control software measures response time and adjusts control parameters accordingly to provide optimum control. The software shall allow self-tuning of the variable control loops (all or any of P, P+I, P+I+D) of the AHU's and chiller system so as to provide the most efficient and optimized controls at different load conditions. The energy management programs shall update their parameters based on past experience & current operating conditions.
- 8) Alarm Lockout shall be provided to prevent nuisance alarms. On the initial start up of air handler and other mechanical equipment a "timed lockout" period shall be assigned to analog points to allow them to reach a stable condition before activating alarm comparison logic. Tenderers shall indicate their proposed system alarm handling capability & features.
- 9) Run time shall be accumulated based on the status of a digital input point. It shall be possible to total either ON time or OFF time. Run time counts shall be resident in non-volatile memory.
- 10) It shall be possible to accommodate Holiday and other planned exceptions to the normal time programs. Exception schedules shall be operator programmable up to one year in advance.
- 11) All DDC shall have trend / log storing capacity in built into it. It shall be possible to have stored the data for at least 40 days @ 1 hour sampling time for all the points of the DDC (used or unused).
- 12) Minimum communication should be 10MBPS for each of the controller.
- 13) DDC should be forward compatible type so that any expansion or upgrade of the system required in the future is easily taken care off without scrapping / removing / disturbing the existing working system.
- 14) DDC should allow user to include graphics, if required, however it shall be of static in nature.

- 15) All DDC Should be capable of sending email to specific user in the event of alarm, identified by Engineer-in-charge.

### **NETWORK BUS OPERATOR TERMINAL OR PORTABLE OPERATOR TERMINAL**

- 1) POT shall be provided to allow operator readout of system variables, override control and adjustment of control parameters. The POT shall be portable and plug directly into individual controllers for power and data.
- 2) The minimum functionality of POT shall include: Set points to a fixed value or state.  
Display diagnostic results.  
Display sequentially all point summary and sequentially alarm summary. Display/change digital point state, analog point value.  
Display/change time and date. Display/change analog limits. Display/change time schedule.  
Display/change run time counts and run time limits. Display/change time and/or event initiation.  
Display/change programmable offset values. Access DDC initialization routines and diagnostics.  
Enable/disable points, initiators and programs. Display/change minimum ON/OFF and maximum OFF times.
- 3) The POT shall be complete with command keys, data entry keys, cursor control keys or liquid crystal display (LCD). Access shall be via self-prompting menu selection with arrow key control of next menu/previous menu and step forward/backward within a given menu.
- 4) Connection of a POT to a controller shall not interrupt or interfere with normal network operation in any way, prevent alarms from being transmitted, or interfere with Control Station commands and system modifications.
- 5) Connection of POT at any controller shall provide display access to all controllers on that bus. In case the controller has a fixed LCD display and entry keyboard, then the display access shall be available on each screen.
- 6) It should be possible to override the commands given through POT by the Operator Control Station.
- 7) POT shall have touch screen color display and it shall possible to hook this to Local area Network so that the entire system data can be visualized.
- 8) POT shall have self-learning capability so that it can recognize the DDCs on the network and update all points without any manual programming.

### **DATA COMMUNICATION**

The communication between controllers shall be via a dedicated or customer provided Ethernet communication network as per standards. Controller's microprocessor failures shall not cause loss of communication of the remainder of any network. All networks shall support global application programs, without the presence of a host PC.

Each controller shall have equal rights for data transfer. There shall be no separate device designated as the communication's master. Those systems using dependent controllers shall be pointed out by the contractor and a dual Hot redundant transmission media with automatic switching and reporting in the event of line faults will have to be provided.

The communication network shall be such that:

- 1) Every DDC must be capable of communicating with all DDC's on its own.
- 2) Network connected devices shall be capable of sending message after successive retries shall constitute a communication or device failure.
- 3) Each controller is to be provided with a communication watchdog to assure that the failure is reported to central station.
- 4) Error recovery and communication initialization routines are to be resident in each network connected device.
- 5) The communication protocol shall incorporate CRC (Cyclic Redundancy Check) to detect transmission errors.

Single or multiple standalone controller failures shall not cause loss of communication between active DDCs connected on the communication network. Full communication shall be sustained as long as there are at least two operational standalone control panels active on the communication network.

All the System Integration Units shall be linked together on a Local Area Network.

The communication network shall include provision for automatically reconfiguring itself to allow all operational equipment to perform as efficiently as possible in the event of single or multiple failures.

The BAS supplier shall be required to provide details of standards to which their system conforms.

## **SENSORS/ACTUATOR AND CONTROL DEVICES LEVEL**

### **GENERAL**

Provide sensors and control devices as indicated on mechanical plants, control flow diagrams and as required to meet specified performance. Where performance specifications exceed capabilities of hardware specified, performance governs. The installation of such devices shall be the responsibility of this contractor.

All analog sensors shall be industry standard 0 to 10 volt or 4 to 20 mA types with built-in circuit protection against reverse polarity and supply voltage transients. The transmitters shall be matched to the sensing elements and be compatible with the DDC. Any additional interfacing modules/transducers required, the same shall be provided free of cost and the same will be treated as part of the sensor/transmitter.

All sensor / transmitters assemblies shall be factory calibrated.

All sensor wiring, analog or digital, input or output shall be capable of sharing single conduit runs without affecting signal performance. All signal wiring shall also be capable of sharing signal conduit runs with switched AC of 240 volts.

The sensor range shall be suitable to the application.

## **TEMPERATURE SENSORS**

### **THERMOWELLS**

Provide brass/Stainless Steel thermowells for each immersion type temperature sensors to be installed. Thermowells shall have extension for pipe insulation and ½ NPT threaded connection to pipe both internal & External. Maximum insertion length shall be 200 mm or ¾ th of pipe diameter whichever is smaller.

### **TEMPERATURE SENSOR-GENERAL**

All Temperature sensors to be installed shall minimum comply with the following technical Features:

PT 100, PT 1000, PT 3000

#### **Thermistor**

Outside air sensors shall be mounted on a Gasketed, Weather tight enclosure.

Duct Type Immersion Temperature shall have Tabs for easy Installation mounting options for versatility as per site requirement.

Wall Plate Type Temperature Sensor shall be tamper resistant with provision of over-ride switch & communication Jack.

## **HUMIDITY SENSORS**

### **General**

Humidity sensors to be installed shall convert a resistance to a linear 4-20mA, 0-5VDC, or 0-10VDC output, well protected against solid and liquid contaminants with a permeable coating. The signal shall remain unaffected by lead wire resistance or electrical noise.

All Humidity Sensors to be installed shall minimum comply with the following technical features:

Operating RH: 0-100%

Operating Temperature: -24 deg.C to +71 deg.C

Accuracy:  $\pm 3\%$  from 20% to 95%.

Sensitivity: 0.1% RH

Hysteresis:  $<0.4\%$  RH

Stability: Less than 2% RH drift/5 years

The sensor shall be made of advance ceramic technology to fully recover from condensation and to maintain accuracy over a longer period of time. The intention is to overcome the limitation of resistance-based humidity sensors that uses water soluble polymer coatings.

Duct insertion relative humidity sensors shall have the sensing element enclosed in a protective, vented, metal sheath for insertion into duct.

Space relative humidity sensors shall have neat and attractive external case protecting the sensing element within and suitable for mounting on wall and / or partition. Casing design and colour shall be similar to space temperature sensors.

Relative humidity sensors mounted external to building shall have proper shields to protect the sensors.

#### **FLOW TRANSMITTER - LIQUID:**

The flow transmitter assembly shall be of Electromagnetic Type. The assembly shall consist of Sensor & Transmitter; Sensor shall convert the flow of the pipe in Electrical signal and transmits it through a cable to the transmitter. The transmitter shall consists of sensor drive and flow computer; the former part provides excitation voltage for the field coils in the sensor & the later converts the velocity signal to actual flow & also totalizes the flow.

#### **PRINCIPLE:**

Specially designed flow coils, generate a Magnetic Field in the flow tube. As the conductive fluid moves in these fields, voltage proportional to velocity is generated in the electrodes. This flow is received by the flow converter, and digital signal processing is done before the flow value is displayed on the converter LCD.

The intention is to achieve the following benefits:

Effect of changes of in physical properties of the medium:

There shall not be any affect in flow measurement due to changes in pressure, density & Temperature of the medium.

There shall not be any effect in flow measurement in partially filled pipes.

To an extent of 5% of presence of Gas Bubbles, shall not affect the performance & accuracy of flow measurement provided it's a homogeneous flow in the medium.

To an extent of 30%-40% of presence of solid particles, the accuracy & reliability shall not be affected.

The Electromagnetic Flow Meter to be supplied shall minimum comply with the following technical requirements:

The Electromagnetic Flow meter shall be with LCD Display with built in key pads in facia.

The Flowmeter shall be user programmable digital flow meter capable of measuring flow rate along with totalized flow, & batching of conductive liquids.

All the programmable values shall be stored in the internal non-volatile memory. The totalized flow shall also be backed up in this non-volatile memory during power down & shall be able to recall while the power is up.

Accuracy: 0.5%

Communication-RS-485.

Flange Material: Carbon Steel.

Coil Housing: Carbon Steel.

Power Supply: 220 VAC/50Hz.

Outputs: Isolated 4~20 mA, Pulses.

### **PRESSURE TRANSMITTER ASSEMBLY**

Pressure Transmitter in Hydrant/Sprinkler Line-Pressure Monitoring:

The assembly shall consist of a pressure transmitter housed in rugged stainless steel housing to resist the harsh and extreme environmental conditions. The output signal of the sensor bridge shall be converted into standard current signal through surface mount technology circuit board. Each pressure Transmitter to be supplied shall be inspected & calibrated to ensure 100% quality.

The Pressure Transmitter(s) to be supplied shall minimum comply with the following characteristics:

Performance Characteristics:

- I. Accuracy at 25 deg.C (Linearity, hysteresis, repeatability):  $\leq \pm 0.5\%$  F.S.
- II. Stability at 25 deg.C  $\leq 0.4\%$  F.S./Year
- III. Thermal Effect:  $\leq \pm 0.04\%$  F.S./deg. C

Environmental Characteristics:

- I. Media Temperature Range: -25 deg.C to +85 deg.C
- II. Ambient Temperature Range: 0 deg.C to +70 deg.C



- III. Weather proof rating: IP65.

Physical characteristics:

- I. Housing: 304 Stainless Steel
- II. Fitting Material: 304 Stainless Steel
- III. Sensor type: Ceramic

Electrical Data:

- I. Output Signal: 4-20mA
- II. Power Requirement: Normal 24 VDC

### **DIFFERENTIAL PRESSURE SENSOR ASSEMBLY - LIQUID**

Differential Pressure Transmitter for application with Variable Pumping System (VFD & Sec. Pumps)

The assembly shall consist of a pressure transmitter housed in rugged stainless steel housing to resist the harsh and extreme environmental conditions. The output signal of the sensor bridge shall be converted into standard current signal through surface mount technology circuit board. Each pressure Transmitter to be supplied shall be inspected & calibrated to ensure 100% quality. The Differential Pressure Transmitter(s) to be supplied shall minimum comply with the following characteristics:

Performance Characteristics:

- I. Accuracy at 25 deg.C (Linearity, hysteresis, repeatability):  $\leq \pm 0.5\%$  F.S.
  - II. Stability at 25 deg.C  $\leq \pm 0.4\%$  F.S./Year
  - III. Thermal Effect:  $\leq 0.04\%$  F.S. /deg. C
- Environmental Characteristics:
- I. Media Temperature Range: -25 deg.C to +85 deg.C
  - II. Storage Temperature Range: -25 deg.C to +100 deg.C
  - III. Weather proof rating: IP65, NEMA-4/4X or better
- Physical characteristics:
- I. Housing: 304 Stainless Steel
  - II. Seal Material: Silicon Rubber/Ethylene
  - III. Sensor type: Ceramic
- Electrical Data:

- I. Voltage Out Put Signal: 0-10 V
- II. Power Requirement: Normal 24 VDC
- III. Load Resistance: >10 K Ohms
- IV. Current Out Put Signal: 4-20 mA
- V. Power Requirement: Normal 24 VDC
- VI. Load Resistance:  $\leq (\text{Supply Voltage } 10\text{V}) / (0.02\text{A}) \text{ Ohms}$

## SWITCHES

Unless specified otherwise, the Contractor shall supply and install flow, High/Low level and Differential Pressure switches necessary for the proper operation of the system, the switches shall comply with the requirements as specified herein.

## WATER FLOW SWITCHES

Flow switches shall be of paddle type SPDT, suitable for monitoring the flow of water in pipes. The switches shall be suitable for operation in high humidity atmosphere and for pipes handling water with high salt or chlorine & below dew point temperature. Parts in contact with water shall be of brass or phosphor bronze construction.

All the water Flow Switch to be supplied shall minimum comply with the following Technical Features:

- |                            |                       |                                 |
|----------------------------|-----------------------|---------------------------------|
| (a) Operating Pressure:    | 1000                  | KPa(10 Kgf/cm <sup>2</sup> )    |
| (b) Withstand Pressure:    | 1750                  | KPa(17.50 Kgf/cm <sup>2</sup> ) |
| (c) Insulation Resistance: | over 100 Ohm, DC500VM |                                 |
| (d) Withstand Voltage:     | AC1500V/1 Min         |                                 |
| (e) Temperature of Fluid:  | Max. 100 deg.C        |                                 |

Pipe connection shall be threaded, complete with stop cock. Flow switches shall be capable of withstanding the duty water pressure, water temperature of the medium and ambient temperature of condition. Paddle length (height) shall be more than 60% of the pipe diameter for pipe up to 150 mm diameter and shall be not less than 150 mm for larger pipes.

Velocity required to actuate switch shall be field adjustable. Flow switches shall be selected to suit the flow velocities expected.

## DIFFERENTIAL PRESSURE SWITCHES-AIR GENERAL

Differential pressure switches open or close a switch contact in response to a change in the pressure rise across a Filter or Blower. Pressure switches shall be of sturdy and corrosion resistant construction. The pressure-sensing element shall be capable of withstanding any adverse effect of the fluid being monitored, pressures. Pressure settings shall be field adjustable.

All Differential Pressure Switch to be supplied shall comply with the following technical features:

- (a) Operating Temperature range: -20 deg.C to +85 deg.C.
- (b) Switching Capacity: -1.5 A/250 V~
- (c) Membrane Material:-Silicone
- (d) Protection Class: -IP54

#### **DIFFERENTIAL PRESSURE SWITCH - AIR ACROSS FILTER FOR FILTER STATUS**

Shall be diaphragm operated and actuate a SPDT snap-acting switch Operating point shall be adjustable.

Pressure Range: 40-400 Pa

Switching Difference (Hysteresis): 20 Pa

#### **DIFFERENTIAL PRESSURE SWITCH – AIR ACROSS BLOWER:**

Shall be diaphragm operated and actuate a SPDT snap-acting switch Operating point shall be adjustable.

Pressure Range: 200-1000 Pa

Switching Difference (Hysteresis): 100 Pa

#### **DIFFERENTIAL PRESSURE SWITCHES-PUMP APPLICATION GENERAL**

Differential pressure switches open or close a switch contact in response to a change in the pressure rise across a pump. Pressure switches shall be of sturdy and corrosion resistant construction. The pressure-sensing element shall be capable of withstanding any adverse effect of the fluid being monitored, pressures. Pressure settings shall be field adjustable.

All Differential Pressure Switch to be supplied shall comply with the following technical features:

Operating Temperature range: -1.1 deg.C to +71.1 deg.C.

Maximum Media Temperature: 93 deg.C at 100psi (698 KPa)

Burst Pressure: 300psi(2068 KPa)

Maximum Pressure at Either Port: 150psi(1034 KPa)

Set Point Repeatability: -1% of Span

Differential Pressure Setpoint (Adjustable) Set Point:

Decreasing Pressure : 4 to 43.5psi (28 to 300KPa)

Increasing Pressure: 5.5 to 45psi (38 to 310 KPa)

Switching Contact Agreement: SPDT Type

Housing/Enclosure: NEMA1, Reinforced Polyester body, Stainless Steel cover with Neoprene gasket.

Approvals: UL & CSA Listed.

## **LEVEL SWITCH-WATER MEDIUM**

Electrode type level switch with DPDT contacts for each electrode.

## **INTEGRATION WITH VARIOUS SYSTEMS**

### **Mechanical & Electrical (M & E) Systems**

INTEGRATION ON MODBUS-RTU OVER RS-485 The integrator for necessary integration shall reside on BACnet/MS/TP Network and should be able to connect any MODBUS devices over EIA-232 or EIA-485 signaling, translating Modbus Points/values to BACnet AV's & BV's. The integrator shall directly connect to BACnet MS/TP LAN on which the Field Level Controller resides. Each Integrator shall minimum have a capacity of 100AV's & 100 BV's supporting at least 10 MODBUS Devices over EIA-485 network. The integrators shall have onboard flash memory for data storage.

Integration of any M & E equipments as detailed in Data Point Summary on BACnet MSTP shall be over serial communication without a gateway in the DDC Network BUS & Integration on BACnet/IP shall be without any use of integrator at the Management Information level.

### **Tenant Billing & BTU Meter Integration:**

It is the scope of BTU Vendor to develop Tenant Billing software to calculate operating & maintenance cost of each end user. It should be based on the BTUH consumed by each end user (based on the reading of BTUH Meters). The pattern should be shown to the Engineer-in-charges prior to installation/ commissioning. The BTU Meters Shall be Integrated in Building Management System & all Tenant Reports shall get generated Monthly.

The Energy Management & Metering System is required to meter the air-conditioning Capacity utilized by the various tenants / blocks of the Project. The air-conditioning capacity (KW of cooling or tons of refrigeration) shall be calculated by measuring the flow rate of chilled water and the temperature in the flow and return pipes from each block. Energy Management & Metering System

The flow measurement shall be carried out by an Ultrasonic flow sensor and relayed to the Energy Management & Metering System. The measurement device shall not create a pressure loss of more than 0.2 bar (the signal may be larger as long as part of it is recovered). The contractor shall locate

the measurement device as per the recommendations of the controls manufacturer (in terms of straight length of pipe, proximity of valves, velocity in pipes etc.) and if required shall allow for locally increasing / decreasing pipe sizes to achieve velocities for accurate measurement.

The Energy Management & Metering System shall calculate the air-conditioning capacity in GJ / kWh / MWh / Gcal being consumed by each tenants / blocks and a time integral function shall allow the calculation of (kW - hours) air-conditioning in order to establish proportionate costs. The Tenant Billing software shall allow generation of graphs using the above data.

#### BTU Meter Technical Requirement:

The Meter Integrator shall be with display & shall come with match pair temperature sensor inputs in the range of 0° C to 165° C, it shall be with a resolution of 0.01°C. The temperature sensor shall be Pt 500 with an accuracy of 0.01K as per EN 60 751. The manufacturer of the BTU meter shall supply the pockets for the match pair temperature sensor and it shall be of SS make suitable for chilled water application. The accuracy of 0.01K as per EN 60 751 are calculated based on the match pair temperature sensor with in the pockets.

The ultrasonic flow sensor shall be based on the ultrasonic measuring principle. The prime area of application shall be for volume flow sensor for use with thermal Heat-cold meter. It shall be designed for use in cooling & Heating installations where water is used as the energy bearing medium. Ultrasonic flow sensor shall employ micro-processor technology and ultrasonic measuring techniques. All circuits for calculating and measuring of flow shall be on a single board mounted on the meter, in addition to an exceptionally high level of measuring accuracy with regards to EN and Measuring Instruments Directive. The flow shall be measured using bidirectional ultrasonic technique based on the transit time method. The accuracy of the flow meter shall be in accordance with EN 1434 for ultrasonic flow meter for metering purposes. The flow meter shall have internal protection against pollution caused due to water contamination over years there by effecting accuracy of the flow meter.

The ultrasonic flow sensor shall use minimum of two ultrasonic transducers to send the sound signal both against and with the flow direction and know the transit time. The time difference between the two signals shall be converted to a flow velocity and thus a volume. There shall be provision for calibration of the flow meter in the future. The signal generated by ultrasonic flow sensor shall be in pulse form & the flow meter to the calculator shall be connected through the three-wire pulse cable supplied by the meter manufacture & no alteration of adding external cable at site shall be acceptable. The ultrasonic flow sensor shall be designed / selected for the flow sensor nominal flow as specified by the manufacturer. The flow sensor shall have a Dynamic flow range of 1:100 [i.e Minimum flow: Nominal flow]. The ultrasonic flow sensor shall be installed horizontally, vertically or at an angle.

#### **JOB DESCRIPTION IN BRIEF:**

##### **GENERAL**

Provide a complete building management and control system in accordance with the Contract Documents.

**WORK IN NETWORK AREA CONTROLLER LDED**

The work under the Section of the specifications includes all labour, materials, equipment's and services, as required to provide a fully operational Building Management and Control System (BMS) in strict accordance with these specifications and the Contract Drawings and subject to the terms and conditions of the Contract. The work in general consists of, but is not limited to, the following:

Central operators console of a central processing unit, colour graphic CRT and printer.

Remote (Stand by) operators' consoles as specified.

Data communications necessary to affect a BMS data transmission system.

Direct Digital Controllers (DDC's), field equipment panels, sensors, control devices, valves, conduit, wiring and piping.

Software required affecting a complete and operational BMS as specified herein.

Complete operating and maintenance manuals and field training of operators and maintenance personnel.

System commissioning and acceptance tests as specified.

Full documentation for all software and equipment provided.

Miscellaneous work as indicated in these specifications and the contract drawings.

**PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION**

Installation of the following items furnished under this Section but installed under the Contractors works.

- Automatic Control Valves
- Thermo wells in pipe lines
- Liquid Flow Sensor - Transmitters
- Liquid Flow Switches
- Any Civil Jobs in Nature
- Mechanical Tapings required in pipelines for instrument installation.

Supervise and co-ordinate the installation of equipment, instruments and materials furnished under this Section but installed under other Divisions of the specifications by producing relevant information to the Contractor. All equipment and instruments shall be installed in strict accordance with the manufacturer's published installation instructions.

**SYSTEM CONFIGURATION:**

The Building Management and Control System (BMS) shall provide both monitoring and control of HVAC, Pump System, ventilation system, electrical monitoring system, Plumbing, firefighting monitoring, etc. for building management, energy conservation, and environmental control.

The BMS control philosophy, shall be direct digital control and shall be implemented by a distributed digital system.

The Central processing unit (CPU) - BMS Controller shall provide for overall building data acquisition and transfer, report generation, historical data storage and retrieval, and operator interface.

The CPU and DDCs shall communicate through dedicated communications network.

The Direct Digital Controllers (DDC) shall perform remote data acquisition and process control. DDCs shall be locally mounted completely self-contained, field programmable, microprocessor based controllers capable of stand-alone operation.

Each DDC shall be connected to its particular controlled environment through field I/O instrumentation.

All controls shall be electric / electronic type.

**DESIGN AND PERFORMANCE CRITERIA**

Provide stable control of all connected systems with a closed loop control accuracy not to be worse than.

Temperature:  $\pm 2$  percent of sensor span.

Humidity:  $\pm 4$  percent of sensor span.

Pressure:  $\pm 2$  percent of sensor span.

Flow:  $\pm 3$  percent of sensor span.

**ENVIRONMENTAL CONDITIONS**

The DDCs, Field Equipment Panels, and other field equipment's shall operate under ambient environmental conditions of 0° to 50° C dry bulb and 10% to 95% relative humidity, non-condensing. Sensors and control elements shall operate under the ambient environmental temperature, pressure, humidity, and vibration conditions normally encountered for the installed location.

Other equipment, such as CRTs and printers, shall unless designated otherwise operate properly under ambient environmental conditions of 10° to 40°C and a relative humidity of 20% to 80%.

**MATERIALS AND EQUIPMENT**

Where multiple units of the same type are required the units shall be products of a single manufacturer. However, the component parts of the system need not be the products of a single manufacturer. The components shall not require customizing other than setting jumpers and switches and adding firmware. Each major component of equipment shall be labelled with the manufacturer's name, address, model and serial number.

### **PROTECTION FORM INTERFERENCE**

Total system shall be immune to electrical noise from the building electrical systems.

Total system to be immune to radio frequency and electromagnetic interference which may be reasonably expected within the building including operation of hand held radio transmitters at close proximity to BMS equipment.

### **SUBMITTALS**

#### **AFTER AWARD OF CONTRACT-SUBMITTALS**

#### **SHOP DRAWINGS-**

Shop drawing submittals shall include sufficient data to indicate complete compliance with Contract Documents. Submissions in form of drawings, brochures, bulletins, catalogue data and / or narrative descriptions. As a minimum requirement submit the following but not limited to: -  
Symbol and abbreviation lists.

System block diagram showing quantity and location of BMS Controller, operator Work Station.

Control diagrams (P&ID) for all systems controlled.

Controls shall be shown on system flow Diagrams. Interfaces (software and hardware) with equipment provided in other sections of specifications.

Narrative description of operation for each system including alarm and emergency sequences and equipment interlocks.

Description of manual override capabilities.

Complete input output point schedule. Identify point function type and location.

Spare capacity provisions.

Detailed bill of materials.

Valve and damper schedule: Provide identification numbers, location system dimensions and performance data. Include damper leakage rates.

Device mounting details. Include as a minimum:

Sensing elements in ducts or casings.



Sensing elements in piping.

Outdoor sensing elements.

Floor Plan drawings showing the above.

Detailed Wiring diagrams for all panels, controllers, power supplies, electrical power Connections, auxiliary function relay etc.

**System riser diagram or diagrams showing:**

Number and size of riser.

Conduits / trunking.

Number, size and type of conductors in each riser.

Number of each type of device on each floor and zone.

Power supply / standby battery load calculation for each power supply in the system.

Each floor plan drawing, typical wiring diagram, detailed wiring diagram and system riser diagram shall be cross-referenced to all related drawings. It is intended that the complete submittal include all information necessary for system installation.

Each shop drawing submittal shall be complete showing all information relative to the system installation in the area concerned and including copies of all cross-referenced drawings.

All drawings shall be sufficiently clear to allow legible, half-scale reproductions.

All required shop drawings whichever after modification/as per actual requirement shall be approved by the Consultant, otherwise shop drawings will not be acceptable/Valid.

**BLOCK DIAGRAMS**

Tenders shall submit with their tenders two sets of block diagrams illustrating their proposed system architecture, arrangement and distribution of components, general system operation and any proposed features / capabilities not specifically required by the specification but required to complete the functional requirement of the system.

Block diagrams shall be supplemented with narrative descriptions as necessary for clarify and completeness.

**RECORD DRAWINGS**

Maintain on-site a separate set of approved shop drawings for the overall system, marked up to indicate as-built conditions. These drawings shall be maintained in a current condition at all times and shall be made available for review upon request. All variations from the approved shop drawings, for whatever reason, including those occasioned by modifications, change orders,

optional materials and / or required co-ordination between trades shall be indicated in sufficient detail to accurately reflect the as -built.

Record drawings are required to show all junction boxes, devices, terminal cabinets, equipment cabinets, electrical enclosures and conduits, as well as all information required for shop drawings.

Record drawings shall also include one-half scale, plasticised copies of all detailed wiring diagrams required by the specification, updated to reflect as - built conditions. One copy shall be attached to the inside of the door or cover of its associated control cabinet or electrical enclosure and one copy shall be included in each required Operations and Maintenance Manual as required by this specifications.

The vendor shall submit copies on floppy disk and CD ROM in addition to the above. All drawings shall be made on Auto CAD.

## **PROGRAMMING**

Point identification code.

System advisory messages, printouts, login formats.

Drawings of system graphics showing monitored points.

Software flow charts for application and DDC programs.

Man machine interface program, include commands, alarm annunciation, logs and programming capabilities.

Description of system operation under failure conditions.

## **QUALITY CONTROL SUBMITTALS**

Proof of compliance to applicable codes and standards.

Final calibration, commissioning and testing reports.

## **MANUALS**

### **GENERAL**

Submit two (2) draft copies of manuals for Review. After review by authorised representative, the Contractor shall incorporate review comments and submit three (3) final copies.

During guarantee period contractor shall update manuals with modifications made to system.

Provide replacement pages or supplements in quantity stated above.

Manuals into multi-volume sets as necessary and required by the Engineer-in-charge.

Each volume shall be protected with a heavy-duty vinyl plastic binder. Volumes shall have plastic printed dividers between major sections and shall have oversized binders to accommodate up to 20 mm thick set of additional information.

Each binder shall be silk screened with project name and volume title on front cover and binder.

The first page of each manual shall identified with project name, manual title, name address and service phone number and person who prepared manual.

Operating Manual to serve as training and reference manual for all aspects of day-to-day operation of the system. As a minimum include the following:

Control flow diagrams.

Sequence of operations for normal and abnormal operating modes. The sequences shall cross-reference the system point names.

Description of manual override operation of controls points.

System manufacturers complete operating manuals.

Maintenance Manual to serve as training and reference manual for all aspects of day-to-day maintenance and major system repairs. As a minimum include the following:

Complete as - built installation drawings for each system.

Overall system electrical power supply scheme indicating source of electrical power of each system component. Indicate which components are on emergency power and indicate all battery backup provisions.

Overall system shielding and grounding scheme indicating all major components and ground paths.

Photographs and drawings showing installation details and locations of equipments.

Charts showing normal operating conditions at significant points such as electrical test points.

Routine preventive maintenance procedures, corrective diagnostic trouble shooting procedures, and calibration procedures.

Parts list with manufacturer's catalogue numbers and ordering information.

List of ordinary and special tools, operating materials supplies and test equipment recommended for operation and servicing.

Manufacturer's operating set up, maintenance and catalogue literature for each piece of equipment.

Maintenance and repair instructions.

Recommended spare parts.

Field Test reports.

Programming manual to serve as training and reference manual for all aspects of system programming. As a minimum include the following:

Complete programming manuals and reference guides.

Details of any special software packages and compilers supplied with system.

Information required for independent programming of system.

Documentation on application and DDC programs: Flow charts, equations, parameters.

Points schedule: include all points, real and virtual.

Software trouble shooting procedures.

### **FIELD EQUIPMENT PANEL**

Field equipment panels shall be provided to interface the DDC panels with control devices. The panels shall house interface relays, transducers and other miscellaneous control components.

### **FIELD CONTROL PANEL**

Compact metallic enclosures shall be used to mount field mounted DDC controller and other associated equipment. The enclosure shall be made out of sheet steel dip coat primed and powder coated. Enclosures shall be made out of 1.5 mm sheet steel of 1.25 mm thickness and doors shall be made out of 1.5 mm thickness sheet steel. The higher sizes enclosures shall be made of 1.5 mm thick sheet steel and doors shall be made of 2 mm thick sheet steel. Mounting plate shall be made

of 2 mm thick sheet steel and shall be dip coat primed and powder coated. Perforated mounting strips spot-welded vertically on both side of the door shall be provided for attachment of cable harness, cable ducts, and covers. Enclosure shall be folded of one piece with perfectly ceiling rare panel. Pre-punched holes shall be provided in the rare panel for wall brackets. Facilities of earth conductor connections shall be provided on the enclosure, mounted plate and door. The earth continuity between the enclosure and door shall be provided by adequately sized braided copper conductor. Factory fabricated sealed gland plates shall be provided. Outdoor mounted enclosure shall be provided with rain canopy. All cable connections to the outdoor mounted panel shall be from bottom.

The panel shall be connected to its associated DDC panel and shall contain barrier type terminal strips mounted for input and output wiring terminations.

All equipment internal to panel or face mounted shall be identified with nameplates to match approved shop drawings.

Field equipment panels shall have master key lock and hinged gasketed front door. Construction to be equal to DDC enclosure.

## **EXECUTION**

### **INSTALLATION OF CONTROL WIRING**

Provide wiring for control devices, monitoring devices, instrumentation and interlocks as required for a complete system.

Provide all BMS wiring, including power wiring to DDC's and BMS equipment. All power wiring for control system shall be from an emergency power panel.

### **INSTALLATION OF CONTROL EQUIPMENT**

Device locations are the responsibility of contractor. Group instrumentation on ductwork and fan casing in organised manner. Locations to be consistent for each type of system. Each control device, field or panel mounted shall be identified by an engraved trifoliate nameplate permanently attached to its enclosure.

Sensors mounted on air ducts having exterior insulation shall be provided with stand-off spacers with insulating material firmly fitted around spacers.

Averaging temperature and low temperature detectors shall be supported by steel grid or multiple bulb holders.

Wall mounted sensors shall be 1.7 m from floor level except in service corridors where subject to damage height shall be 2.2m or if noted otherwise. Provide insulated base where mounting on exterior wall is required. Provide metal guards where mounted in mechanical, electrical, storage, maintenance areas or in any area where subject to damage.

Pressure transducers shall be located within 15 m of sensing point. Connect to sensors with tubing of diameter recommended by sensor manufacturer and as required to prevent signal phase lag. Provide gauge tees as transducer for connection to pressure gauge.

Direct Digital Controllers and Field Equipment Panels shall be located in approved locations adjacent to system served.

## **TRAINING**

The Contractor shall furnish the services of competent instructors who will give instruction in the adjustment, operation and maintenance including pertinent safety requirements of the equipment and system specified. The training shall be oriented toward the system installed rather than being a general training course. Each instructor shall be thoroughly familiar with all aspects of the subject matter they are to teach. All equipment and material required for classroom training shall be provided by the Contractor in the Engineer-in-charge's office.

The training shall be given prior to the acceptance test period at a time mutually agreeable between the Contractor and the Engineer-in-charge, and shall be at least two (2) Days (6 hours / day) in length. Operating personnel will be trained in the functional operations of the BMS installed and the procedures that the operators will employ for system operation. The training shall include but not be limited to: -

General BMS Configuration

Operation of Computer and Peripherals

Command Line Mnemonics

Report Generation

Operator Control Function

Graphics Generation

General equipment layout

Troubleshooting procedures

Preventive Maintenance procedures

Sensor maintenance and calibration

## **CALIBRATION AND COMMISSIONING**

The Contractor shall perform commissioning procedure consisting of field I/O calibration and commissioning, system commissioning and integrated system program commissioning. All commissioning information shall be documented on commissioning data sheets, which will be submitted prior to acceptance testing.

## **FIELD I/O CALIBRATION AND COMMISSIONING**

Prior to system program commissioning, the contractor shall verify that each control device has been installed according to the shop drawings and shall test, calibrate and bring on-line each control device. Commissioning shall include but not be limited to: -

Sensor range.

Sensor accuracy at 10, 50 and 90% of range.

Verify analog limit and binary alarm reporting.

Point value reporting.

Binary alarm and switch settings.

Actuator ranges.

Fail-safe position on loss of control signal, and electric supply.

Calibration and test data shall be recorded on commissioning data sheets and submitted. Data sheets shall include the device designation, the date of commissioning and name of the person who performed commissioning.

## **SYSTEM PROGRAM COMMISSIONING**

After control devices have been commissioned, each DDC program shall be put on-line and be commissioned. The contractor shall confirm that the DDC program logic follows the approved software flow chart and sequence of operation. Each control loop shall be adjusted to provide stable control and control within the specified accuracies. System program commissioning results and loop adjustments shall be recorded on commissioning data sheets and submitted.

## **INTEGRATED SYSTEM COMMISSIONING**

After all DDC programs have been commissioned, the contractor shall verify the overall system performs as specified. Tests shall include but not be limited to: -

Data communications, both normal and failure modes.

Fully loaded system response time.

Impact of component failures on system operation.

Time / Date changes

End of month / end of year operation.

Global application programs

System backup and reloading.

System status displays

Diagnostics

Power fail restart procedure

Battery backup

## **AUTOMATION CONTROL SEQUENCES**

### **GENERAL**

Contractor to customize control strategies and control sequences and be able to define appropriate control loop algorithms and choose the optimum loop parameters for loop control. All control loops shall be tuned to stabilize within  $\pm 1\%$  of set point within 5 minutes of set-point change or system start-up.

Safety devices shall be hardwire inter locked with “hand” and “automatic” positions in series with motor controller holding coil circuit.

Startup sequences and automatic control sequences as described on hereinafter shall operate in both automatic and manual modes.

Rest schedules and set points shown in sequences are for initial programming and start-up; during system check out the reset schedules and set points shall be fine-tuned to obtain desired comfort and energy results.

The output of the reset schedules should be limited between maximum and minimum values. In the control sequences when a reset schedule is indicated, the range of the output be limited between the minimum and maximum values indicated in the reset schedules.

All functions which use analog points to switch equipment on and off (e.g. fans, pumps) must be programmed with dead bands, and if necessary, time delays to prevent short cycling of equipment.

An additional Chiller and chilled water pump may be installed after the BMS is operational. The control programs must be written so that the future equipment can be easily integrated by a trained operator. To add this equipment to the program, the operator must only enable the associated program lines and input / output points. During the commissioning period both the current and future plant control programs must be tested and shown to be operational.

## **ENCLOSURES FOR CONTROLLERS AND ELECTRICAL PANELS**

### **ENCLOSURES**

All the controllers shall be housed in Lockable Vandal proof boxes, which shall either be floor mounted or wall mounted. These shall be free standing, totally enclosed, dust and vermin proof and suitable for tropical climatic conditions.



The panel shall be metal enclosed 16 SWG CRCA sheet steel cubicles. All doors and covers shall be hinged and latched and shall be folded and braced as necessary to provide a rigid support. Joints of any kind in sheet metal shall be seam welded with welding slag ground off and welding pits wiped smooth with plumber metal.

All panels and covers shall be properly fitted and secured with the frame and holes in the panels correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with nuts. Self-threading screws shall not be used in the construction of control panels. Knockout holes of approved size and number shall be provided in the panels in conformity with the location of incoming and outgoing conduits/cables. Clamps shall be provided to support the weight of the cables. The boxes shall be painted as per the requirement decided in consultation with the Consultant.

Wiring for connection to the respective panels shall be in BMS scope. This shall be done with co-ordination to the Panel Vendor/Other service Provider. Besides this a circuit diagram showing the arrangement shall be pasted on the inside of panel door and covered with transport perspex sheet 2 mm thick.

## **GENERAL**

Prior to laying and fixing of conduits, the contractor shall carefully examine the drawings indicating the layout; satisfy himself about the sufficiency of number and sizes of conduits, sizes and location of conduits and other relevant details. Any discrepancy found in the drawings shall be brought to the notice of Consultant. Any modifications suggested by the Contractor shall be got approved by the Consultant before the actual laying of conduits is commenced.

## **CONDUITS/TRUNKER**

Conduits and accessories shall conform to relevant Indian Standards mild steel conduits of 25 mm dia, protected by black bituminous enamel shall be used. Buried cabling passing under floor of ground floor, if any, shall run in galvanized steel conduit. Joints between conduits and accessories shall be securely made, to ensure earth continuity.

The conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

## **CONNECTIONS**

All jointing methods shall be subject to the approval of the Consultant. Separate conduits shall run for all power outlet wiring. Conduit connections for MS conduits shall be screwed metal to metal with white lead and exposed threads shall be painted with one coat of self-etching zinc chromate and two coats of enamel paint.

The threads and sockets shall be free from grease and oil. Connections between screwed conduit and controller metal boxes shall be by means of brass hexagon smooth bore bush, fixed inside the box and connected through a coupler to the conduit. The joints in conduits shall be free of burrs to avoid damage to insulation of conductors while pulling them through the conduits.

**BENDS IN CONDUIT**

Where necessary, bends or diversions may be achieved by means of bends and/or circular inspection boxes with adequate and suitable inlet and outlet screwed joints. In case of recessed system each junction box shall be provided with a cover properly secured and flush with a finished wall surface. No bends shall have radius less than 2-1/2 times the outside diameter of the conduit.

**FIXING CONDUITS**

The conduits, junction boxes, outlet boxes and controller boxes once installed in position, shall have their outlets properly plugged or covered so that water, mortar, insects or any other foreign matter does not enter into the conduit system. Surface conduits shall be fixed by means of spacer bar saddles at intervals not more than 500 mm.

The saddles shall be 2 mm x 19 mm galvanized mild steel flat, properly treated, primed and painted, securely fixed to supports by means of nuts and bolts/raw bolts and brass machine screws.

**DRAWING OF CONDUCTORS**

While drawing insulated wires/cable into the conduits, care shall be taken to avoid scratches

Following points are to be considered by Contractor

The Contractor has to carry out the detailed engineering design of services in coordination with Architectural, Structural and other services requirement as per the duly approved layouts to be obtained by the Contractor.

The services drawing are indicative and show the detailed design parameters to be adopted: makes to be used by the contractor in addition to parameters specified in DBR and Technical Specification.

## **SUB HEAD - 21**

### **CCTV SYSTEM**

#### **SCOPE OF WORK:**

These technical specifications cover the requirements for Designing, Engineering, Manufacturing, supplying, Delivering, Installing, Testing and Commissioning an IP based CCTV Surveillance System.

The IP CCTV Surveillance System shall consist of the following elements:

IP CCTV Cameras mounted in the critical areas.

#### **STANDARDS:**

All the CCTV products will be supplied and integrated end to end and shall be UL Listed.

The proposed Camera and Chipset should not from country sharing land border with India. Camera OEM need to submit declaration on letter head regarding quoted model specific sensor and SoC details (Make, Model etc.).

All the camera should NDAA(National Defense Authorization Act) compliant. No internal component should be manufactured/ imported/ originated from China

OEM should not be blacklisted or barred by any Ministry of Government of India or globally or any of the Government / PSUs or any other government department at the time of bidding.

The cameras offered must be UL 2900-2-3 and IEC 62443-4-1 cyber security certified for mitigating cyber security risk.

The camera shall offer embedded edge video analytics . The video analytics software shall run in full on the camera without any need of external hardware or software. It shall provide the following alarm and statistic tasks: Intrusion Detection, Loitering, Counting, Crowd Detection, Occupancy Monitoring, tampering.

All the CCTV products shall be of the same manufacturer.

#### **IP SURVEILLANCE SOLUTION'S CAMERA REQUIREMENT SHALL BE WITH BELOW MINIMUM STANDARD:**

The cameras shall meet/ exceed the below mentioned minimum requirement;

- I. The cameras must have minimum of 3 MP resolution
- II. It must have H.264 slandered video compression with high compression ratio.
- III. The camera should have 128 GB On-board storage.
- IV. The device should have CCD / CMOS based Scanning sensor.
- V. The camera must be equipped with Digital Wide Dynamic Range (120db or better), Auto-iris, Auto White Balance, BLC, electronic shutter etc. like features.
- VI. The Camera must support dual stream and the sub-stream for mobile surveillance.

- VII. The Camera must be equipped with proper noise reduction functionality like 3D Digital Noise Reduction (3D DNR)
- VIII. The Camera must be equipped with High-performance and long service life Infrared (IR) LED shall be factory fitted. No external IR Housing / LED will be allowed to install with camera.
- IX. The Camera shall be able to capture the image in pitch dark conditions at 0Lux in IR ON condition.
- X. The Network Camera must have dual power supply input option of direct power in of 12V/24V AC / DC & Power over Ethernet (PoE).
- XI. The Camera must have the facility to store the images at field level itself inside the camera in the available Memory Card Slot support to the minimum of 1 Day storage (Memory Card should be encrypted)
- XII. The Complete Camera range must have ONVIF complaint slandered.
- XIII. The Camera must have of minimum weather protection level of Ingress Protection level: IP66
- XIV. The complete product range must adhere the listing of UL rating.
- XV. The Camera, NVR / NAS must be supplied from the same manufacturer for ease of connectivity & proper reception of all camera devices.

#### **IP SURVEILLANCE SOLUTION SOFTWARE PACKAGES SHALL BE WITH BELOW MINIMUM STANDARD:**

The Video Management Software for the IP Surveillance Solution Devices shall provide multiple functionalities, including real-time live view, video recording, remote search and playback, file backup, etc., for the connected devices to meet the needs of monitoring task. With the flexible distributed structure and easy-to-use operations, the client software is widely applied to the surveillance projects of medium or small scale.

The client software shall be composed of the following function modules:

- Support of IT Standards and Internet Technologies
- Secure User Access
- The Main View module provides live view of network cameras and video encoders, and supports some basic operations, such as picture capturing, recording, PTZ control, etc.
- The Remote Playback module provides the search, playback, export of record files
- The E-map module provides the displaying and management of E-maps, alarm inputs, hot regions and hot spots
- The Device Management module provides the adding, modifying and deleting of different devices and the devices can be imported into groups for management
- The Event Management module provides the settings of arming schedule, alarm linkage actions and other parameters for different events
- The Software & hardware must support forensic Zooming at Live view mode.
- The Record Schedule module provides the schedule settings for recording
- The Account Management module provides the adding, modifying and deleting of user accounts and different permissions can be assigned for different users
- The Log Search module provides the query of system log files and the log files can be filtered by different types

The System Configuration module provides the configuration of general parameters, file saving paths, alarm sounds and other system settings

### **3MP Dome Camera**

<b>S.No</b>	<b>Features</b>	<b>Specifications</b>	<b>Compliance</b>
1	Form Factor	Dome	
2	Certification	UL,CE,FCC	
3	Weather Protection	IP 66 or better	
4	System Compatibility	ONVIF profile S & G	
5	Max Resolution	3 MP ( 2048 X 1536 )	
6	Image Sensor	1/2.8" or larger	
7	Min-illumination	0.05Lux @ (F1.2, AGC ON), 0 Lux with IR	
8	lens	Motorized varifocal , 2.8 mm - 12 mm , autofocus	
9	Shutter Speed	1/5 s ~ 1 / 100,000 s	
10	Min Stream	Triple Stream or more , Each stream should support H.265 compression	
11	IP Filter	Should support IP filter for security purpose	
12	Frame Rate	30 fps @ 3 MP	
13	Digital Zoom	should have the capability to digitally zoomed in web browser by selcting the area using mouse	
14	ROI	Should Support ROI	
15	WDR	Digital WDR	
16	IR	Inbuilt IR Leds with IR distance upto 30 mtrs	
17	Day & Night	IR cut filter with auto switch	
18	Day / Night Switch	Auto / Schedule / Triggered by Alarm In	
19	Noise Reduction	2D / 3D DNR	
20	Video Compression	H.265 , H.264	
21	Bit Rate	256K ~ 8M	
22	Image setting	Rotate Mode, Saturation, Brightness, Contrast, Sharpness adjustable by web browser	
23	Edge analytics	Motion Detection, Perimeter Intrusion, Line Crossing, Stationary Object, Face detection ,Cross counting	
24	Protocols	TCP / IP, UDP, ICMP, HTTP, HTTPS, FTP, DHCP, DNS, DDNS, RTP, RTSP, RTCP, PPPoE, NTP, UPnP, SMTP, SNMP, IGMP, 802.1X, QoS, IPv6, Bonjour	
25	Security	Flash-prevention, dual stream, heartbeat, mirror, password protection, privacy mask, IP address filtering	
26	Privacy masks	Should support atleast 4 privacy masks	
27	Factory default	Should have the option of setting the configuration to factory default except network settings.	

28	Power	POE / 12 V DC	
29	Corridor Mode	Should Support Defog mode	
30	Firmware upgrade	Firmware upgrade shall be done through web browser	
31	Remote Update	Camera IP and firmware should be upgradable through the device search tool/Software without directly logging in to the camera. Firmware should also be upgradable through web browser	
32	Power Consumption	Max. 7 W with IR cut filter on	
33	Operating Temperature	-30 °C ~ 60 °C, Humidity 95% or less	
34	Users	should support 1 admin and 6 user accounts	

**3MP BULLET Camera**

S.No	Features	Specifications	Compliance
1	Form Factor	Bullet	
2	Certification	UL,CE,FCC	
3	Weather Protection	IP 66 or better	
4	System Compatibility	ONVIF profile S & G	
5	Max Resolution	3 MP ( 2048 X 1536 )	
6	lens	2.8mm to 12 mm motorized varifocal length	
7	Focus	Auto focus	
8	Shutter speed	1/5 s ~ 1 / 100,000 s	
9	Image sensor	1/2.8" or larger	
10	Min illumination	0.05 Lux @ (F1.2,AGC ON), 0 Lux with IR	
11	WDR	120 dB	
12	Video compression	H.265, H.264	
13	Noise reduction	2D / 3D DNR	
14	Video Streams	triple stream , Each stream should support H.265 compression	
15	frame rate	30 fps @ 3 MP	
16	Edge analytics	Motion Detection, Perimeter Intrusion, Line Crossing, Stationary Object, Face detection ,Cross counting	
17	Image setting	Brightness , Contrast , Saturation adjustable by web browser	
18	Rotate Mode	Yes	
19	Alarm	1 input, 1 output	
20	Audio	1 input, 1 output	
21	Defog	Should support Defog mode	
22	SD Card support	SD card upto 128 GB	

23	Protocols	TCP / IP, UDP, ICMP, HTTP, HTTPS, FTP, DHCP, DNS, DDNS, RTP, RTSP, RTCP, PPPoE, NTP, UPnP, SMTP, SNMP, IGMP, 802.1X, QoS, IPv6, Bonjour	
24	Security	Flash-prevention, heartbeat, mirror, password protection, privacy mask, IP address filtering	
25	Privacy zones	Atleast 4 Nos of privacy mask	
26	Digital Zoom	should have the capability to digitaly zoomed in web browser by selcting the area using mouse	
27	bit Rate	Bit rate should be adjustable from 256K ~ 8M	
28	ROI	Should Support ROI	
29	IR LED	Should have inbuilt IR LEDs	
30	IR Distance	Min IR distance 40 meters	
31	user accounts	should support 1 admin and 6 user accounts	
32	Factory default	Should have the option of setting the configuration to factory default except network settings.	
33	Firmware upgrade	Firmware upgrade shall be done through web browser	
34	Remote Update	Camrea IP and firmware should be upgradable through the device search tool/Software without directly logging in to the camera. Firmware should also be upgradable through web browser	
35	Operating Temperature	-30°C ~ 60°C Humidity 95% or less (non-condensing)	
36	Power Supply	12 V DC /POE	
37	Power Consumption	Max 7 W with IR cut filter on	

**PTZ Camera**

		<b>PTZ CAMERA</b>	
<b>S.N o</b>	<b>Features</b>	<b>Specifications</b>	<b>Compliance</b>
1	Form factor	Dome PTZ	
2	Sensor	1/2.8" Sony Progressive CMOS	
3	Day/ Night Operation	Yes with IR Cut Filter	
4	Minimum illumination	0.05 @ F1.6 (Color), 0 (B/W) @ F1.6	
5	Focal Length	4.3-129 mm	
6	Zoom	30X optical Zoom ,12 X Digital Zoom	
7	Electronic Shutter	1 ~ 1/10,000 s	
8	Image resolution	3 MP ( 2048 X 1536 ) or better	
9	Video Compression	H.265,H.264	

10	Frame Rate and Resolution	H.265/H.264 3M (2048 X 1536) @25/30 fps , 2 MP (1920 X 1080 ) @ 50/60 FPS	
11	Simultaneous Stream	Minumum 2 streams should be configurable at 1920 X 1080p simultaneously	
12	White Balance	Auto / Manual / ATW / One Push	
13	GOV Length	It should be possible to vary the GOV length in the camera setting.	
14	Field of view	64° - 2.4 ° or better	
15	Noise Reduction	2D DNR , 3D DNR , Color Noise reduction	
16	Resolution	3 MP ( 2048 X 1536 ) or better	
17	Multiple Stream	Quad Stream	
18	Frame Rate (Main stream)	upto 25 fps @ 3MP , upto 50 fps @ 2 MP	
19	Video Streams	Quad Stream supportable , Each stream should be H.265,H.264 configurable at different resolutions, frame rate and bit rate.	
20	Image Setting	Saturation, Brightness, Contrast, Sharpness,Hue adjustable	
21	Focus	Auto / Manual	
22	Two way audio	Line in , Line Out	
23	WDR	120 dB	
24	Audio Compression	G.711 , G.726 , AAC	
25	Iris	P iris	
26	IR	Inbuilt IR , IR distance upto 200 mtr	
27	Illumination Adjustment	IR illumination adjustment by zoom ratio with inbuilt IR LEDs	
28	Alarm	4 input , 2 Output	
29	Edge Video Content Analytics	Camera should have in-built Edge Based Analytics, Abandoned Object, Intrusion Detection,Tampering, Wrong Direction, Loitering Detection, Object Counting, Stopped Vehicle, Object Removal	
30	Storage backup on network failure	Camera should support network failure detection , Camera should have the capability to start the recording automatically on SD card in case of connectivity between camera and NVR/Storage device goes down	
31	Edge Storage	Built in SD card slot with support upto 128 GB SD card	
32	Protocols	IPv4/v6, TCP/IP, UDP, RTP, RTSP, HTTP, HTTPS, ICMP, FTP, SMTP, DHCP, PPPoE, UPnP, IGMP, SNMP, QoS, ONVIF	
33	Text Overlay	Date & time, and a customer-specific text etc	
34	Security	HTTPS , IP Filter , IEEE 802.1X	
35	Firmware Upgrade	The firware upgrade shall be done though web interface, The firmware shall be available free of cost	
36	Privacy Mask	upto 20 privacy zones	



37	PTZ	Pelco D, Pelco P, DSCP Protocol Support	
38	PAN	360 ° endless , Manual speed 0.1° ~ 300°/s , preset speed 9° ~ 350°/s	
39	Tilt	,-20° ~ 200° , Manual speed 0.1° ~ 200°/s , Preser speed 7° ~ 300°/s , Auto flip	
40	Presets	256	
41	PTZ Operation	8 sequence , 8 cruise , Auto pan	
42	Speed by zoom	Pan and tilt speed proportional to zoom ratio	
43	Home Function	Preset , Sequence ,Auto pan , Cruise	
44	Calibration	Auto( On/Off)	
45	Resume after power loss	Supported zero downtime power switching	
46	Alarm response	Preset , Sequence ,Auto Pan , Cruise	
47	BNC	1 X BNC	
48	Ethernet Interface	1 X RJ 45	
49	Certifications	UL ,CE,FCC	
50	Compatibility	ONVIF profile S , G and Q	
51	Supported Web browser	Internet Explore (10.0+) / Firefox / Safari	
52	Weather Proof	IP 66	
53	Operating Temperature	,-40°C ~ 50°C	
54	Power Supply	802.3at (PoE+) 4-Pair 60W / AC 24V ± 20%	
55	Power Consumption	45W or less (with IR & Heater on)	

**64 Channel NVR upgradable upto 128 Channel**

S.No	Feature	Specification	Compliance
	System	CCTV Camera and NVR should be of same make	
1	CPU	Intel i7 core or better	
2	RAM	2x4GB, DDR3 or better	
3	Graphics	Intel HD Graphics	
4	IP Camera Input	64 CH upgradable to 128 CH	
5	Operating System	Embedded Linux OS	
6	Video Management System	Pre-Installed with appropriate licenses	
	Recording / Playback		
7	Throughput	640 Mbps	
8	Decoding	Upto 3840 PPS @ D1	
9	Recording Mode	Continuous, Schedule, Event Recording	

10	PlayBack Mode	Auto, Custom, Split Mode	
	Storage and I/O		
11	Built-in SATA Interface	2.5" SATA x 1 (for OS) + 3.5" SATA x 8 (for storage)	
12	RAID	Hardware RAID 0/1/5/10	
13	e-SATA	1 port	
14	COM Port	RS-232 x 1 + RS-485 x 1	
15	Video Output	HDMI / VGA	
16	Audio Input	1 x Mic In	
17	Audio Output	1 x Line Out	
18	USB Port	USB 3.0 x 2 + USB 2.0 x 3	
19	Digital Input	TTL-level x 8	
20	Digital Output	Relay NC/NO x2 (DC24V/1A)	
	Network		
21	WAN Port	1 x 10/100/1000 Mbps	
22	LAN Port	1 x 10/100/1000 Mbps	
23	SFP Combo Port	1 x 1 Gbps	
	Built-in PoE Switch		
	General		
24	Operation Temperature	0°C ~ 40°C	
25	Operation Relative Humidity	10% ~ 90% Non-condensing	
<b>VMS Specification</b>			
<b>S.NO</b>	<b>Features</b>	<b>Specifications</b>	<b>Compliance</b>
1	Maximum Number of Clients	1 admin / 5 users or more (concurrent) per NVR	
2	Compression	H.264 , H.265	
3	Compatibility	ONVIF profile S & G	
	Live view		
4	View Manager	An interface to define layouts and pre-set cameras in multiple view mode	
5	View Patrol	Able to switch between different view pages and devices	

6	Layout Manager	An interface to modify display layout, position and the size of live view of camera within layout	
7	Digital Zoom	Zoom in/ Zoom out digitally by mouse scroll wheel	
8	Snapshot	Instant snapshot upon mouse click	
9	Event Notification	Alarm, Motion detection, Connection loss/ auto reconnect between VMS and NVR/camera	
10	Bandwidth Management	Live view with stream 1 in full screen mode or stream 2 in multi-view screen mode (Bitrate adjustable)	
11	Camera Management	Camera control, image setup, camera video format, IR/Exposure setup, Camera information	
	E-Map		
12	Layout	Area maps with camera icons, small live view screen; alarm trigger, event trigger	
13	Setup	Google map positioning; E-Map image upload; camera positioning; camera vision angle and direction	
	PTZ		
14	Control	Pan, tilt, zoom control; focus, exposure adjustment	
15	Preset Points and Tours	Support	
16	Joytick	USB based Joystick support	
	Device Management		
17	Device Search	Auto connect/ Auto scan / Manual add NVR or Camera	
18	Device Information	Model name, IP address, MAC address, type, protocol, streaming port, port, video snapshot	
19	Search Filter	IPCAM, NVR, DVR, VSS; ONVIF	
	Playback & Export		
20	Recording Search	Search video recording by time, event, channel from multiple cameras/ NVRs Instant view, snapshot and export	
21	Playback control	Continuous forward and backward with speed 1/4x, 1/2x, 1x, 2x, 4x; pause	
22	Synchronized Playback	32 CH(Local)/ 64 CH(Remote)	
23	Snapshot	Instant snapshot upon mouse click	
24	Digital Zoom	Zoom in/ Zoom out digitally by mouse scroll wheel	
25	Video Export	Export Video clips with AVI, RAW, MP4, MKV, MOV; digital signature supported	
	Event Management		

26	Event Source	Multiple cameras/ NVRs	
27	Event Trigger	Video motion detection, Alarm, Video loss	
28	Event Response	Instantly Record video, audio notification, full screen pop-out with live video, email notification	
29	Smart Search	Smart search list for recorded videos by video motion detection/ alarm/ video loss	
	System		
30	Permission Management	Unlimited number of users, Active Directory, customized permissions for different user including covert cameras/ NVRs, device management, playback & export	
31	Language	Multiple language support	
32	Operation Log Management	Recorded list of user operation, IPCAM event, NVR event	
33	System status	Instant view of CPU usage, RAM, HDD valid space, Network status	
34	Setting Import/ Export	Possibility to import or export setting packs for convenient VMS setting management	
	Remote Access		
35	PC Web Browser	Microsoft Internet Explorer 11+ with 16CH display layout	

#### **Pole For Outdoor Camera**

- Shall be of Lightweight aluminum and feature welded construction, providing an extremely rigid camera mount
- 6Mtr Indoor/Outdoor
- Feed-through Wall Mount
- Maximum Load 9 kg (20 lb)
- Mounting Head Adjustable 360° pan, 180° tilt
- Finish Light grey

#### **Operator Workstation:**

The Client workstation which shall have following specifications

- a) Processor Intel ® i7 750 2.66 GHz with internal memory of 8 GB (expandable to 16 GB) RAM, 2 TB HDD .
- b) Operating system Windows® 7 Professional 64-bit (WOW64mode).
- c) Dual or compatible pair of NICs, 1 Gbps.
- d) NVIDIA 2 GB dedicated Graphic Card. Resolution support for cameras 2560 x 1600 display resolution capable and DirectX true color 32 bit.
- e) Client workstation shall support Dual monitors each displaying 32 cameras simultaneously. A maximum of 64 cameras viewing per workstation at a time programmable

- f) Each Display Unit shall be of 32" Commercial Display Color Monitors (HD LED) for 24x7 operations

#### **IT Infrastructure:**

- a) The equipment racks to mount passive and active components, Data Cross Connects and Equipments.
- b) All the racks should support 19" rack mountable equipments/components and should be of 6U or 36U size.
- c) Two types of racks will be used: 6U rack to mount at field level for layer 2 unmanaged switch & components. 42U rack to mount in control room for server / NVR & layer-3 switches mounting.
- d) Each equipment rack should have two numbers of power strips each with at least 5 numbers of 5A/15A sockets.
- e) Each 42 U rack should have two numbers of High density vertical wiring managers and three numbers of horizontal wire managers.
- f) Each 42U rack should be supplied with floor mounting kit and ladder.
- g) Racks to be sized based on the assumption & as per required at site conditions.

#### **Technical Specification of 24 Port Core Switch**

S/N	Description	Parameters	Compliance
1	<b>General Features for switch</b>		
1.1	Form Factor	19 Inch Rack mountable Ethernet switch.	
1.2	Architecture	Non-Blocking architecture. Must have EAL3 /NDcPP or above common criteria certification.	
1.3	IPV6 Compliance	All Functionalities of Switch shall be IPv6 compliant and it should work on IPv6 Platform without any additional hardware/ software.	
1.4	End of sale	OEM End-of-sale declaration shall not have been released for the quoted model at the time of the bid submission.	
1.5	Latest OS version	The switch shall be supplied with the latest OS version and all the proposed switch should be of same IOS.	
1.6	Feature Availability	All the specified features/parameters/certifications must be available on the Technical Bid opening date. Features /parameters /certifications proposed to be available in near future / on roadmap shall not be considered.	
1.7	Basic Layer-3 Support	Switches must be managed Basic layer-3 type for better broadcast segmentation.	
1.8	Interface Specifications:	Non-blocking architecture	
1.9	Ports	Min 24 x 10 G Based SFP+ port , Min 1 x QSFP+ port , 2x Stacking port comprising 400 Gbps of stacking bandwidth from day 1 ,Min 2xQSFP28 Port from day1	
1.10	SFP Transceivers	All the Transceivers/Modules used to connect the Switches should be from the same OEM/make of the switches only	
1.12	Port status display	Each port must have a dedicated LED for status display.	

2	<b>Hardware Specifications:</b>		
2.1	Back Plane Bandwidth	At least 850 Gbps switching bandwidth	
2.2	Packet throughput	400 Mpps or more for each member switch.	
2.3	MAC Addresses and MTBF	270 K or more,	
2.4	VLANs (802.1q tagged VLAN)	4000 or more Concurrent	
3	<b>Standards and Protocols</b>		
3.1	L2 Loop Protection	IEEE 802.1d Spanning tree protocol	
		802.1s MSTP (Multiple instances of STP)	
		802.1w RSTP (Rapid spanning tree), ), Should support less than 50 Millisecond convergence .	
3.2	Link Aggregation	802.3ad Link Aggregation	
3.3	QOS Support	At least 8 nos of 802.1p Priority Queues per port.	
3.4	IP Multicast	IGMP Snooping	
3.4	Port Mirroring / Span port	Port mirroring must be available.	
4	<b>Routing Features</b>		
4.1	Routing Protocols:	The switch shall have hardware based forwarding for IPv4 & IPv6. Following protocols shall be supported with IPV4: Static routing, PBR, RIPv2, OSPFv2 IPV6: PBR, Static routing, RIPv6, OSPFv3 The switch shall have Dual stack mode to run both IPv4 & IPv6 RIP and RIPv6 ready from day 1.MPLS,SyNCE,DCBx.PFC.QCN,ETS	
4.2	Router redundancy	Shall support VRRP for IPV4 and IPV6.	
4.3	Security Features		
4.4	Network Login	MAC and 802.1 X based Login must be available	
4.5	Port Security	MAC Address based Lockdown and Limited Learning	
4.6	Access Control Lists:	L2/L3/L4 IP based, Source port, destination port, MAC based, Time based	
4.7	AAA (authentication, authorization and accounting)	AAA using RADIUS must be available	
5.	<b>Management and Monitoring:</b>		
5.1	Management	Following in-band management methods shall be available:	
		Secure Web based management (On https)	
		SSH based management (SSH v2).	
5.2	Out-of-band management	Following out-of-band management methods shall be available:	
		Serial console port	

		Management ethernet port .Dedicated OOB port	
5.3	Role based Administration	The switch shall support multiple administrator accounts. Each administrator account shall be configurable with the desired level of management privileges.	
5.4	Remote Monitoring	RMON Support RFC 5357 for measuring round-trip performance between two devices	
5.5	Network Management	The switch should support SNMP V2c and V3, XML api and SDN with Openflow	
5.6	Log Management	Syslog shall be supported with multiple syslog destinations.	
5.7	Flow export	Shall support Netflow/IPFIX/sflow for flow exports.	
5.8	Time synchronization	Time synchronization using Network time protocol must be available.	
5.9	Configuration backup & restore	The switch shall have feature of backing up the configuration & restoring a backed- up configuration. Multiple Configuration files must be supported.	
5.10	TFTP/FTP upload and download	Config/image upload and download from TFTP/FTP server shall be available.	
6.	<b>Other Requirements:</b>		
6.1	Interface cables and other features	Console cable and power cable (As per Indian standards) to be provided. All Cables shall be factory-terminated. The Switch Operating System (OS) should mandatorily support individual process (eg ssh , snmp, telnet, dhcp etc) restart to prevent reboot in case of Software Process Crash by running processes on top of Kernel. Should support AVB to ensure set of standards that provide the means for highly reliable delivery of low-latency, time-synchronized AV streaming services through Layer 2 Ethernet networks	
6.2	Power Supply & FAN	Each switch should be populated with 1 PSU, should have option for RPS.	
6.3	Safety certification	The switch shall conform to IEC-60950/CSA-60950/EN-60950/UL-60950 standard for safety requirements of information technology equipment.CB,CE	
6.4	Environmental conditions	The offered equipment must be able to operate in the following environmental conditions	
		“ Operating temperature: 0°C to 45°C	
		“ Relative Humidity: 10% to 95% Non-condensing	

**Technical Specification of 24 Port PoE Switch**

S.No	Features	Specifications	Compliance
1	Port Configuration	24 Nos of 10M/100M/1G RJ45 Port ,4 Nos of1G/10G SFP+ Port , 1 Nos of DB9 Console Port .	
2	PoE Function	IEEE802.3at (PoE+ 30W) ,IEEE802.3af (PoE 15.4W)	
3	PoE Port	24	

4	Available PoE Power	370W	
5	Switching Bandwidth	128 Gbps	
6	Forwarding Performance	95.232 Mpps	
7	MAC Address	32 K	
8	Jumbo Frames	10056 Bytes	
9	Spanning Tree	IEEE802.1D (STP),IEEE802.1W (RSTP),IEEE802.1S (MSTP)	
10	VLAN	802.1Q VLAN , Port-Based ,Private VLAN , Voice VLAN ,Guest VLAN, Q-in-Q , 802.1v Protocol VLAN , MAC-Based VLAN ,IP Subnet-Based VLAN	
		4K VLAN Entries	
11	IEEE 802.3ad LACP	Dynamic Trunk , Static Trunk	
12		GARP/GVRP , IGMP Snooping , MLD Snooping ,Multicast VLAN Registration (MVR)	
16	L3 Features	Static Route , DHCP Server	
17	Class of Service	Port Based , 802.1p ,DSCP, TCP/UDP Port	
18	Rate Limiting	Ingress , Egress	
19	Priority Queue Scheduling	WRR , Strict Priority	
20	Hardware Queues	8	
21	ACLs	L2/L3/L4 , IPv6 Support	
22	Security	Port Security (MAC-based) , IP Source Guard ,Storm Control ,RADIUS Authentication 802.1x , TACACS+ Authentication ,HTTPs and SSL (Secured Web) ,BPDU Guard ,STP Root Guard ,DHCP Snooping,Loop Protection	
23	DHCP	Client , Relay , Option 66 , Option 67 , Option 82	
24	Event/Error Log	Syslog , SMTP (RFC821)	
25	Management Access Filtering	SNMP , Web , Telnet , SSH	
26	PoE Management	Scheduling ,Auto-Checking ,Power Delay	
29		SNMP (v1, v2c, v3) , RMON ( 1,2,3 & 9 Groups) , Software Upgrade	
32		Configuration Export/Import , Port Mirroring ,	
34		LLDP (IEEE802.1AB)	
35		LLDP-MED (IEEE802.1AB)	
36		CDP Aware ,sFlow ,IPv6 Management , NTP	
40	Device Management	Topology View , Floor View ,Map View , Dashboard ,Traffic Monitoring , Cable Diagnostics	
41	Operating Temperature	0°C to 40°C	
42	Operating Humidity	10 to 90% RH	



43	Storage Temperature	-20 to 70°C	
44	Storage Humidity	10 to 90% RH	
45	AC Input	100V-240V	
46	Certifications	EN61000-4-5 (for RJ45 Port, Surge 6KV) ,CE/FCC Class A	

**Cable & Conduit:**

To Establish the Connectivity between Switches to Switches & Camera to Switches shall be UTP CAT-6 level cable will be installed, if distance between the above object is less than 80 Mtr. If the distance get exceed from 80 Mtrs. Then Single Mode OFC Cable will be required to install.

**CAT-6 UTP cable:**

- Cables should be dressed and terminated in accordance with the manufacturer's recommendations and/or best industry practices.
- Pair untwist at the termination should not exceed one-half an inch.
- Bend radius of the cable in the termination area should not be less than 4 times the outside diameter of the cable.
- The cable jacket should be maintained as close as possible to the termination point.
- Cables should be neatly bundled and dressed to their respective panels or blocks. Each panel or block should be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- The distance between UTP data cable and any power cable should be more than 4 inches.
- Each cable should be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view should not be acceptable.
- Cables should be installed in continuous lengths from origin to destination (no splices).
- Cables should not be attached to ceiling grid or lighting support wires.
- Care should be taken when pulling cables into trucking to avoid damage due to snagging. Trucking partitions should be used to separate the data cables from power, and bridges should be used where data cables have to cross the mains.

**Heavy Duty Conduits:**

Conduit & accessories shall confirm to relevant Indian Standard.

- All rigid conduit pipes shall be of Heavy Duty PVC and be ISI marked. The wall thickness shall be not less than 2 mm for conduit up to 25 mm dia.
- The maximum number of PVC insulated cables / wires conforming o ISI: 694-1990 that can be drawn in one conduit as per standard norms. Conduit sizes shall be selected accordingly in each room.
- No conduit less than 25 mm in diameter shall be used. Flexible conduits will only be permitted for interconnections between switchgear, DB's and conduit terminations in wall.

**Power Cable:**

- Cables should be dressed and terminated in accordance with the manufacturer's recommendations and/or best industry practices.

- b. 3CX1.5 Sq mm Power Cable for UPS shall be required for existing Conduit/raceway/cable tray with clamp/saddles/tie
- c. The cable jacket should be maintained as close as possible to the termination point.
- d. Cables should be neatly bundled and dressed to their respective panels or blocks. Each panel or block should be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- e. Each cable should be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view should not be acceptable.
- f. Cables should be installed in continuous lengths from origin to destination (no splices).
- g. Cables should not be attached to ceiling grid or lighting support wires.
- h. Care should be taken when pulling cables into trucking to avoid damage due to snagging. Trucking partitions should be used to separate the data cables from power, and bridges should be used where data cables have to cross the mains.

**OFC cable:**

- a. Proper cable preparation is essential for splicing and installation. The following points outline some special precautions which are specific to fiber optic cable installation and therefore need to be noted.
- b. 6 core SM/MM fibre optic cable shall be used for establish the communication wherever required.
- c. Fiber Stress: The fibers in the cable should not be subject to any undue stress. This means that if the cable is to be pulled into a long duet route then the specialized equipment and procedures should be used.
- d. Bend Radius: The cable manufacturer's minimum bend radius should be observed. i.e. there should be no bends tighter than specified either during installation or once cable has been seen fixed.
- e. Cable Ties: If cable ties are used, then it is very important that they are not over tightened, thereby causing localized bending and fiber stress.
- f. Spare Cable: At least 5m of cable should be left at each end to allow testing, positioning of enclosures, spare fiber for repairs etc. Where appropriate, spare loop of cable should be included along the cable run to assist repair in case of accidental damage.
- g. Labeling: All cables and cable end should be labeled clearly.
- h. Cable End Protection: Where cable ends are to be left exposed then that should be sealed with heat shrink caps to prevent ingress of dirt or moisture.

**Accessories:**

- a. The conduit wiring system shall be complete in all respects, including their accessories.
- b. Bends, couplers, etc. shall be solid type in recessed type of works and may be solid or inspection type as required.
- c. Saddles for surface conduit work on wall shall not be less than 0.55 mm (24 gauge) for conduit up to 25 mm dia. and not less than 0.9 mm (20 gauge) for larger diameter.
- d. The minimum width and the thickness of clips used for fixing conduit to steel joints, and clamps shall be per standard norms.



**SUB HEAD - 22****PARKING MANAGEMENT SYSTEM****SCOPE OF WORK:**

These technical specifications cover the requirements for Designing, Engineering, Manufacturing, supplying, Delivering, Installing, Testing and Commissioning of Parking Management System

**Stack Parking**

- The Contractor will supply, install and Commission the Stack parking, as per technical specification, to cover 100% parking slots marked in drawings in the basements.
- Simple Stacker minimum 702 No.s
- The Electro Mechanical Stack parking must have minimum lifting capacity of 2300 Kgs. The Structure shall be Powder Coated and the Lifting Platform shall be for corrosion resistance. The Equipment shall be fixed with Automatic Raising and lowering of platform on one time push of the relevant button for operation. Equipment shall be designed to transfer the vehicle load on to the structure by relieving the load on the hydraulic piston and valves for long term parking of the vehicle. It should not be possible to lower the vehicle when a car is parked underneath.
- Wireless Connectivity with BMS

Should be capable to communicate with the BMS for automatic raising / Lowering, and status of its electrical and mechanical parameters

**Car Parking Management System:**

- Issue of Bar-coded Parking Ticket through Automated manned Ticket Dispenser.
- Boom Barrier for automated vehicle entry.
- Boom Barrier at exit to operate after receipt of Parking Charges at manned Payment Booth.
- Manned Payment Booth at exit to collect payment as per Parking Tariff on scanning the parking ticket issued at entry.
- Display of available parking capacity at LED Display Boards installed at Entry.
- Minimum 5 KVA UPS with 30 minutes battery back-up to be provided for the Parking Management System.

**Parking Management System:****STANDARD REPORTS**

- Car entry and exit reports
- Shift wise/operator wise collection report
- Occupancy/vacancy report

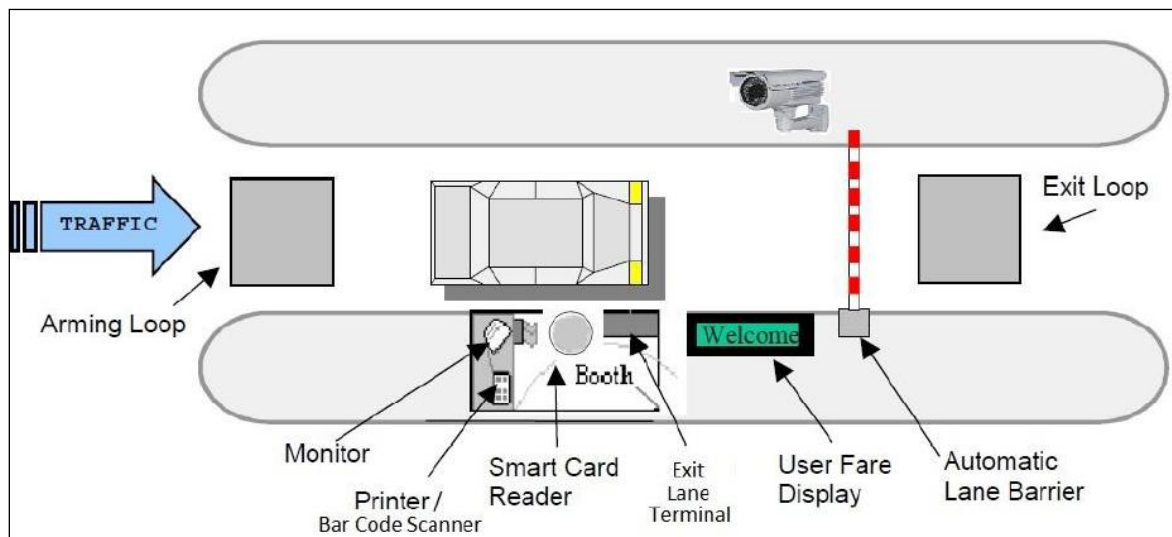
- Daily/weekly/monthly collection report
- Night parking report
- Any other customized report.

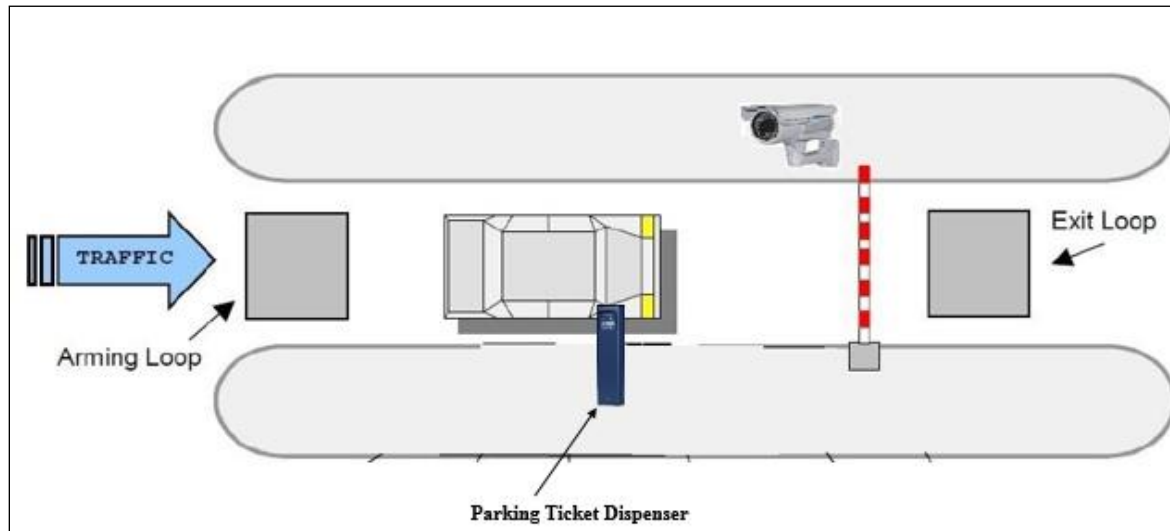
#### Data Communication to Central Command & Control Centre:

All entry & exit data, as a single record, as per format (csv, xml) shall be transmitted to Central Server using internet connectivity. Vehicle License Plate images, duly linked to specific transaction ID shall be also be made available to Central Server, if the internet bandwidth permits.

The data so sent shall include the pre-defined codes for the location of the parking lot.

#### Typical Basement Parking Exit Lane



**Typical Basement Parking Entry Lane****ITEM WISE SPECIFICATIONS:****Automatic Ticket Dispenser**

Input Power	230 VAC $\pm$ 10%, 50Hz
Cabinet/Housing	MS Powder coated Grey color or any other suitable color.
Size	310 x 335 x 1215 mm (l x p x h)
Weight	20 Kg
Absorbed power	100 VA
Temperature of use	from -20 to +50°C
Display	LCD backlit 20x2"
Processor	Micro-Processor based with built-in memory, storage space for min 10000 cards, 50000 transactions
Ticket Printer	Heavy Duty Thermal Printer with Auto-Cutter, and bar code printing capacity
Printing Speed	140mm/s
Type of Paper	78mm x 80 GSM

Paper Roll Capacity	3000 Ticket , 200 MM OD
Loop sensors	Dual channel
Push button	Illuminated for Ticket Request , SS for SOS
SOS Feature	POP-UP message at Server
Communication port	TCP-IP
Proxy Card Reader	Contact less Reader of passive transponders
Card detection frequency	13.56 MHz
Card format	ISO

**Boom Barrier**

Voltage rating	24VDC
Power Consumption	72W
Movement	Direct movement on the reduction gear output shaft
Opening& Closing time	2-6 sec
Model	LOG-BR
Power Supply	230V 50Hz
Clutch	Electronics (Torque adjustment)
Approaching at the end of the maneuver	With slowing down
Safety on impact	Encoder
Sensors input	Photo cell, loop sensors
Duty Cycle	100%
Reaction to impact	Reversal of movement
Travel	Self-learning
Structure	Fe 360 - Pickled 2 plates mm

Size	320Lx220Px1010H mm
Hand Operation	From outdoor with Key
Protection Level	IP65
Boom	Aluminum
Road passage	4M
Certification	CE

**LPR/NPR (Number Plate/License Plate ) Camera**

Voltage rating	12Vdc
Current rating	1A
Power Consumption	<11.5W
Max. IR LEDs length	50M
Day/Night	Auto (ICR) /Color/ B/W
Focal length	2.7mm ~ 12mm
Max Aperture	F1.4
Focus Control	Motorized
Communication	TCP-IP
Resolution	1080P
Image sensor	1/2.7" 2 mega pixel
Overall Size	272x94x94mm
Weight	1.1kg
Operating Temp	-20 to +60°C
IP Grade	IP67
Certification	CE

**Manned POS Station**



Voltage rating	220Vac
Current rating	1.3A
Power Consumption	280 W
Processor	Intel Dual Core Processor
RAM	4GB
HDD	500GB
DVD	Inbuilt
Monitor	19"
Key board	Standard
Mouse	Optical
Handheld scanner	Zebra LS1203
Smart Card Reader	125khz ISO card reader
Interface	RS485 to USB
LCD Display	Posiflex PD320U
Thermal Printer	Epson TM-82
Operating System	Window7
Software	POS-1

**Central PMS Server**

Voltage rating	220Vac
Current rating	1.3A
Power Consumption	280 W
Processor	Intel i5 Processor
RAM	4GB
HDD	500GB
DVD	Inbuilt

Monitor	19"
Key board	Standard
Mouse	Optical
Connectivity	To Ticket Dispenser, NPR Camera, Boom Barrier, Exit Ticket Verifier via RS-485/TCP-IP
Smart Card Reader	125khz ISO card reader
LCD Display	Posiflex PD320U
Thermal Printer	Epson TM-82
Operating System	Window7
Software	Custom Made Software: Central Server will connect to ticket machine, NPR camera and boom barrier. It also shares information with PGS server about vehicle in transit and exit verifier about vehicle exit details. Also contains details of proximity cards and their access rights along with new issue & recharge options. It will open the barrier and give command to ticket dispenser to print ticket depending upon access rights or card use classification of vehicle detected and corresponding button pressed at ticket machine. In case of error, a message will be sent to ticket dispenser machine display, manned booth and barrier shall not open.

**LED Display**

Voltage rating	AC 230V - 50Hz
Current rating	1.2A
Power Consumption	250W
Communication	GSM

No. Of Rows	1
No. Of Dynamic Digits	3 digits
Height of Character	10"
LED Type	LED 5mm single row oval ultra-bright RED led
No. Of the Fix Character	Configurable, 3M reflective tape
Enclosure	48"x30" (Approx)
Mounting	Pole/Wall mounting - Outdoor weatherproof
Operating Temp	20 to +60°C
Enclosure	MS powder coated Panel

**~~PGMS Server(DELETED):~~**

- PC i3 Processor, 4 GB DRAM, 500 GB HDD with 19" TFT and Windows 7 or higher OS.
- PGS Server software to show vehicle occupancy in graphical mode for cars.
- Suitable software and hardware for web interface for showing parking availability on different client nodes.
- Connection to PMS server through TCP/IP and software support to extract information for vehicle in transit.
- MIS Report generation as per requirement.
- Software shall be user friendly to the maximum extent so that addition and alterations can be done by the Engineer without the help of suppliers and programmer. For any newly added train, it shall be possible to record a file externally and attached to the train through user interface. The application shall take care of placing the recorded file at appropriate internal application folder.
- The system shall have provision to select messages and language to be broadcasted. The announcement shall be fluent and professional enough to avoid unnatural pauses between two pieces of voice clips.
- The broadcast messages shall be categorized like courtesy, emergency messages. Recording & playback of new messages shall be possible only from CDC with microphone and speaker provided with CDC using Windows standard sound recording tool.

- The entire voice recording shall be done in a sound proof professional studio. All the voice recording shall be of professional grade shall have approval of user railway before using in the systems.
- It should be possible to select and play courtesy slogans. There should be provision to play any of the pre-recorded music & same could be started or interrupted by touching a single button.
- Mainly there will be three types of announcements one for a train arriving on platform, one for train arrived on platform and one for train departing from platform in English, Hindi & a regional language. It should be possible to update announcement if Platform No./Train No. is changed .
- Provision shall be made for the operator to send announcement related to train number, platform numbers, and arrival/ departure just by entering the train number, platform number and status in conditions.
  - i. Late arrival of trains.
  - ii. Platform No. of arriving/ arrived trains and change in platform No.
  - iii. Right time arrival of trains.
  - iv. Departure of trains at scheduled or unscheduled time.
  - v. Announce/display that trains is arriving/ departing shortly or terminated and Current status of the train.
  - vi. Cancellation of train
  - vii. Route Diversion of train
  - viii. Any other message required to be announced/ displayed regarding train arrival/departure.
- Voice files used in announcement for hour, minute and status (i.e. bajkar, baje etc.) shall be recorded by the same announcer & same shall be used.

**SUB HEAD - 23****SECURITY SCANNERS(DELETED)****SCOPE OF WORK:**

These technical specifications cover the requirements for Designing, Engineering, Manufacturing, supplying, Delivering, Installing, Testing and Commissioning of Security Scanners

**LARGE SIZE BAGGAGE INSPECTION SYSTEM**

- Minimum Tunnel size– 100cmW (Width) x 100cm H (Height)(+/-10%)
- Conveyor belt speed should be between 0.18 and 0.3meter per second. Conveyor movement bidirectional.
- All machines should operate on 230 VAC, 50 Hz power supply and should be able to withstand voltage fluctuations in the range of 170V to 260V. Single Phase, 3 to 5 Amp
- Conveyor capacity – 200kg or more
- Through put should be 200 bags per hour or more
- Sensors >1000 diodes, L-shaped detector (Folded array type), In case defective diode arrays, scanning should be disabled and error message should be displayed on the screen.
- X-ray voltage – 160 kV or more
- X-ray Source/Generator – It should be capable to operate smoothly for a period of at least six years
- Duty Cycle- 100%
- The X-ray beam divergence should be such that the complete image at maximum size of bag is displayed without corner cuts
- The radiation level should not exceed accepted health standard (0.1m R/Hr at a distance of 5 CM from external housing). Relevant certificate from AERB
- The operating temperature should be -10deg C to 50 deg C.
- Storage Temperature -20 Degree C to 50 degree C
- Humidity- 90% non-condensing
- Resolution: The machine should be able to display single un-insulated tinned copper wire of 42-SWG or 38 AWG. All penetration and resolution condition should be met without pressing any functional key and should be online.
- Penetration should be 27 mm thickness of steel (Guaranteed) or more.
- Continuous Electronic Zoom facility should be available to magnify the chosen area of an image eight times (8X) or more. Image features shall be keyboard controllable.
- Video display – 17’’ or better LCD Monitor SVGA High resolution, low radiation, flicker free, resolution at least 1280 x 1024, 24 bit colour real time processing.
- The machine should have features of Multi-energy X-ray imaging facility where materials of different atomic numbers will be displayed in different colours to distinguish between organic and inorganic materials. With this method to distinguish high density organic materials including explosives. Machine should have variable colour or materials stripping to facilitate the operator to monitor images of organic

materials for closure scrutiny. All suspicious items (Explosives, High density, material narcotics) should be displayed in one mode and that should be on line.

- Radiation safety:-  
The machine must comply with requirements of health and safety regulations with regard to mechanical electrical and radiation hazards. Before installation of the machine, the supplier/ manufacturer should furnish relevant certificate from Atomic Energy Regulatory Board of India regarding radiation safety. The company manufacturing the equipment should have ISO certification for manufacturing and servicing of X-Ray Screening machines.
- Film Safety:- Guaranteed safety for high-speed films upto ISO1600. The machines should be film safe. In other words, photographic films must not be damaged due to x-ray examination.
- Machine should be properly sealed from all sides for pest proof. Dust proof cover is to be provided for covering when system is not in use.
- Facility of variable contrast must be incorporated to allow enhancement of lighter and darker portion of the image
- The machine should be so designed that the software enhancement can be easily implemented to take care of new technique in image processing and pattern recognition.
- Full diagnostic built in test facility. All models should have software controlled diagnosis report facility and system should give printout if printer is connected
- All software features of the machine should be online and password protected.
- Machine should be capable of recalling 15 or more previous images
- It should have the capability of archiving 2000 or more images with date & time stamp.
- Control desk with security housing and locking provision should be available. The operator personal identification number can be entered the keyboard along with generation of log.
- Facility of image enhancement should be available
- All models should have online recording facility and images can be recorded in CD R/W or/and USB and should be able to view images so recorded on stand-alone PC.
- Lead impregnated safety screen should be available at either ends of the tunnel. This should be covered by relevant AERB certificate. Idle rollers to be provided at either ends of the tunnel to facilitate the placing of baggage at input and output
- All software features should be controlled from key board of machine only. Keyboard function should be user friendly. To enable/ disable the software features system should not be rebooted.
- If the machine fails to penetrate a particular item then an alarm video and audio both should be generated to notify the operator.
- The threat Image projection (TIP) system software to be incorporated in all X-ray BIS operation as per details given in CI No 4.
- Copy of all software including X-Ray Software with recovery CD must be provided.
- Operational Training- Operating staff has to be provided free training
- Operating & service manual shall be provided with each machine.

- Other Features:
  - a) Edge & variable edge enhancement
  - b) Inverse Video
  - c) Set up time not more than 10 minutes
  - d) Pseudo colour
  - e) Date & Time Display
- Minimum Computer configuration:
  - a) CPU: Should be able to deliver the output to meet the specifications mentioned as above.
  - b) Hard Disk Drive: 320 GB 7200 rpm serial ATA HDD or Better
  - c) Mouse: Optical
  - d) Ports: 6 USB Ports (with at least 2 in Front, 1 serial Port, 1 Parallel port, 1 PS/2 Keyboard and 1 PS2 Mouse Port, audio ports for microphone and headphone in front
  - e) CD R/RW Drive: DVD Writer
  - f) Networking Facility: 10/100/1000 on board integrated Network port with remote booting facility, remote system installation, remote wakeup, out of band management using any standard management software
- UPS: 3 KVA online with backup time of 30 minutes.

#### **SMALL SIZE BAGGAGE INSPECTION SYSTEM**

- Minimum Tunnel size – 60 cm W (Width) x 100 cm H (Height) (+/-10%)
- Conveyor belt speed should be between 0.18 and 0.3 meter per second. Conveyor movement bidirectional.
- All machines should operate on 230 VAC, 50 Hz power supply and should be able to withstand voltage fluctuations in the range of 170V to 260V. Single Phase, 3 to 5 Amp
- Conveyor capacity – 100kg or more
- Through put should be 200 bags per hour or more.
- Sensors > 1000 diodes, L-shaped detector (Folded array type), In case defective diode arrays, scanning should be disabled and error message should be displayed on the screen.
- X-ray voltage – 140 KV or more
- X-ray Source/Generator – It should be capable to operate smoothly for a period of at least six years
- Duty Cycle- 100%
- The X-ray beam divergence should be such that the complete image at maximum size of bag is displayed without corner cuts
- The radiation level should not exceed accepted health standard (0.1 mR/Hr at a distance of 5 CM from external housing). Relevant certificate from AERB
- The operating temperature should be -10 deg C to 50 deg C.
- Storage Temperature -20 Degree C to 50 degree C
- Humidity- 90% non-condensing

- Resolution: The machine should be able to display single un-insulated tinned copper wire of 40-SWG or 36 AWG. All penetration and resolution condition should be met without pressing any functional key and should be online.
- Penetration should be 27 mm thickness of steel (Guaranteed) or more.
- Continuous Electronic Zoom facility should be available to magnify the chosen area of an image eight times (8X) or more. Image features shall be keyboard controllable.
- Video display – 17’’ or better LCD Monitor SVGA High resolution, low radiation, flicker free, resolution at least 1280 x 1024, 24 bit colour real time processing.
- The machine should have features of Multi-energy X-ray imaging facility where materials of different atomic numbers will be displayed in different colours to distinguish between organic and inorganic materials. With this method to distinguish high density organic materials including explosives. Machine should have variable colour or materials stripping to facilitate the operator to monitor images of organic materials for closure scrutiny. All suspicious items (Explosives, High density, material narcotics) should be displayed in one mode and that should be on line.
- Radiation safety:-
- The machine must comply with requirements of health and safety regulations with regard to mechanical electrical and radiation hazards. Before installation of the machine, the supplier/ manufacturer should furnish relevant certificate from Atomic Energy Regulatory Board of India regarding radiation safety. The company manufacturing the equipment should have ISO certification for manufacturing and servicing of X-Ray Screening machines.
- Film Safety:- Guaranteed safety for high-speed films upto ISO1600. The machines should be film safe. In other words, photographic films must not be damaged due to x-ray examination.
- Machine should be properly sealed from all sides for pest proof. Dust proof cover is to be provided for covering when system is not in use.
- Facility of variable contrast must be incorporated to allow enhancement of lighter and darker portion of the image
- The machine should be so designed that the software enhancement can be easily implemented to take care of new technique in image processing and pattern recognition.
- Full diagnostic built in test facility. All models should have software controlled diagnosis report facility and system should give printout if printer is connected.
- All software features of the machine should be online and password protected.
- Machine should be capable of recalling 15 or more previous images
- It should have the capability of archiving 3000 or more images with date & time stamp.
- Control desk with security housing and locking provision should be available. The operator personal identification number can be entered the keyboard along with generation of log.
- Facility of image enhancement should be available
- All models should have online recording facility and images can be recorded in CD R/W or/and USB and should be able to view images so recorded on stand-alone PC.



- Lead impregnated safety screen should be available at either ends of the tunnel. This should be covered by relevant AERB certificate. Idle rollers to be provided at either ends of the tunnel to facilitate the placing of baggage at input and output
- All software features should be controlled from key board of machine only. Keyboard function should be user friendly. To enable/ disable the software features system should not be rebooted.
- If the machine fails to penetrate a particular item then an alarm video and audio both should be generated to notify the operator.
- The threat Image projection (TIP) system software to be incorporated in all X-ray BIS operation as per details given in CI No 4.
- Copy of all software including X-Ray Software with recovery CD must be provided.
- Operational Training- Operating staff has to be provided free training
- Operating & service manual shall be provided with each machine.
- Other Features:
  - a) Edge & variable edge enhancement
  - b) Inverse Video
  - c) Set up time not more than 10 minutes
  - d) Pseudo colour
  - e) Date & Time Display
- Minimum Computer configuration:
  - a) CPU: Should be able to deliver the output to meet the specifications mentioned as above.
  - b) Hard Disk Drive: 320 GB 7200 rpm serial ATA HDD or Better
  - c) Mouse: Optical
  - d) Ports: 6 USB Ports (with at least 2 in Front, 1 serial Port, 1 Parallel port, 1 PS/2 Keyboard and 1PS2 Mouse Port, audio ports for microphone and headphone in front
  - e) CD R/RW Drive: DVD Writer
  - f) Networking Facility: 10/100/1000 on board integrated Network port with remote booting facility, remote system installation, remote wakeup, out of band management using any standard management software
- UPS: 2 KVA online with backup time of 30 minutes.

### THREAT IMAGE PROJECTION

- The large size as well as small size baggage inspection system shall have Threat Image Projection software as per following specifications:

#### THREAT IMAGE PROJECTION(TIP)

	Tip software family shall be incorporated in the offered X-ray machine to assist supervisors in Testing the operator alertness and training X-ray screeners to improve their ability in identifying specific threat object. The system will create a threat object and the same will be superimposed on the monitor screen while a bag is being screened. To acknowledge that the operator has seen the false object, operator must press the control panel key that will cause the computer generated threat object to disappear from X-rayed bag image on the VDU screen. Each operator's action shall be recorded in the hard disc of the computer for the auditing purpose by the supervisor or other authorized person.
<b>DESIGN OF SYSTEM</b>	
	TIP software should be compatible with other X-ray technologies such as automatic reject unit, Dual X-ray screen technologies, automatic threat recognition system etc. All X-ray image function must be available at the same time along with TIP
<b>IMAGE LIBRARY</b>	
	The image library should have an image library containing at least 100 explosive devices. 100 knives and 100 firearms of various sizes, shapes, location and orientation. However, the system shall have facility to expand the library to incorporate additional images by user without assistance of the manufacture
	The image library should contain images of the threats at different orientations both plan and end on orientation should be used. Although these will be assigned different file names and preferences, it must be possible to cross reference these as the same threat. All threat image, projection images must be realistic, representative and non distinguishable from real threat items
<b>TIME INTERVAL</b>	
	Programming facility shall be available to project threat images in different intervals. The time period for threat images as well as image mix in percentage shall be user programmable e.g. software shall select 40 % image of explosive devices, 35 % of fire arms and 25 % knives of random etc.
	Once the screener has responded to identify the computer generated threat images, it should remain on the screen for a predefined user programmatic feedback message shall be visible to the screener
<b>SYSTEM ADMINISTRATOR</b>	
	The threat image projection facility shall have details of user data-base such as Department name, screener name, Organization, User ID Number, level of access such as screener, administrator, maintenance & password, etc.

	Access to start up menu should be restricted only to the authorized individuals. A log in procedure by means of “Password” or “Security Key” could achieve restricted access to each of the comment. The log-in procedure should not take longer than 20 seconds. The system should have facility to by-pass the TIP facility, if programmed so by the system administrator. It is to be ensured that the TIP software shall not be hindrance to normal functioning of X-ray machines
	When the operator logs-in or logs-out, message should be displayed on the x-ray BIS VDU screen to confirm that he/she has been correctly logged-in or logged-out
<b>FEEDBACK REPORT</b>	
	The threat image projection should be capable of giving feedback “Hit, MISS or FALSE ALARM” message. No message will be presented if a screener correctly passed as clear bag
	A “HIT “message to be presented when a screener has correctly identified a threat image projection image. A “MISS” message shall be presented when screener fails to identify the TIP image. A “FALSE ALARM” message shall be given when screener incorrectly indicate TIP image when in fact no threat image projection is present. The feedback should clearly indicate in a screen that a tip object has been correctly identified/ tip object has been missed that a TIP object has been missed/ no TIP object was present. Information should be recorded in the database
	Different color coding shall be used for feedback to the screener. It is recommended that color code Red for “MISS” Green for “HIT” and Yellow to “False Alarm on Interrupt” be used
	The system shall automatically prepare the daily log of events for each shift and for each screener performance. TIP log shall include particulars of name of screener. Time date of threat image, whether threat image was successfully identified or missed etc.
	The report on the threat image projection system may have date and time (From- To) as per requirement. Screener particulars and decision/ outcome i.e. MISS, HIT or FALSE ALARM in percentage as well in absolute numbers, numbers of bags screened, categories such as explosive devices knife or weapon etc.
	As a standard, daily/weekly/monthly report shall be retrieved. Report shall be for any given time and period as per command
	All data should be stored on the system for a minimum of two months, after it has been downloaded. No individual, regardless of access rights of the threat image projection components would delete or amend any of threat image projection data or

	time i.e. threat image projection data on the actual X-ray machine will be read only file.
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## HAND HELD METAL DETECTOR

- Hand Held Metal Detector shall have following specifications:

S. No.	Parameter	Specifications
1	Dimensions	
	Length	Maximum 500mm
	Probe width	Maximum 120mm
	Body width	Maximum 65mm
2	Weight	Maximum 500gms
3	Power source	Alkaline battery 3 volt (1.5x2) volt, should run minimum 550 hrs on 10% detection rate
4	Battery protection	To be provided against damage due to reverse polarity
5	Indication	a) Single LED based audio and visual multiple indication for- <ul style="list-style-type: none"> <li>i. SWITCH ON</li> <li>ii. METAL DETECTION</li> <li>iii. LOW BATTERY INDICATION</li> </ul>
6	Operation	Single push button operation
7	Construction	Should be rugged and impact resistant ABS moulded casing
8	Scan rate	Minimum 3" to 24"/sec
9	Detection	Should be able to detect Ferrous and Non-Ferrous metals <ul style="list-style-type: none"> <li>- Pistol .22 at min 6"</li> <li>- Cartridge .22 at min 2"</li> <li>- Razor blade at min 1"</li> </ul>
10	Tuning	Automatic to ensure equal results on wide range of metals and alloys

11	<p>Miscellaneous- The firm should be able to provide the following, as applicable, along with the equipment:-</p> <ol style="list-style-type: none"> <li>Cleaning kit</li> <li>Technical manual giving full description of the item</li> <li>User's hand book</li> <li>Battery charger with spare rechargeable battery set</li> </ol>
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### MULTI ZONE DOOR FRAME METAL DETECTOR

- The Multi zone Door frame Door Frame Metal detector shall have following specifications:

S.No.	Technical Specifications
1	<p><b>DETECTION</b></p> <p>i) The system should be capable of detecting ferrous, non-ferrous and alloy metals concealed in the body of a person when passed through the archway</p> <p>ii) Uniform detection from top to bottom is required</p> <p>iii) Should be able to detect multiple metal objects of various weight, size and shapes in all the zones simultaneously from head to toe</p>
2	<p><b>PASSAGE DIMENSION</b></p> <p>Height – Min 200 cm</p> <p>Breadth – Min 72 cm</p> <p>Width – Min 57 cm</p>
3	<p><b>SPEED OF PASSAGE</b></p> <p>Performance of the DFMD should be independent of the speed of person passing through. This is particularly important as a person's foot may swing through the archway without touching the ground, or may come to rest on the ground between the archway pillars</p>
4	<p><b>WEIGHT</b> – 80 Kg Max.</p>
5	<p><b>POWER SUPPLY</b></p> <p>100-260 VAC, 50-60Hz, 12-24 VDC, should be provided with internal battery back-up for 6 hours minimum in operational conditions.</p>

6	<b>ALARM INDICATION</b>  i) There should be acoustic and optical alarm with alphanumeric display, height on person bar display (Metal locator) and low battery indication.  ii) There should be a provision for suitable setting for adjustment of volume of the audible alarm to overcome the ambient noise present in the vicinity
7	<b>SENSITIVITY</b>  DFMD should have multi-zone capability with uniform sensitivity in all zones
8	<b>ZONES:-</b>  Not less than eight real horizontal detection zones, covering full height of the equipment
9	<b>CALIBRATION:-</b>  DFMD shall have inbuilt feature of both manual and automatic calibration
10	<b>SECURITY:-</b>  i) There should be provision to secure the access to the control unit by a password protected alpha numeric keypad  ii) DFMD should reset itself within 3 sec after alarm condition  iii) Unit should have traffic and alarm counter. The equipment should work in bidirectional mode
11	<b>OTHER FEATURES:-</b>  i) High discrimination between small masses and personal metallic objects  ii) Automatic synchronization for DFMDs located close to each other up to a distance of one feet side by side
12	<b>STATIC METAL COMPENSATION:-</b>  DFMD installed closed to fixed sheet or pieces of metal which form part of the building or its fittings. The DFMD should compensate for the presence of such metal and its performance should not be degraded by the presence of metal as stated above
13	<b>HEALTH AND SAFETY:-</b>

	<p>i) Magnetic field should be harmless to magnetic media, electronic devices and should be film safe, (Supplier shall submit test certificates from national / international accredited lab)</p> <p>ii) Operation of DFMD shall not be affected by infrared, ultraviolet, electromagnetic or RF radiation. Offered equipment shall comply with CE or equivalent safety/ immunity standard (Supplier shall submit test certificates from national / international accredited lab)</p> <p>iii) DFMD should be harmless to pacemaker and pregnant woman (Supplier shall submit test certificates from national / international accredited lab as per ICNIRP guidelines)</p>
14	<p><b>INTERFERENCE REJECTION:-</b></p> <p>i) Interference, which is 'mains-borne' or radiated by an external source, should not cause the DFMD to raise the alarm spuriously. It should be possible to use equipment such as radio, portable telephone, walkie-talkie sets, X-ray monitors etc. at a distance of one mtr from the archway without causing spurious alarms.</p> <p>ii) Moving metal beyond 1 mtr from DFMD should not affect performance of the DFMD. It should be possible to move metallic items like trolleys, metallic gate opening/ closing one mtr away from the DFMD without the generation of false alarm</p>
15	<p><b>OPERATING TEMP:-</b></p> <p>DFMD shall work satisfactory without any deterioration in performance within the temperature range -20 degrees to (+)55 degrees, RH up to 90% non condensing.</p>
16	<p><b>ACCESSORIES TO PROVIDE:-</b></p> <p>i) Operating manual for the user</p> <p>ii) Standard test piece (STP) for testing of equipment to be provided by the supplier with each equipment</p> <p>iii) Should have a ruggedized polypropylene shock proof container for safe transportation of product compliant to IP-65 and latest Mil Std.</p>

**~~SUB HEAD—24(DELETED)~~**

**INTEGRATED PASSENGER INFORMATION & ANNOUNCEMENT SYSTEM**

**(Not Applicable)**

**1. GENERAL:**

- The contractor shall provide an Integrated Passenger Information System consisting of Train Information Display Boards, Coach Guidance Display Boards and PC based Announcement System as Per RDSO Specification Number: RDSO/SPN/TC-61/2015, Rev 4.0 or Latest.
- This covers the general, functional, technical and performance requirements of Integrated Passenger Information System which includes display of train information on LED based display board i.e. Single Line, Multiline, At a glance & coach guidance display boards and PC based announcement for train information to passengers.
- **The integrated passenger information & announcement system is to be provided for the station building, Platforms, FOB etc.**
- **The Integrated Passenger Information & Announcement System is to be integrated with the Railway System.**
- **The integrated passenger information & announcement system shall be as per RDSO specifications RDSO/SPN/TC-61/2015, Rev 4.0 or Latest.**
- The points mentioned below are the minimum requirement to be provided. The contractor shall design the system as per project requirement.



## 2. SYSTEM DESCRIPTION:

- The Integrated Passenger Information System (IPIS) will consist of Central Data Controller (CDC) loaded with software for announcement, Platform Data Controller (PDC), LED display and display boards of different sizes including Coach Guidance display boards.
- **Multiline Display Board** to display train Information i.e. Train number, Name, time of arrival/departure and platform number. It will show information of multiple trains at a time. There shall be two separate display boards for arrival & departure. The multiline display boards will be placed at main entrance/ concourse of the station and platform display boards at suitable places on platforms/ foot-over bridges/ waiting areas.
- **Platform Display Board** to display the information of the train scheduled for arrival/departure from that platform i.e. Train number, Name, time of arrival/departure.
- **At-A-Glance Display Board** for displaying information of the train arriving/departing from that platform with coach composition.
- **Coach Guidance Display Board** to indicate position of coach No. scheduled for arrival/departure from that platform for guidance of passengers.
- It should be possible to display train information being displayed on **Multiline Display Board** and LED Display placed at different locations of the platform. LED Display shall be provided in the enquiry offices, waiting rooms or at any suitable place to be decided by the purchaser.
- It should also be possible to network all systems provided at different locations at a station for carrying out operation from a centralized place.

## 3. SYSTEM REQUIREMENT

- **Hardware Requirements:** The IPIS shall consists of following units/sub-systems:
  - c) Central Data Controller (CDC)
  - d) Platform Data Controller (PDC)
  - e) Multiline Display Board
  - f) Platform Display Board
  - g) At-a-glance display Board
  - h) Coach Guidance Display Board
  - i) LED Display
- **Central Data Controller:**

- (i) The Central Data Controller (CDC) shall consist of two CPUs (PCs) connected through a Central Data Switch (CDS) for data synchronization. One 17" (minimum) Colour LED/TFT monitor to be connected through a Keyboard-Video-Mouse (KVM) switch. Audio/Video selection device with speaker and microphone shall be provided for live announcement.
- (ii) The CPU of CDC shall be of reputed make having minimum configuration as mentioned in RDSO specification.
- (iii) Both the CPUs of CDC shall be pre-loaded with necessary software for working of Integrated Passenger Information System (IPIS). There shall be continuous data synchronization between both the CPUs connected through a LAN link. At a time only one CPU will work but database of both CPUs shall be updated automatically.
- (iv) It should be possible to operate CDC from a suitable control center or enquiry office, preferably a dust free or AC environment.
- (v) CDC shall be provided with voice recording and playback facility for making live PC based announcement. There shall be provision for one speaker of minimum 5W of reputed make with volume control.
- (vi) The selection of Audio/ Video (A/V) output for PC based announcement and LED/LCD Display shall be automatic/manual with the help of a suitable Audio & Video selection device from both CPUs of CDC. A/V selection device shall provide properly isolated audio output which can be connected to audio amplifier of public address system. It shall also provide video signal for LED Display of PIS.
- (vii) UPS of minimum 1 KVA with minimum 30 minutes battery backup shall be provided for uninterrupted operation of the CDC.
- (viii) By Pressing "ON" Push button switch provided on CDC cabinet, both the CPUs of CDC (main/standby) should switch ON and automatically run system software. Repeat pressing of the button should switch "OFF" the CDC.
- (ix) CDC should be switched OFF only after closing all running programs and with proper shut down operation.
- (x) Cabinet of the equipment shall be well designed to sustain external vibration due to movement of trains.
- (xi) System shall be fully equipped with suitable hardware & software to acquire updated train information data using TCP/IP protocols from NTES/COIS or any central server process updated data of running trains automatically to display updated train information on various types of display boards, coach guidance systems and announcement on PA system. Any change in data protocol shall be updated time to time. NTES/ other central server connectivity shall be provided by concerned Railway.

- (xii) LED Monitors of suitable size as specified by the purchaser shall be used for LED Display for IPIS. LED Monitors shall be of reputed make or as specified by the purchaser.

- **Central Data Switch:**

- (i) The Central Data Switch (CDS) shall provide Ethernet connectivity for data communication between both CPUs of CDC and multiline display board & Platform Data Controllers of the station.
- (ii) 8-port or 12-port Layer 3 switch (as per site requirement) shall be used as Central Data Switch. Switch shall be of CISCO, HP, Juniper, Brocade, Avaya, Extreme, Netgear, D-link etc make or as specified by the purchaser.
- (iii) Data communication between Central Data Switch to Platform Data Controller and Multiline display board shall be on Ethernet using CAT-6 cable or it should be on Optic Fibre cable if distance is more. CAT-6 cable should be compliant with TIA/EIA-568 B or latest standards or latest from reputed make & necessary test certificate shall be produced from CAT-6 cable manufacturer.
- (iv) Switch should have at least two 10/100 or better Base X SFP ports (fibre ports) for connecting field devices on optic fibre cable and remaining ports shall be Ethernet (copper).
- (v) Necessary diagnostic tools shall be provided in CDC for health monitoring of various devices connected to it.

- **Platform Data Controller (PDC):**

- (i) The Platform Data Controllers shall drive Platform display boards and Coach guidance display boards.
- (ii) The PDC should have two 10/100 or better Base X SFP ports with single mode optical interface for connecting CDC and at least eight Ethernet ports for connecting field display devices.
- (iii) The Platform Data Controller design should be based on a minimum 32-bit microcontroller. The PDC shall route the data/ instructions coming from the Central Data Controller to the downstream display devices and health/ diagnostics information from the display devices to CDC.
- (iv) PDC should also have eight serial ports (RS-485) for connecting Coach Guidance Display boards and Platform Display boards (already available on platform). Each serial port shall be capable of driving minimum 6 coach guidance display boards.
- (v) Serial port (RS-485) connection to coach guidance display boards shall be of multi drop type and in case of failure (like power down) of any device, extension of communication

link shall not be affected. Also in case of removal of any Display Board for repair it should not affect working of other display Boards.

- (vi) PDC should be equipped with wireless Zig-Bee module for data connectivity on wireless to connect Platform Display boards and Coach Guidance Display boards in license free band of 2.4 GHz (Optional).
- (vii) All the ports shall have LED indications for monitoring the communication status of the connected devices.
- (viii) Necessary Platform Data Controller shall be installed on each platform to cater data connectivity requirement of all the display board.
- (ix) It should be possible to mount PDC on wall or Platform Display Controller, fiber termination box etc. shall be accommodated in a standard 19" Euro Rack of suitable height.
- (x) The PDC shall be IP54 environmental standard compliant to protect it against dust, Rain & other environmental hazards.

#### **4. Functional requirements of various types Train Information Display Boards:**

- Display board shall be of four types, depending on its location.
  - a) Multiline Display Boards for displaying information of multiple trains.
  - b) Platform Display Board for displaying information of single train.
  - c) At-A-Glance Display Board for displaying information of the train arriving/departing from that platform with coach composition
  - d) Coach Guidance Display Board to indicate position of coach No. scheduled for arrival/departure from that platform for guidance of passengers.
- Hardware and software of IPIS of the different vendors shall be interoperable in such a way that:
  - a) It should be possible to send and display data on display boards of different make and read & set configuration of the display board through wired or wireless media.
  - b) The display boards of different make shall be also compatible with other hardware and software of IPIS of different make.
- It should be possible to read data file generated as text file by other vendors and shall be able to process and display updated information on display boards.

- Display Data Controller design should be based on a minimum 32-bit microcontroller having Ethernet port for data transfer.
- Single Face Multiline display board shall be located at the concourse/ main entrance of the station. Double Face Platform display boards shall be placed at the respective platforms. The exact location is to be indicated by the purchaser.
- Multiline display board shall be of minimum 5 lines. Purchaser has to specifically mention the number of lines in each main display board as per site requirement.
- At major stations separate multiline display boards for “arrival” and “departure” of trains are to be provided if specified by the purchaser, otherwise a common display board showing information of both “arrival” & “departure” of trains can be provided. However, the software should permit to display either “arrival” or “departure” on both the boards.
- Data transfer from CDC to PDC shall be only on Ethernet using standard TCP/IP protocol.
- Data transfer from CDC to all type of display boards excepts CGDB should be on Ethernet using standard TCP/IP protocol or on wireless using 2.4 GHz Zig-Bee module in license free band (Optional)
- PDC to CGDB it should be either on wired serial interface (RS-485) or on wireless using 2.4 GHz Zig-Bee module in license free band (Optional)
- In case, the information is more than the number of lines in display board then information shall be displayed on time slot basis.
- The Platform Display board (PFD) shall display the information of a train scheduled for arrival/departure on that platform. If the platform display board is common between two platforms, it can be used to display the train information of trains scheduled on both the platforms alternatively.
- Fixed titles on display boards viz. train number, name, expected time, arrival/ departure, platform number shall be screen printed preferably in white/ yellow (or stickered) on the top of first display line on casings in capital letters. The character size of these titles shall be minimum 6 cm height.
- It should be possible to display Train information status as late, rescheduled, cancelled, indefinite late, diverted etc.
- It should be possible to mount or fix a display board on wall at the platform entry or inside a concourse/main entry of a Railway station.
- The information on display boards shall be displayed in English, Hindi and also in a Regional language, if required by the purchaser. The information shall be displayed for a specific period of up to 30 seconds and shall be selectable in steps of 10 seconds from the Central Data Controller.‡

- LEDs with equal fringe and uniform intensity are to be used to manufacture display boards to ensure that the information being displayed is with excellent contrast & without any visible black patches on the display screen and it shall be flicker free.
- All display boards shall be constructed using 16X48 LED matrix PCB modules. Fixing of these modules shall be such that easy replacement of PCB module should be possible in case of failure. Such replacement shall not call for removing any other PCBs.
- It should be possible to set intensity of display boards by software on time bond basis depending upon day/night conditions. Intensity Mode selection shall be user configurable. It shall be also possible to manually adjust intensity of the display boards through software from CDC in steps of 25%, 50%, 75% and 100%.
- ICs used for the display board should be preferably of surface mounted devices (SMD) to ensure high reliability.
- Class-D surge protection device shall be provided in CGDB and serial port of PDC for protection of data line against surge as per clause no. 5.7 of RDSO specification no. RDSO/SPN/TC/98/2011 Rev.0 or Latest. Typical parameters of Class-D surge protection device shall be as under:
  - a) Max. continuous DC Voltage: 13 V DC
  - b) Total Nominal discharge current (8/20 $\mu$ s) line-Ground: 5 kA or equivalent for 10/1000  $\mu$ s pulse.
  - c) Impulse limiting voltage/ Let through Voltage Line – Line (1kV/ $\mu$ s pulse or 8/20  $\mu$ s pulse or 10/1000 $\mu$ s pulse): 40V
  - d) Impulse limiting voltage/ Let through Voltage Line – Ground (1kV/ $\mu$ s pulse or 8/20  $\mu$ s pulse or 10/1000  $\mu$ s pulse): 1000 V
  - e) Nominal load current: 100 mA
- The Coach Guidance Display (CGD) Board shall indicate the Coach No./Train No. scheduled to arrive/depart from that platform.
- Individual coach display board across the platform should display Train No & Coach No. alternatively like GEN, D1, S10, B1, A1, H1 in English and “, एस-10, ए-1, एच-1”etc. in Hindi. The information of Train No/Coach No shall be displayed alternatively at an interval of 10 sec. The information of Train No/Coach No. shall be displayed in Hindi and English alternatively. Time period for display of information should be programmable in step of 10 sec.
- Following character sizes shall be used for displaying information on Display boards:

- a) **Character Size on display board with 16 Rows of LEDs:** For English and Numeric, the character size shall be adjusted to appropriate character width subject to maximum of 16X10 & for Hindi or Regional Language it should be maximum up to 16X14 LED matrix. There should be a gap of min. 16X1 LED matrix between two consecutive characters and 16X3 LED matrix between two consecutive words. However, actual character size may depend on type of font used.
- b) **Character Size for coach composition data display:** For English, the character size shall be preferably of 7X5 LED matrix. There should be a gap of minimum 8X1 LED matrix between two consecutive characters and 8X3 LED matrix between two consecutive words. However, actual character size may depend on type of font used.

## 5. GENERAL REQUIREMENTS OF DISPLAY BOARDS

- The display systems shall be suitable for working in AC/DC electrified and non-electrified sections. It shall be suitable in all sections including where locomotives thyristor controlled single phase or 3-phase induction motors having haul passenger or freight trains and chopper controlled EMU stocks are operated.
- Performance of the system shall not be affected in AC/DC electrified area.
- When there is no data to be displayed, it should not display anything on the display board. The boards shall have proper built -in recovery mechanism to automatically recover the information in case the processor goes haywire.
- Construction of different type of display boards should be modular, such that any defective module (i.e. PCB, connector, cable, power supply unit etc.) can be easily replaced to make the system functional.
- LED displays of IPIS of various vendors shall be interoperable. It should be possible to receive & display train information data coming from CDC of other Firm using standard data protocols. From CDC, it should be also possible transfer data to display boards of other make and monitor link status & health of the display devices connected in the system.
- It should be possible to have data of Multiline display board on cloud server so that it can be accessed through a web based application on android based smart phones (Optional).
- Material used for the printed circuit board (PCB) shall be copper clad glass epoxy of grade FR-4 or equivalent. The PCB thickness shall be minimum 1.6 mm  $\pm$  0.1mm.
- Conformal coating shall be applied on assembled and tested printed circuit boards to protect them from Humidity, Dust and dirt, Airborne contaminants like smoke and chemical vapors, Conducting particles like metal clips and filings, Accidental short circuit by dropped tools, fasteners etc.

- The solder masks (green/black/combination of both) shall be applied on the solder side and component side of the card.
- All display boards shall be protected with U.V. stabilized polycarbonate sheet having minimum thickness of 3mm (with tolerance of  $\pm 0.1$  mm) for better visibility and protection against dust/Rain.
- Only single polycarbonate sheet without any joint should be used to cover all type of display boards however for Multi line display boards of more than two lines can be covered either by a single polycarbonate sheet for complete board or for individual line.
- Wiring between different modules should be done with the help of male/female type of connectors. There should not be any requirement of rewiring, re-soldering/de-soldering for replacement of defective module. Proper cable guides shall be provided for fastening of cables and wires.
- Suitable "Earthing" point shall be provided for earthing the body of display board. Brass bolt of 6 mm dia shall be provided at appropriate place & suitably marked.
- Proper Earthing arrangement shall be ensured by Zonal Railway for IPIS display boards & data hubs.
- The Earthing Resistance shall not be more than  $2 \Omega$ .
- For installation of coach guidance display board on uncovered portion of the platform shall be provided using GI pipe of minimum 3 inchdia or as specified by purchaser.
- Local power supply available on platform may be used for CGDB power supply.
- Manufacturer shall maintain proper account of LEDs being used. The record shall include various details like source of supply, procurement invoice number & date, quantity, incoming rejection, lot wise consumption etc. which can be verified by the inspecting officials.
- LEDs used in LED display units shall be of high performance quality and from reputed manufacturers as stipulated by RDSO. Number of LEDs and their part number shall not be changed without prior approval of RDSO.
- The mounting of LEDs on all types of display boards should be such that it should have more horizontal viewing angle. Data sheets from the LED manufacturer shall be submitted to support the parameters of the LEDs used.
- Protective grid made of Nylon-66 shall be provided on LED matrix for uniform intensity of the display boards. It should be preferably 16 X16 in size and in black colour.
- Cabinet of CDC should be of standard design as per schematic shown in diagram-1 & made of Cold Rolled Closed Annealed (CRCA) sheet of minimum 18 SWG (1.2 mm) thicknesses. It should be powder coated in ivory/gray colour to protect from rust. Shelves of suitable height



shall be provided to accommodate the equipment. Proper power supply distribution with plugs & sockets of appropriate capacity and earthing connection point shall be provided on the cabinet. Gland plates shall be provided on the top and bottom panel of cabinet for cable entry.

- The cabinet shall have locking arrangement for front and back doors for equipment safety. Front side of the cabinet may have two or three doors. Only keyboard & mouse and/or monitor shall be accessible to operator whereas the other equipments remain in locked condition. Front door of the cabinet shall be of toughened glass/transparent UV polycarbonate sheet.
- The housing of various display boards should be made of Cold Rolled Closed Annealed (CRCA) sheet of minimum 18 SWG (1.2 mm) thicknesses & dimension as per table shown in clause 3.7.9.
- Both faces of Coach Guidance Display board should have nominal 5° tilt with a tolerance of + 1° from vertical plan downwards for better visibility.
- Following information shall be etched/screen printed on the component side of the PCB.
  - a) Manufacturer's name
  - b) PCB name/Part number
  - c) Component outline (in proximity of the component)
- Following information shall be engraved or marked with permanent ink on the PCB
  - c. Card serial number
  - d. Month and year of manufacture
- All Display board shall be manufactured using 16 X 48 LED matrix having pitch of 10 + 0.5mm.
- Field format of Single/multiline display board, each line consisting of the LED matrix of 16x336 should be preferably as per following format:

<b>55</b>	<b>3</b>	<b>192</b>			<b>3</b>	<b>45</b>	<b>3</b>	<b>10</b>	<b>3</b>	<b>22</b>
<b>Train No.</b>		<b>Train Name</b>				<b>Expt. Time</b>		<b>A/D</b>		<b>PF No.</b>
<b>5 Digits</b>						<b>4 Digit + Colon</b>		<b>1</b>		<b>2 Digit</b>
								<b>Char.</b>		
44444		AAAAAAA	AAAAA	EXP		20:45		A		10

- Display format of Single/multiline display board (16 x 336) shall be as under:
- Field format of At-a-glance Display board shall be preferably as per following format with LED matrix of 32X192. However, actual format will depend on the font type and information to be displayed.

TRAIN No.	TRAIN NAME	EXPT. TIME	A/D	PF No.
15046	GORAKHPUR Exp.	18:20	D	4

64	3	53	3	28	3	38
Train No.		Expt. Time		A/D		PF No.
5 Digits		4 Digit + Colon		1 Char.		2 Digit +
						1 Char.
44444		20:45		A		10A

- At-a-glance display board shall be display coach composition information in a four line LED matrix of each 8 x 192.
- Display format for at a glance Display Board (32 x 192) shall be as under:

It shall be possible to give Train information on at a glance Display Board as a two lines LED matrix of each 16 x 192. The display shall preferably be as per the following format. Train information & coach composition information are to be shown alternatively.

TRAIN No.	EXPT. TIME				A/D	PF No.	
15046	ENG	GEN	GEN	S1	S2	S3	S4
	S5	S6	S7	B1	B2	B3	A1
	A2	H1	S8	S9	S10	S11	S12
	GEN	GEN	SLR				

TRAIN No.	EXPT. TIME	A/D	PF No.
15046	18:20	D	4
GORAKHPUR Exp.			

## 6. SOFTWARE REQUIREMENTS:

- **General Software Features:**

- The privileges to different users shall be configurable in such a way that the respective user can modify only the relevant information. It should be possible to categorize users as administrator, supervisor and operator. Creation of a new category user shall also be possible.
- Data integrity should be maintained even though the system is being accessed and controlled by different user.
- It should be possible to generate different reports as per requirement for all operational and functional activities being done in the system. It should be also possible to generate customized reports.
- Any failure in data transfer from CDC to display boards shall be available in the system as an event for use of Administrator. Event logging shall also be available.
- History of events or log of information transferred to various display boards shall be available for 45 days for analysis & logs beyond 45 days shall be automatically deleted.
- It should be clearly distinguished from user interface that which train information has been sent to display and which is yet to be sent.
- HELP menu shall be provided for all software and its associated modules.

- **Train Arrival/Departure Information Entry Software Features:**

- It should be possible to configure the language of information to be displayed through software i.e. English and Hindi or regional language. Data entry shall be preferably through in script keyboard layout as defined by Ministry of Information Technology, Govt. of India.
- It should be possible to apply various effects like Scrolling effects, Typing effects, Flashing effects, Curtain effects etc. through configuration menu to the information being displayed.
- It should also be possible to increase/decrease running speed of display information.
- It shall be possible to add, modify & delete timings of existing trains in the master data base by authorized user in Hindi, English & Local language.
- The entry into Master Data Base should be password protected. It should be also possible to add data of new trains. There should be provision to change the password.

- The operator should be able to make broadcast message by typing only train number and modification to timing and platform nos.
- Mouse click should be used to transfer data from CDC to various Display Boards.
- The information to be displayed at various boards shall be selected automatically only by selecting Train No. and platform No.
- While deleting or modifying any train entry the software shall prompt the user before data transfer to display boards, so that the information at board always matches with monitor information.
- The modified information shall be automatically saved as soon as it is transferred to the display board, so that in case of any failure the information data remains updated.
- The Train Arrival/Departure information display system software should be developed on Windows based operating system using standard package
- Software should provide pictorial representation of the tasks through ICONS.
- Various ICONS shall represent applications which can be used by click of mouse.
- Buttons with corresponding pop-up labels shall be available for the user to perform tasks. The user has to just click mouse on the button and the corresponding task shall be completed.
- Command Buttons: This button shall be clicked to perform a command.
- Check Box shall be used to turn ON/OFF a particular feature.
- Data Communication, health status of display boards and data controller shall be available in CDC.
- The Software should have provision to receive the data of Train information like train coach position and platform No. from control office or any other designated location. All these data should be integrated for making announcement and display of train arrival/ departure information on display boards and coach guidance system. However, there should be provision to manually enter coach position and platform number.
- The software shall have provision to configure the number of lines present in the multiline display board.
- If two Trains are merged to form a single Train at a particular station, it should be clearly indicated on display boards by showing No of both Train alternatively and shall be suitable announced on a PA system about the two merged Trains.
- Display of train arrival/departure information display boards shall preferably be in the following format.

- i. For example, Expected Time is taken as “05:30 Hrs” & platform number as “02”.
  - ii. For the types “Running Right Time”, “Running Late” & “Rescheduled”, platform number is optional. For the rest, it is mandatory.
  - iii. For the types “Rescheduled”, “Terminated at” and “Diverted” two separate display texts containing as show above shall be displayed alternatively with configurable duration.
- BIT MAP shall be used to generate Codes for character/ special characters in different languages or standard Uni-codes shall be used.

Main Status	Sub Status	English and Hindi Display		
		Exp. Time	A/D	PF No.
Arrival	Running Right Time	05:30	A	1
	Will Arrive Shortly	05:30	A	1
	Is Arriving on	05:30	A	1
	Has Arrived on	05:30	A	1
	Running Late	05:30	A	1
	Cancelled	Cancelled		रद्द की गई है
	Indefinite Late	Indefinite Late		अनिश्चित देश से
	Terminated	Terminated at <Station Name>		<स्टेशन का नाम> तक जायेगी
	Platform Changed	05:30	A	1
Departure	Running Right Time	05:30	D	1
	Cancelled	Cancelled		रद्द की गई है
	Is Ready to Leave	05:30	D	1
	Is on Platform	05:30	D	1
	Has Left	05:30	D	1
	Rescheduled	Rescheduled		परिवर्तित / पुनर्निर्धारित समय पर
		05:30	D	1
	Diverted	Diverted		परिवर्तित मार्ग से
		<diverted route in English>		< मार्ग / स्टेशन का नाम>
	Scheduled Departure	05:30	D	1
	Platform Changed	05:30	D	1

• **Software Feature requirement for Coach Guidance Display Boards:**

- The software should have preloaded information of coach composition of all the trains arriving or departing from the station. When the train is likely to arrive at station or depart from the station, the concerned operator is required to enter the train number and update position of coaches i.e., from ENGINE to GUARD Brake Van.
- It shall be possible to acquire & update data of coaches for Rake formation of a train from central server of Coach Operation Information System (COIS) or any other central server using TCP/IP protocols having information of coach composition.
- On the corresponding platform the train coach positions details are displayed on the individual display boards (double faced), installed for display of each coach across the platform.

- Information display period shall be programmable from the control console with respect for Coach No. & Train number.
- It should be possible to display data on Coach Guidance Display Boards in English & Hindi.
- It should be possible to add, modify & delete coach composition of trains in the master database.
- The entry into Master Data Base shall be password protected. It shall also be possible to add new trains. The operator shall be able to enter details by typing only train number and modification to coach nos.
- While deleting or modifying any train entry on the monitor, the software shall prompt user before transferring data, so that the information at board always matches with monitor information.
- The modified information shall be saved as soon as it is transferred to the display board, so that in case of any failure the information remains updated.

## **7. FEATURES OF ANNOUNCEMENT SYSTEM:**

- The system supplied shall be of Windows 7 or higher – GUI based fully programmed for the announcement of all type of passenger carrying trains through key board.
- Fixed audio messages shall be recorded in soundproof sound studio and professional female voice with minimum 16 bit sample resolution.
- It should be possible to make repeated announcements without affecting other operations. However for making a repeated announcement just by repeated pressing of keys shall not be possible until the initiated announcement is finished successfully or paused by the operator.
- The format of the operation for the updating and announcement shall be user friendly.
- The announcement system shall be digital announcement system, consisting of digital modular power amplifier, Box speaker / Ceiling Speaker / Column shall be provided in the Building, Line array speakers at lobby area and Wide range Box speaker / Column speakers / Music Horn Speaker shall be provided at the Platform area.

## **8. GPRS CLOCK:**

The GPRS Clock shall consist of the following components:

1. GPS/Radio equipment with antenna and all required accessories.
2. Master clock with data storage and a master PC for control and monitoring
3. Suitable number of Double sided LED Clock display board on all platforms, waiting halls, entrances and other suitable areas.

4. Minimum 5 KVA UPS.
5. The GPRS clock shall be integrated with the Railway System to avoid any discrepancy in timings.

**9. MINIMUM REQUIREMENT :-**

The minimum requirement of equipment is given as below :-

1. Multi Line Display Boards :-  
Minimum Two nos. Boards (Single Face) to be installed at the Station Building as per requirement.
2. Platform Display Boards :-  
Double Faced Platform Display Boards to be installed at the Platform as per requirement.  
Single Faced Platform Display Boards to be installed in Station Building, FOB as per requirement.
3. At-a-Glance Display Boards :-  
Double Faced / Single Faced At-a-Glance Display Boards to be installed at the FOB/Platform as per requirement.
4. Coach Guidance Display Boards :-  
Coach Guidance Display Boards to be installed at each platforms.
5. GPRS Clock :-  
Minimum Eight nos. GPRS Clock (Double Faced) to be installed at the Station (Station Building, Platform, FOB etc.)..  
Minimum four nos. GPRS Clock (Single Faced) to be installed at the Station Building.
6. GPS/Radio equipment with antenna and all required accessories.
7. Master clock with data storage and a master PC for control and monitoring
8. Minimum 5 KVA UPS.
9. The GPRS clock shall be integrated with the Railway System to avoid any discrepancy in timings.

**SUB HEAD - 25**  
**ELEVATORS AND ESCALATORS (DELETED)**

**General Technical Specification for Station Building**

1. All works shall be executed as per latest RDSO's specifications, RDSO's Technical specification for Passenger Escalator to be installed at various Railway Stations of Indian Railways issued in 2017 bearing No. **RDSO/PE/SPEC/TL/0095 (REV '2') -2017** and RDSO's Technical specification for Passenger Escalator to be installed at various Railway Stations of Indian Railways issued in 2015 bearing No. **RDSO/2013/EM/SPEC/0016 (Rev '0') amdt-1** with amendments upto date shall be utilized as per direction of Engineer in Charge.
2. In items of work for which RDSO specifications are not available, execution of work shall be carried out in accordance with standard practices and/ or Manufacturer's catalogue and as per directions of Engineer in Charge. Before execution of such items, Contractor has to submit his methodology of execution & Manufacturer's catalogues for approval to Engineer in Charge. Decision of Engineer in Charge in this regard shall be final & binding on the contractor.
3. The tenderers are requested to obtain the copies of the above documents directly from the office of RESEARCH DESIGNS AND STANDARDS ORGANISATION (RDSO) as these specifications are not being issued along with the tender documents. These specifications with upto date revisions will form part of the contract agreement to be executed with the successful tenderer.

**Technical Specification for Office Building**

**ELEVATORS**

**1.1 SCOPE OF WORK**

These specifications cover the details of lifts to be designed supplied, inspection as may be necessary before dispatch, delivery at site, installation, testing, commissioning and handing over to CLIENT and the defects liability period as specified after completion of all works & handing over to CLIENT.

These specifications shall be read in conjunction with the General Conditions of Contract, Special Conditions of Contract. The specific requirement of Elevators are given under Annexure-A.

**1.2 GENERAL**

The equipment and installation covered by these specifications shall conform to codes of practice in force and highest standards of workmanship and materials. This work shall be done in accordance with the provisions of the Local Lifts Authority rules and shall also conform to requirements of local municipal by laws, and subsequent provisions, as also any state or local Act in force and latest Indian Standard 14665 and all latest applicable BIS, NBC code and 'CPWD General Specifications for Electrical Works (Part III, Lifts & Escalators) 2003'.



The Entire electrical installation shall be done in accordance with the Indian Electricity Act 2003, Indian Electricity Rules 1956 as amended to-date. The Electrical wiring shall strictly comply with IS:732 and latest applicable BIS and NBC code. The electrical works shall also conform to CPWD General Specification for Electrical Work Part-I (Internal) 1994 and Part-II (External) 1994 as amended up to date.

The Contractor shall follow all Statutory Requirements as well as best trade practices in the manufacture & installation of lifts. The Contractor shall arrange to obtain the statutory approval of the Inspectorate of Lifts as may be required for commissioning of the lifts and handover for operation after satisfactory tests.

### **1.3 DRAWINGS**

Before commencing work, the Contractor shall prepare and submit all drawings for individual lifts in required nos. necessary to show the general arrangement and details of lift installation, electrical etc. These drawings must be approved by the CLIENT before installation and shall become part of the contract.

The Contractor shall submit 04 copies of all working drawings showing pit, hoistway and machine room layouts clearly indicating and specifying all connected structural, electrical and architectural works including imposed structural static / dynamic loads (including breaking load on guides, reaction of buffers on lift pits, reaction on support points in machine room, lift well etc.) and electrical ratings including calculations for selection of kW rating of motor. The Contractor will be responsible for any discrepancies, errors and omissions in the drawings or particulars submitted by him even if these have been approved by the CLIENT. On approval of these drawings, the Contractor shall submit 04 copies of approved working drawings incorporating corrections / comments, if any, and shall commence the work.

On completion of work, the contractor shall supply four sets of CD's and 8 (eight) copies of the detailed wiring diagram, 'As built' drawings and equipment operation & maintenance manuals and original certificates from 'Inspector of Lifts' for all the lifts. Further, a copy of such detailed diagram and a set of instructions for evacuation of passengers in case of breakdown of the lifts shall be framed and installed in the respective machine room by the Contractor.

The Contractor shall carry out all the work strictly in accordance with drawings, details and instructions of CLIENT.

### **1.4 WORKS TO BE ARRANGED BY CLIENT**

All works are to be executed by the contractor.

### **1.5 CONTRACTOR'S RESPONSIBILITIES :**

- i. All steel items i.e. machine beam/bases, pedestals/ bearing plate in the machine room, separators wherever required and buffer support channels, vertical iron ladder in lift and

structural steel supports and brackets for the installation in etc., to suit the sizes of the hoistways.

- ii. Sill tracks including sill supports, supporting protection at all landings.
- iii. Screen guards, fascia plates and other protection for installation.
- iv. To carry out minor civil work, such as chipping & making openings in slabs, grouting of foundation bolts in shaft, pit and machine room, modification and making rail bracket, hall buttons indicators and laying of sills in positions. Or any other work required for smooth operation/ commissioning of lifts. All chiselling and cutting of pockets and making good. (All cutting shall be as approved by CLIENT).
- v. Ensuring safety against accidents including barricading all openings and caution signs.
- vi. Scaffolding and other Tools & Tackles required for installation in the hoistway required for erection of lifts.
- vii. All other items necessary for satisfactory execution & completion of works, whether specified or not.
- viii. Power shall be provided at incoming of main DB for lifts. From main DB to lifts, cables shall be in the scope of lift contractor. However, lighting for machine room shall be done under other package.
- ix. Trap doors, floor gratings, steps / ladders and openings in machine rooms and ladders for pits as required by the lifts Contractor. Contractor shall furnish the details of these items in the layout drawing for lifts to be submitted after award of the job.

## **1.6 SOUND REDUCTION**

The Contractor shall provide necessary sound reduction materials, such as rubber pads/ anti vibration pads of proper density to effectively isolate the machine from the machine beams and/or flooring.

Noise level inside cars and in the machine room shall be maintained at minimum levels as laid down in the relevant codes and in any case not more than specified under PERFORMANCE PARAMETERS.

## **1.7 TRACTION MACHINE**

The gearless machine shall consist of a motor, traction sheave and break-drum or brake disc completely aligned on a single shaft. Gearless machine shall be A.C. gearless with VVVF drive.

## **1.8 HOIST MOTOR**

The motor shall be suitable for 415 Volts +10% to -20%, 50 Hz.  $\pm 5\%$ , 3-Phase A.C. Supply. The motor must be designed for arduous lift duty, rapid reversals and constantly repeated starts & stops

as defined in the relevant codes of practice. All windings must be heavily insulated, adequately impregnated for tropical climate and mechanically strengthened and must be specifically designed to have a high starting torque and low starting current characteristics within the limits acceptable to electricity supply co. requirements and I.E. Rules. The motor shall be designed in such a way as to withstand occasional overloading above its rated capacity and shall have overload protection. The motor shall have good speed regulation under different conditions of load and shall be designed to give a noiseless and vibration-free operation. Insulation shall be class F.

### **1.8.1 MOTOR CONTROL AND DRIVE**

The lift motor shall be controlled by a variable voltage variable frequency (V.V.V.F.) micro-processor control system which shall control and monitor every aspect of lift operation at all stages of the car motion cycle on real time basis.

The A.C. V.V.V.F. drive system shall control A.C. voltage and frequency concurrently with the hoist motor to regulate the lift's actual performance to match closely the ideal speed pattern, obtain maximum efficiency of operation and provide a very smooth ride.

Frequency shall range fully between zero and rated value.

The Controller shall be provided with a self diagnostic programme to keep downtime to a minimum possible.

The controller shall intelligently adjust door times in response to car calls, hall calls and "Door Open" button operation.

An Inspector's changeover test switch and set of test buttons shall be provided in the controller. Operation of the Inspector's changeover switch shall make both the car and landing buttons inoperative and permit the lift to be operated in either direction from machine room for test purposes by pressing corresponding test buttons in the controller. It shall not, however, interfere with the emergency stop switches inside the car or on the top of the car.

## **1.9 GUIDES AND FASTENINGS**

- i. Guide-rails for car and counterweight shall consist of machined mild steel Tee sections, erected plumb, and securely fastened to the lift well framing by heavy steel brackets, suitably spaced, to limit deflection of guide rails to 3 mm under normal working conditions.
- ii. The guide-rails shall be of suitable section with ends tongued and grooved, forming matched joint and shall be connected with steel fish plates.
- iii. Guide-rails shall cover the full height of the hoistway and pit, such that it shall be not be possible for any of the car or counter weights shoes to run off the guides.
- iv. Guides shall be designed to withstand the action of safety gear when stopping a counter weight or fully loaded car.

- v. The max. deviation from true plumb and alignment of guide rails shall be 2 mm.
- vi. All support framing shall be rigid and shall be designed to restrict displacement of the point of support of brackets to 3 mm under normal working conditions.
- vii. The whole guide rail installation, including expansion joints, shall be designed for a smooth ride.
- viii. The guide-rails shall be protected during storage and installation with a rust inhibiting coating which shall be cleaned off on completion of installation.
- ix. Guide-shoes shall be adjustable type & mounted so as to provide continuous contact with guide rails under all conditions.  
Guide shoes shall be provided at top and bottom of each side of car and counterweight and shall be designed for quiet operation.

Additional guide shoes shall be provided on each side of buffer frame in case of oil buffers.

Each lift shall be equipped with roller guides for up and down travel. There shall not be any metal-to-metal contact between Car and rail. Roller shall be mounted on ball bearings to provide quiet operation and excellent ride quality. (It is not required in case the design varies however the ride quality shall not be compromised for any other design).

## **1.10 CAR**

### **a. Cabin Size**

The internal clear dimensions of the cabin shall not be less than those specified in IS 14665-Part I, NBC & CPWD General specifications for electric work (Lifts). The car shall be so mounted on the frame that vibration and noise transmitted to the passengers inside is minimised.

### **b. Frame and Safety Device**

The car frame shall consist of mild steel channel/structural steel top and bottom securely riveted or bolted and substantially reinforced and braced so as to relieve the car enclosure of all strains when the safety device comes into action due to over speed or when the capacity loaded car is run on the buffer springs at normal speed.

The safety device mounted on the bottom members of the frame operated by a centrifugal speed governor shall be arranged to bring the car to a gradual stop on the guide rails in the event of excessive descending speed; and provision shall be made to shut off the power supply to the motor.

### **c. Buffers**

Substantial spring buffers (2 Nos.) shall be furnished and installed in the pit under the car and counterweight. These buffers shall be mounted on RCC Pedestals in the pit. The car buffer spring must be of correct design to sustain the car with capacity load without damage should the car terminal limits become inoperative. The car buffers must be located symmetrically with reference to centre of car.

The Contractor may alternatively offer oil type buffers. The plunger shall be mild steel, designed for a very high factor of safety and accurately machined. A toughened rubber bumper shall be fitted to the plunger top to cushion the impact of steel buffer plates attached under the car and the counterweight. An oil gauge shall be provided to check the oil level.

**d. Counterweight**

The lift shall be suitably counter-balanced for smooth and economical operation. Cast iron weights shall be contained in a structural steel frame properly guided with suitable guide shoes (minimum 4 Nos). It shall be equal to the total weight of lift plus approx. 50% of the contract load.

Substantial expanded metal counter-weight screen guard shall be furnished and installed at the bottom of hoist way, as required by Lift Inspector.

**e. Hoisting and Governor Ropes**

Bright steel wire ropes with fibre cores suitable for Lift duty as per BIS Code shall be used for hoisting ropes.

Not less than 3 independent suspension ropes shall be provided and designed to share load equally by means of adjustable shackle rods with equalizer springs at each end of hoisting ropes.

Each rope shall have adequate section to provide a minimum factor of safety of 4 based on the max. force on the rope.

Governor ropes shall be similar to hoisting ropes. Their ends shall be securely attached to the car and to the safety gear. The governor ropes shall be tensioned by a weight loaded device in the pit.

The contractor shall submit the technical details and source of supply of ropes to the CLIENT as well as a certificate of performance of ropes from an approved test laboratory or Authority.

Compensation for travel shall be provided for all lifts having a travel of more than 30m.

**f. Enclosure**

The car enclosure shall be as specified in technical data sheet. The cabin floor, roof and walls shall be free of distortion and undue deflection as per IS 14665 – Part 4, Section 3.

**g. Brakes**

D.C. brakes will be spring-applied and electrically released. They shall be designed to provide smooth stops under variable loads.

**h. Doors**

Provision shall be made for vertical and horizontal fine adjustment of doors as per the specifications given in technical data sheet.

**i. Door Operators**

The door operators shall be VVVF inverter controlled heavy duty A. C. motor, allowing variable opening and closing speeds, and full synchronization of car and landing doors.

**j. Travelling Cables**

The traveling cables shall be multi-core with high conductivity stranded conductors specifically designed for lift duty. The cables shall be provided with retaining straps and individual cable clamps.

**k. Emergency Lighting**

A self-contained, non-maintained emergency light with a trickle boost charger shall be provided.

**l. Intercom**

An Intercom system shall be provided between the car, main landing, machine room and Fire Console room linked to EPABX.

**m. Manual Cranking Facility**

Manual cranking facility shall be provided in the machine room to facilitate evacuation of passengers in case of power failure. The manual mode shall be in addition to automatic car failure operation specified elsewhere.

**n. Emergency Stop Switch**

A stop switch in the machine room / top of car shall be provided for use by maintenance crew to cancel all car and landing calls for a particular lift.

**o. Maintenance Switch**

On operation of the maintenance switch located on top of the car by the maintenance crew, the car shall travel at slow speed not exceeding 0.85 m / sec by continuous operation of a button

**p. Landing Door Interlocks**

Electrical interlocks shall be provided to ensure that the car does not operate unless all doors are closed and unless the car reaches a landing zone.

**q. Overload Indicator**

An overload indicator with buzzer shall be provided in the cabin to indicate to the passengers that the car will not start as it is overloaded.

**r. Other Features**

All features specified in the BIS/NBC/CPWD and in the enclosed technical specifications shall be provided.

**s. Lift for Disabled**

All the Passengers lifts shall be suitable for use by disabled persons. The following additional facilities shall be provided in this lift:

- i. Full length handrails shall be provided on the rear and side wall panels.
- ii. The door closing time shall be set for min. 5 seconds and the door closing speed shall not exceed 0.25 m/sec.
- iii. The “door open” and “door closed” announcements shall be audibly made in the car.
- iv. Braille signs / buttons.

**t. Operating Panels, Buttons & Switches**

Main and secondary car operating panels, buttons and switches shall be located on one of the two front wall panels next to the car door and as specified in the Schedule of lifts & as per approved G.A. drawings.

All buttons and switches shall be clearly legible with fade-proof text and figures, and shall be easily accessible, (especially for disabled persons in the lift designated for them).

## **1.11 ELECTRIC WIRING**

Necessary insulated wiring to connect all parts of the equipment shall be furnished and installed. Insulated wiring shall be flame retardant and moisture resistant and shall be run in G.S. conduits. All cables shall be flame – retardant with copper conductors.

Trailing cables shall be PVC sheathed copper conductor multi-core ribbon type designed for lift service and shall be flame retardant and moisture resistant. They shall be flexible and shall be suitably suspended to relieve strains on individual conductors. All copper conductors shall be of appropriate gauge copper to avoid excessive voltage drop. All wires, cables, conduits, metal boxes, fittings and earthing shall comply with statutory requirements and BIS specifications.

The controller unit comprising of the MCCB, adjustable overload and phase reversal and phase failure protection, all the circuit elements, transformer, rectifier for D.C. control supply, inverter power pack, terminal blocks etc. shall be enclosed in an insect vermin proof, sheet steel floor or wall mounted cabinet with hinged doors at front or at both front and rear. Proper warning boards and danger plates shall be provided on both sides of the controller casing. Sheet steel used for controller cabinet shall not be less than 14 gauge and shall be properly braced, where necessary.

Suitable gland plate shall be provided for cable entry. The battery for the charger unit shall be suitably placed in the machine room. Degree of protection of Enclosure shall be IP54. Enclosure shall have provision of earthing studs.

All sheet steel work shall be painted with two coats of synthetic enamel paint of suitable shade both inside and outside over two coats of zinc primer.

### **1.13 PAINTING**

All exposed metal work furnished in these specifications, except as otherwise specified, shall be given one shop coat of anti-corrosive primer after approved surface treatment of metal surfaces and two coats of approved enamel paint of approved shade. After installation of Lifts, a final Touch-up Coat of paint shall be applied.

### **1.14 WORKS TESTS**

The following tests shall be carried out at Works. CLIENT shall be given notice of the time and procedure of the tests before they are carried out, and shall be given facilities for observing the tests at Works.

- a. High voltage works tests of equipment which is not already tested in accordance with appropriate IS codes.
- b. Buffer test.

### **1.15 TESTS ON COMPLETION**

The following tests shall be carried out to the satisfaction of the CLIENT.

- i. Insulation resistance and earth test for all electrical apparatus.
- ii. Continuous operation of the lift under full load conditions and simulated starts and stops (150 nos. per hour each) for one hour at the end of which time the service temperature of the motor and the operating coils shall be tested. This shall be as per B.I.S. specification.
- iii. The car shall be loaded until the weight on the rope is twice the combined weight of the car and the specified load. The load must be carried on for about 30 minutes, without any sign of weakness, temporary set or permanent elongation of the suspension rope strands.
- iv. The following items shall be tested :
  - a. Levelling accuracy at each landing in conditions of fully loaded and empty car.
  - b. No load current and voltage readings both on 'Up' and 'Down' Circuits.
  - c. Full load current and voltage readings both on 'Up' and 'Down' Circuits.
  - d. One and quarter load current and voltage readings both on 'Up' and 'Down' Circuits.
  - e. Stalling current and voltage and time taken to operate overload.
  - f. Overload protection.



- g. Gate sequence relays, if provided and installed.
- h. Car and landing door interlocks.
- i. Collective control and priority sequences, if installed.
- j. Safety gear mechanism for car and counterweight with fully loaded car and also with only 68 kg load.
- k. Speeds on Up and Down travel with full load, half load and empty car.
- l. Door contacts.
- m. Final terminal stopping device.
- n. Normal terminal stopping device.
- o. Car and counterweight buffers with contract load and contract speed.
- p. Operation of controllers.
- q. Manual operation of lift at mid-way travel.
- r. Emergency operation.
- v. Tests on completion shall also be performed to the satisfaction of Inspector of Lifts and a certificate will be obtained from the 'Lift Inspector ' by the contractor.

## **1.16 STATUTORY APPROVALS**

All statutory approvals from commencement to commissioning of lifts shall be obtained by the Contractor from the Inspector of Lifts and / or other authorities. However, the CLIENT will provide all necessary assistance for providing documents, drawings and certificates pertaining to other contractors, if required.

The contractor shall pay necessary fees in connection with the approval of installation of lifts.

## **1.17 FEATURES REQUIRED FOR ACVVVF LIFTS**

### **1.17.1 Automatic- Cum-Attendant Operation**

#### **a) Single Automatic Push Button With/ Without Attendant**

The operating devices for this operation shall incorporate in the car control panel, car buttons corresponding to the various landings served and single landing button at each landing, all electrically connected to controller governing floor selection, direction of travel, acceleration, retardation etc.

This system shall be so arranged that when the car is not in use, on pressing a landing call button the car shall start automatically provided all the doors are closed. During the movement of the car and also when car stops at floor landing, other landing call buttons are in-operative for a predetermined time. The pressing of a car button shall automatically start the car and send it to the desired landing. In all the cases, the starting of the car is contingent on the establishment of landing door and car interlock circuits. To indicate the availability, or 'in use' light shall be placed in the landing call button panel. When light shall be 'OFF' the passenger shall be able to call the car. In case of manual operated door if the lift is standing at any landing with doors open (when not in use), the pressing of the landing call button shall ring a bell, fitted at the top of car

to attract the attention of the people soliciting their help for closing the lift door if anyone of the them happens to be near the lift.

Incase of power operated doors, the landing and car doors shall be arranged to open automatically when the car is parked at landing after all the calls are served and the lift is parked at any landing. The doors can remain open or alternatively if desired, the car shall be arranged to close after a pre-determined time unless closing is prevented or interpreted by the car doors re-opening device or the door open button.

The lift shall be suitable for dual operation with or without attendant by the provision of key operated transfer switch indicating 'attendant' and 'automatic' positions. During 'attendant' operations the landing call shall be disconnected from the control system and shall be connected to an annunciator in the lift car. The attendant shall then operate the car to answer the registered calls. This operation is recommended for single speed control lift for low rising building having a single lift installation.

**b) Simplex Selective-Collective Operation With /Without Attendant**

Automatic operation by means of one button in the car for each landing level served and by up-and-down buttons at the landings, wherein all stops registered by the momentary actuation of the car made as defined under non-selective Automatic Operation but where in the stops registered by the momentary actuation of the landing buttons are made in the order in which the landings are reached in each direction of travel (irrespective of the sequence in which the buttons have been actuated). With this type of operation, all 'up' landing calls are answered when the car is traveling in the up direction and all 'down' landing calls are answered when the car is traveling in the down direction, except in the case of the uppermost or lowermost calls which are answered as soon as they are reached in-respective of the direction of travel of the car.

**c) Duplex Collective Selective Operation With/Without Attendant**

The control system for this operation shall be similar to the one described under simplex selective-collective operation except that in this system there shall be two lift cars in adjacent wells. It shall be arranged to co-ordinate both cars for efficient service and prevent them from answering the same calls by the provisions of only one set of landing call button fixtures. It shall automatically assign each call to the car that will be in the best position to answer promptly. The system shall be so arranged that when the cars are idle, normally one car will be parked at the lower main landing with its doors closed or open and the other car shall be free car parked with the doors closed or open to the landing where it answered its last call, and shall be the one to attend to the nearest call.

Each car shall always respond to calls registered by its own car call buttons. When either car is parked out of service for any reasons the other car shall function as single car (simplex) selective collective. Besides the control system shall also be arranged for independent service from inside the car.

A by-pass button (non-stop button) shall also be provided inside the car to enable the attendant to by-pass any landing if the car is full or if otherwise so required.

The two lifts shall be arranged with or without attendant operation and shall function as described using single car selective-collective operation. When the transfer switch is in the attendant position the operation of the cars shall be identical with that described for automatic operations except that:

- i) Closing of doors and starting of cars shall be initiated by the car buttons only;
- ii) Buzzers and directional lights in the car are operative, and
- iii) Landing by-pass shall be effective.

The pressing of an up or down landing call shall illuminate appropriate direction indicator in the car panel, which is to answer that call and if the doors are open shall also sound buzzers as a signal to the attendant. If both cars are parked at the lower landing the above signals shall be given to the car which has been at the floor for longest time.

#### **1.17.2 Fireman's Switch**

A fireman's toggle switch shall be provided in a break glass for the specified lift at ground floor to enable firemen to bring the lift non-stop to ground floor from any location and to cancel hall calls until the car is operated on attendant control.

#### **1.17.3 Emergency Power Operation**

In case of power failure, standby power equipment shall enable lifts to reach a pre-determined floor, in a pre-determined sequence, and then permit operation of one or more lifts on emergency power.

A trickling battery shall be provided to supply power to light fixtures, fan, alarm and intercom.

#### **1.17.4 Profile Generator**

A profile generator or similar device shall be provided to use the car at an optimum speed level and to improve levelling accuracy.

#### **1.17.5 Predictive Car Selection**

Once a hall call is registered, a dynamic car algorithm shall transfer the call to an optimally selected car to provide the maximum traffic efficiency.

#### **1.17.6 Home Landing Facility**

A car shall return to a pre-determined landing after the last call is answered.

**1.17.7 Door Safety**

Multi-beam infrared / ultrasonic electronics curtains shall be provided to scan the doorway and reverse the door closing in case of any obstruction.

**1.17.8 Double Door Operation**

If both up and down calls are registered at a hall which is the last registering hall in the direction of the car, the lift shall travel to that hall and open / close the doors. After this, the car shall reverse its travel and shall open / close the doors again unless no car calls are registered at that floor.

**1.17.9 Nudging Door Operation**

When the doors remain open for more than a predetermined period, a buzzer shall sound and the door shall close automatically. The door sensing device shall be rendered inoperative but the Door Open button and the safety shoe shall remain operative

**1.17.10 Selective floor Service**

Programming for selective floors services shall be software driven.

**1.17.11 Manual Cranking & Slow speed Travel**

A manual cranking facility shall be provided.

Slow speed operation shall be possible from machine room and car top.

**1.17.12 Auto Fan Off**

In case no calls are registered for a pre-set time, the cabin fan shall be automatically switched off.

**1.17.13 Automatic Rescue Device**

In case of mains power failure and Lift control system failure, the Lift's own rechargeable and maintenance free battery power shall move the car to the nearest floor and the door shall open automatically for automatic rescue of passengers. A battery run-down indicator shall be provided.

**1.17.14 Elevator Access control system**

The visitor who has been issued an access card by the management system shall have access to only that floor where he/she is supposed to go. This shall be integrated to the elevator display system which shall display the name of the visitor when his/hr floor comes.

**1.18 PERFORMANCE PARAMETERS**

The following parameters shall be achieved in the installation :

* Levelling Accuracy	$\pm 3$ mm for 1.5 m/s speed $\pm 4$ mm for 0.75 m/s speed
* Jerk level	$0.9 - 1.5 \text{ m/s}^3$
* Noise level in car	55 dB
* Noise level at 1 M in machine room	65 dB
* Acceleration rate	$0.6 - 1.0 \text{ m/s}^2$ (adjustable)
* Max. car vibration	20 milli gals.

## ESCALATORS

- The Escalators shall be of heavy-duty, reversible to be provided at the Railway Stations of Indian Railways.
- The Escalator shall be of State-of-the-art technology, having nominal step width of 1000mm, with 4 nos. horizontal Steps on top and bottom landing area and the nominal speed will be 0.5 m/sec. For the aforesaid step width and nominal speed, maximum carrying capacity as per EN115-1:2008 will be 100 passengers per minute. The escalator shall be complete with all safety features and shall fully comply with International Standard EN-115 latest version.
- The angle of inclination of escalator shall be 30.
- The level of the escalator Floor Plate should be higher than the platform floor level by approx. 100mm or as decided by site engineer. This is absolutely essential for minimizing the chance of rain or cleaning water running into the escalator truss.
- Each Escalator shall be independently driven by a geared type driving machine (or traction machine), comprising mainly of the driving motor, a coupled Gear Box unit (for Speed reduction) and an electrically released and mechanically applied Brake (for stopping the escalator). A VVVF converter shall control the Driving Motor.
- Each traction machine shall be mounted within the truss or the machine pit and shall be removable en-bloc from the truss for repair or maintenance. Suitable lifting points shall be provided.
- The escalator's driving machine shall be suitable for operation on 3-phase, 415Volt  $\pm 10\%$ , 50Hz  $\pm 3\%$  AC supply and it shall comply with IS: 325/IEC 60034. The Total Harmonic Distortion (THD) due to escalator motor drive shall be within 20 %:
- The 3-phase Induction Motor shall be totally enclosed with external cooling fins having minimum IP-55 Protection and class F Insulation level.
- Sound level of the system shall not be more than 65 dBA at 1 meter from the balustrade. The required acoustic treatment shall be provided as necessary, to meet this requirement.
- Cladding of the truss shall be done with 1.5mm thick SS 304.

- The truss of escalator shall be hot dip galvanized up to minimum thickness of 80µm. Other parts inside the truss such as track, return station, shaft etc. shall be given suitable anti-corrosive treatment with zinc plating/ painting or similar process.
- **Balustrade:** The escalator shall be provided with a solid inclined balustrade on its each side, having adequate mechanical strength and rigidity.
- The Interior and Exterior Panels shall be fixed in a manner to withstand the stresses and impacts expected during operation and use of the escalator at its full capacity. The balustrade height shall be minimum 1000mm.
- Material of the skirting shall be SS 304 having thickness of 2.0 mm for skirt .
- The escalator Steps shall be made of corrosion-proof Casting-grade Aluminum Alloy, having sufficient mechanical strength and good construction to fully satisfy the intended purpose of their use i.e. carrying the peak load of passengers without distortion.
- **Key Operated Start Function:** The escalator operation shall be started/ switched-off by a special key provided along with the escalator.
- **Traffic Direction Light:** The escalator shall have traffic direction light of distinct color at highly-visible location(s) on the escalator, to indicate the direction of its movement to the approaching passengers and thus, prevent their wrong-way Entry.

## **SUB HEAD - 26**

### **ACCESS CONTROL SYSTEM**

**General Intent:**

The intent of this document is to specify the minimum criteria for the Design, Supply, Installation, and Commissioning & Maintenance of Access Control System. The work under this system shall consist of design, supply, installation, testing, training & handing over of all materials, equipment's and appliances and labour necessary to commission the said system, complete with Door Controller, Proximity Card Reader, Electromagnetic locks/ door strike, Magnetic Contact, Emergency Release Switch, Passive infra-red sensor and hooters etc. It shall also include laying of cabling, necessary for installation of the system as indicated in the specification and Bill of Quantities. Any openings/chasing in the wall/ceiling required for the installation shall be made good in appropriate manner.

**Scope:**

The scope of work shall include the design, supply, installation, commissioning, integrating, guaranteeing and maintenance of an integrated access control system.

**Access Control System:****General Requirement**

The following clauses outline the minimum requirements for the design, supply, delivery, installation, testing, commissioning and maintenance of the proposed Access Control Systems (ACS) to be implemented in the proposed project.

The ISMS /ACS shall be designed to provide and integrate the following key functions as indicated in the Tender Specifications and Drawings:

- a. Map for real time monitoring
- b. Alarm management + response
- c. Cardholder management
- d. Web Visitor management
- e. Cardholders DB sharing (MIS)
- f. Security Threat levels
- g. Area Control
- h. Hour on site reporting
- i. Evacuation control (Mustering)
- j. Guard Tour
- k. Elevators low level interface
- l. Cabinet Control
- m. Building Automation System integration.

For Smooth Data Transition from Access Control System to Building Management System, ACS & BMS Solution will be accepted only from the same manufacturer.

The ACS shall be designed to allow security of the premises to be monitored from the security control room.

Displaying of floor plans indicating real time alarms, status of access control readers and, through the use of computer input peripheral devices,

The ACS shall allow the distribution of system functions such as monitoring and control and GUI etc. across the network to allow maximum flexibility and performance.

The ACS architecture shall make use of the industry standard Ethernet IEEE802.3, TCP/IP protocols to interconnect all various nodes / subsystem.

The ACS shall provide the possibility to monitor the status of such subsystems and their peripheral devices when connected. If supported by the subsystem, controls from ISMS workstation shall also be attainable.

The ACS shall provide English descriptions and messages using both text based menus and graphical icon displays.

The ACS shall be expandable in the following areas:

Flexible and modular design shall provide ease of installation, robustness, reliability, and expansion.

Additional hardware units shall easily be added without any modification to the existing hardware, software and network configuration.

ACS shall be designed such that any failure of any sub-systems shall not affect the other sub-systems. This shall also apply to any loss of power supply or suffer a loss in communications due to a break in the communication loop. In any case, each sub-system shall continue to function in a fully operational state with no loss of functionality.

The ACS subsystems shall be capable to carry their own processing intelligence and shall function independently in the event of network fail. Each subsystem shall be configured with a distribution system architecture consisting of field controllers that control the terminal equipment and sensors.

The ACS provided shall contain all the features and requirements specified, but not limited to, in this document. The Tenderer shall highlight and update the owner of any new or special functionality that are useful and relevant to the user's application but not found in any part of this document.

### **System Design Architecture and Configuration.**

- The ACS shall be of an open-architecture, PC-based system utilizing the Windows Operating Systems (OS). The system shall consist, but not be limited of the following major components:



- Central Management Server
- Central Database Server
- Dedicated workstation for centralized security management functions.
- The ACS shall have a modular structure that allow for future system expansion with minimum cost and disruption to the existing operational system. Common extensions shall include but not limited to the following:
- Number of operator workstation

**Subsystem connections**

- Each of the ACS modular itself shall also be modular and extendable. The modules and their extensions, as well as all the common system features, shall allow any combination of usage.
- The ACS shall use make used of Microsoft SQL Server database for configuration and central event logging. It must be modularly designed, providing an individual system for specific requirements.
- All server and workstation shall be connected via industry standard Ethernet IEEE802.3, TCP/IP protocols.
- The ACS shall require only one hardware license key on the central login/database server for system operation even for redundant server systems. Hardware or software key shall not be required at the operator workstation.
- Use of proprietary PC software shall be minimized. The Tenderer shall list out the list proprietary PC software, if required.
- The ACS central management server shall act as the source that provides time synchronization to all sub-systems.
- The ACS servers' hardware provided shall be of industrial EIA standard 19-inch rack mountable.

**ACS Server / Workstation Configuration**

The **ISMS central management server** minimum hardware requirements:

- i. Intel® Xeon® X5670, 2.93GHz, 12M Cache, Turbo, HT, 1333MHz
- ii. 4GB, DDR3, Non-ECC SDRAM Memory, 1333MHz
- iii. 1 TB SATA 3.0Gb/s, 7200 RPM Hard Drive with 16MB Cache or higher
- iv. Microsoft Windows XP SP3 or Windows Vista Enterprise, Business or Ultimate (32-bit) DVD+/-RW, SATA, Internal
- v. Dual Integrated 100/1000 Ethernet NIC
- vi. NVIDIA Quadro FX 4800 PCIe 1.5 GB graphics card
- vii. Integrated 100/1000 Ethernet NIC
- viii. Keyboard and Optical Mouse
- ix. Monitor 17 inch flat LCD panel

**ACS Software Functions.**

- The ACS shall support central alarm monitoring and management. It shall provide the same look and feel regardless of which alarm is activated and received.

- The ACS shall provide a number of display features inside the user interface. Permission, placement and contents shall be easily customized. A clear and precise overview of every incoming alarm or event shall be presented to the operator.
- The ACS shall be of web-server/Server-Client and browser/application based on a truly open protocol and non-proprietary standards.
- The ACS shall provide multi-divisions / multi-tenants feature that divide larges premises between autonomous parties, giving each division its individual views / function. The division shall include, but not limited to the following:
  - Individual display of locations / location maps
  - Individual access to subsystems.
  - Individual control into subsystems.
  - Individual assignment of access hardware to different / separate sub-areas.
  - Individual assignment of alarm / event messages distribution.
- The ACS shall support multi-client operation that distribute message to dedicated operator or operator groups whom are permitted to operate on those alarms or events. The operator shall only see the alarm and event messages destined to him for monitoring and processing based on his user login access profile
- The ACS shall support a real-time system status monitor that provides an overview of all devices. All connected sub-systems shall be shown on the status tree where direct control into the subsystems shall be possible by clicking on the panel or detector address.
- The ACS device overview shall display, but not limited to, the following:
  - Operators logged in. and status of each and every device connected to it.
  - All windows open (magnetic contacts, blocks arming of IDS).
- The /ACS shall permit the operation as follow:
  - Allow multiple windows to be open at one time.
  - While an operator is working on one window, all other windows shall continue to display and update transaction activities, including processing of alarm.
- Display graphic maps superimposed with icons to reflect the type of device represented and the state of condition.
- Only authorized operators shall have access to the device overview. Status of the devices can be viewed from Tree View or from graphic Maps
- The device overview shall support state filtering and / or sorting function to search for specific device status. The states indicated in the device overview shall reflect exactly the same color as the detector icon shown in the location map.
- The ACS shall allow the operator to send remote commands or activate controls manually, from the workstation, when requested. The commands function are, but not limited to the following:
  - i. Unlock an access controlled door momentary.
  - ii. Unlock an access controlled door permanently.
  - iii. Relocked back the access control door back to its normal operations.
  - iv. Reset alarms.
  - v. Arm a single alarm point or groups of alarm points.
  - vi. Disarm a single alarm point or groups of alarm points.
  - vii. Enable or isolate a single alarm point or groups of alarm points.

viii. Control one or more output points.

- The ACS shall provide the central configuration platform / tool from where everything concerning sub-systems, system behavior, access control cardholder settings, display features, and authorizations are set up.
- The ACS shall provide timer and schedule functions to support, but not limited to, the following:
  - i. Time based display of information.
  - ii. Time based automatic controls into any sub-system or devices.
  - iii. Time based access.
- The timer and schedule functions provided shall supports time frames per weekday, public holidays, and individual programmable special days as desired by the user.
- The ACS shall allow the creation of authorizations of individual operator / operator group. These shall include, but not limited to:
- Selectable displaying, monitoring, and control of locations, such as individual floor, building, or site permissions.
- Selectable displaying, monitoring, and control of detector points, such as readers, doors.
- The ISMS shall allow the configuration for information access permissions, that is, operator profile for the access on the master records and event data, the permissions shall restrict to;
  - i. Read only.
  - ii. Read and write.
  - iii. Read, write, and change.
  - iv. Read, write, change, and delete.
- The ACS shall provide a separate login as well as login via Windows authentication (single login). A 4-eye-principle login must also be possible.
- The ACS shall seamlessly log all events, messages, controls, or alarms in the entire system, such as user login, fire/intrusion/access alarms into the central event log. The stored information shall be secure from manipulation.
- The events log database shall include an advanced filter functions such that archive can be kept small and precise. Operators must have the ability to store their own individual filters. Filters functions should include but not limited to the following:
  - i. Device addresses
  - ii. Attribute
  - iii. Date / times
  - iv. Event type
  - v. States
  - vi. Operators
  - vii. Access control
- The events log database must be able to export in a standard CSV format text file must be possible for additional processing.
- The ACS shall support generation of report from the event log page or directly from any detector in the device or location overview to display events from the event log database.

- The printers shall be connectable directly to a workstation or to the network.
- The ISMS shall allow the manual and automatic printing of all alarm related documents, including location maps, instructions, and alarm details, such as location, detector address, and type.

### **Graphical User Interface (GUI).**

- The ACS GUI shall be user friendly to allow user to operate the system with minimum training. It should provide the same look and feel regardless of which alarm comes in.
- The ISMS GUI shall be adaptable to; the information requirement, the expertise of the operator, and the configuration of the workstations (resolution and number of monitors). All interface control functions shall be provided in the default GUI.
- The ACS GUI shall support location tree display structure to allow easy selection of locations and sub-locations. Creation of the location tree and the location names shall simply by scanning the drawings for the pre-defined logical sub-areas.
- The location tree display structure should have no limits in the number of levels or sub-levels. A single click on the location/sub-location should show the assigned graphics or sub-areas with all detector icons visible for that area.
- The ACS GUI customizations shall include, but not limited to the following:
  - Inclusion of corporate logo(s) / images.
  - Provision of individual contents to each operator or operators group. An operator logging in to the system shall be automatically be detected and the ISMS shall supply the right contents and display resolution pre-assigned to him.
- The ISMS shall support the display of location maps site / building floor plan drawings that are of standard vector graphics format, such as AutoCAD DWF/WMF/BMP.
- The drawing format for the location maps shall support a logical partitioning by defining sub-areas inside the drawing, by marking the area and giving it a logical name.
- The ACS shall provide a zoom and pan feature for zooming into a location and move around inside the map, simply by using a standard PC mouse.
- The ACS shall support multi-layered drawings and allows layers to be shown or hidden in the GUI depending on the incoming event. A manual layer control during normal operation shall also be provided.
- The ACS shall provide a library of standard detector icons for intrusion detectors, doors, readers, cameras, etc, to be placed directly onto the drawing. All assigned control commands shall be provided when clicking the icon.
- When a detector point sends an alarm / event message, the assigned icon animates inside the drawing, displaying the corresponding event color.
- The icons shall be provided in a vector format, such that when the operator performing zoom-in or out of the map, the icon size scales automatically to the view.
- Moving the mouse cursor over a detector icon provides a tool tip with detailed detector information, such as complete address, actual status, and detector type.
- Extensive on-line help shall be incorporated into the ACS, including a copy of the User's manual being used as part of the on-line Help function.

### **Alarm Management and Monitoring**

- The ACS shall support a central alarm management and monitoring function, providing an alarm / event queue where all incoming events are display. The alarm queue shall provide, but not limited to, the following information:
  - i. Alarm date and time
  - ii. Alarm status
  - iii. Current alarm condition
  - iv. Detector/input name/address
  - v. Alarm location
  - vi. Message priority
- Operator who is working on the alarm/event when it was acknowledged.
- The ACS shall be able to handle a wide range of alarm / event states with definable parameters. It shall be able to create additional customer specific event states. For each of the event state, the following parameters, but not limited to, shall be definable:
  - i. State name
  - ii. Background / foreground color
  - iii. Alarm sound (standard formats such as WAV, MP3 or WMA)
  - iv. Priority
- The alarms message shall only appear in the message list of the operators who are authorized to process the message. The operator who accepts the message first is responsible for further processing.
- The alarm message shall be displayed at the destined ACS operator workstation together with an external audible siren or via PC internal speaker. The audible siren shall be able to turn off for 30 seconds. The siren shall sound again until the message has been accepted / acknowledged.
- All incoming alarms at the ISMS GUI workstation shall consist of the following
  - Comprehensive alarm message.
  - Blinking icon representing new alarm.
  - Graphical map showing alarm location with flashing icon associated with the alarm.
  - Audible alarm / buzzer.
  - Status of the alarm messages
- All alarm and event messages received at the authorized ACS workstation shall be queued according to their pre-defined priority settings.
- The alarm and event messages received shall be classified into the following status:
  - **NEW** – All the incoming messages that have not been accepted by any operator are marked NEW. These messages are displayed to all operators authorized to accept these messages.
  - **ACCEPTED** – All messages which have been accepted by any operator are marked ACCEPTED. The name of the operator who accepted the message shall be displayed. Only this operator can delete the message or put it into the workflow.
  - **WORKFLOW** - Messages that have been placed in the workflow are marked WORKFLOW. These messages are displayed to all operators authorized to accept these messages.
- When the alarm / event message is acknowledged and accepted by the operator, the ACS shall log the operator's name, date and time of the acknowledgement into the database.

- In the event if a higher priority event occurs while an operator is working on a low priority event, the higher priority event shall automatically place in the foreground, while the lower priority event maintained in the background.
- The operator shall be able to toggle between all acknowledged events. Assigned location maps and documentation shall follow and toggle automatically.
- The ACS shall provide an easy and intuitive way of defining / designing the system behavior of alarms or events when they activate. It shall provide and allow system administrator during configuration with the use of 'IF' and 'THEN' and 'ELSE' or similar conditional functions to define the behavior of individual or groups of alarm/event.
- The ACS shall support but not limited to the following alarm triggers:
  - i. Event / alarm from any single detector point.
  - ii. Event / alarm from any group of detectors.
  - iii. Event / alarm from any subsystem, such as common status.
  - iv. Event / alarm from any subsystem interface.
  - v. Internal timers, such as timeout in alarm operating.
  - vi. Status changes of alarms / events, such as deletion or forwarding by operator.
- The ACS shall support the following outputs when a condition / trigger is TRUE:
  - i. Display message to authorized operators.
  - ii. Display corresponding alarm documents and location maps.
  - iii. Reset the triggering detector.
  - iv. Trigger an output or a group of outputs.
  - v. Start internal timer for creating time-dependent chains of events.
- The ACS shall be capable of handling up to 5000 alarms/events simultaneously. A minimum of 500 events per second must be handled.
- The ACS shall support the displaying of individual alarm documents / plans depending on the alarm type. The alarm document shall provide, but not limited to, the following information:
  - i. Alarm or event date and time
  - ii. Alarm or event status
  - iii. Alarm or event location
  - iv. Detector/input type and its name/address
- The ACS shall support the use of macros to minimize the number of alarm documents / plans. The macros shall be dynamically substituted by the real alarm or event data when displayed. The use of macros shall not limit the number of alarm/event action plans and miscellaneous documents that can be created.
- The alarm documents / plans shall be assignable to locations inside the location tree to display information when an alarm / event is generated from that pre-defined location.
- The alarm document's format shall be of open standards allowing the user to create and configure using standard editors.

### **Integration to Access Control System (ACS).**

- The ACS shall be handling all access control alarms. Access alarms / events shall be visualized with all the common display features like location maps, alarm documents / instructions. The access control alarms shall include, but not limited to the following:

- i. Door held open
  - ii. Door forced open
  - iii. Door open under duress
  - iv. Door held open time exceeded
  - v. Unknown card
  - vi. Unauthorized card / cardholder
  - vii. Card anti-pass back
  - viii. Card blocked / blacklisted
  - ix. Access denied
  - x. Access timeout
  - xi. PIN code error
  - xii. Controller communication failure
  - xiii. Tampering alarm (reader / controller)
  - xiv. Guard tour alarms
  - xv. Other individual alarm extensions
  - xvi. Power loss
  - xvii. Low battery
- All alarm / events must be logged in the central ACS event log database together with all assigned alarm documents for a complete reporting.
  - The operator at any of the ACS shall be able to perform the following tasks:
  - View the transaction activities and graphical maps showing the location of the doors and the status of conditions.
  - Display the transaction activities.
  - The transaction activities displayed shall include the name of person entering / leaving a controlled door, time and date.
  - Assigning new card or make changes in existing cardholders' database, such as re-assigning access rights.
  - Remotely unlock doors or group of doors manually.
  - The ACS shall provide video verification access, by combining access control with. Dedicated card readers shall be easily configured for video verification mode through clicking on the checkbox in the configuration.

### **Integration to the ACS subsystem**

- The ACS shall allow the operator to display associated camera images when there is an access control alarm, such as:
  - i. Duress alarm
  - ii. Door open time exceeded
  - iii. Card/cardholder not authorized
  - iv. Card unknown
  - v. Tamper alarms
- With integration to the ACS subsystem, the ACS shall support video verification access control.

- The ISMS shall provide access control by means of restricting life access to floors in the complex. The interface of the ACS (intelligent local controller) with the lift system shall be at the lift motor room unless specified otherwise.
- The Tenderer shall include all related works, accessories and costing in the tender to provide all necessary lift travelling data cables and equipment for the complete installation of the access card reader within the lift cars. The mounting of the access card readers shall be either surface or concealed mounted. The final mounting of the access card readers shall be subjected to the final approval of the superintending officer.
- With the definition of floor authorization configured and assigned to card holders, card holder shall only allow to gain access to floors he is authorized to.
- A fail-safe method of interconnecting the ACS controller to the lift floor select buttons shall be used, so that, if the ACS is powered down, or shall fail, control of the lift shall be bypassed

**Integration to Fire Detection and Alarm System.**

- The Tenderer shall provide input and output points to be interfaced with the Fire Detection and Alarm System at every level of the complex for all electrically controlled doors and speed gates.
- The ISMS shall be able to monitor and report fire alarm condition from the main or sub fire alarm panels to facilitate evacuation and firefighting process. All or selected electrical operated doors / speed gates shall be unlocked / released automatically.
- The Tenderer shall include all related works, equipment, accessories and cost to run and terminate the required control cables to the main or sub fire alarm panels in this tender. A separate fire alarm cable (fire retardant type) shall be run from the main or sub fire alarm panel to suitable interface of the nearest ACS controller.
- All or selected electrically operated doors shall be automatically unlocked by the fire alarm signal. The unlocking of doors shall be done on per storey basis. The fire alarm signal shall be used to disconnect the electrical power to each fail-safe electric door lock. When the power to each electric lock is disconnected, there must be a status signal that will relay back to the ISMS, to indicate the door status.
- The Tenderer shall include all necessary works for fire alarm interface to unlock door according to the complex's fire plan.
- The Tenderer shall make provision of fire signal to be linked up to all and / or selected doors for fire escape release of doors.
- A break glass (double pole type) shall be installed at the secured side of each electrically controlled door. The break glass is used to disconnect the electrical power to the local fail-safe electric door lock. When the break glass is broken, there must be a status signal that will relay back to the ISMS, to indicate the particular door status.

**Access Control Subsystem:****Functional Requirement.**

- The Access Control Subsystem (ACS) shall be provided as a function within the ACS to assist in the control and monitoring of all designated access to the area / zone.



- The ACS shall be designed such that any point of failure within the system shall not affect the normal operation of the other sub-systems. It shall continue to operate even if the connection with the management software is not present.
- The ACS shall support up to 5,000 card holders.
- The ACS shall support up to 2000 card readers.
- The ACS shall support up to Hundred twenty Eight (128) different Wiegand card formats simultaneously.
- The ACS database shall be MS SQL 2005 or higher.
- The ACS shall provide a simple way of configuring access points in the form of pre-defined door templates. The administrator of the access system shall be able to configure access points by selecting the following list of door templates provided:
  - i. Access control system to use IP based controller for handling 2/4 readers
  - ii. Door with entry and exit reader
  - iii. Door with entry reader and request to exit button
  - iv. Door with entry or exit reader
  - v. Parking lot with barrier and traffic light control
  - vi. Mantrap
  - vii. Door with combined arm/disarm IDS feature
  - viii. Time and attendance door
  - ix. Combined vehicles entrance with double reader
- Selecting a pre-defined door template automatically assigns the next free reader / input / output channel inside the controller to the chosen function. The access configuration should provide a wiring table for the installer for printout.
- The ACS shall provide a configuration tool allowing the installer to set up associations as follows:
- Allow the triggering of spare relay outputs based on standard access or door events.
- Allow the installer to define the period of time, pulsing, and pulse length. The defined associations must be functional even when the access controller is in offline mode.
- The ACS shall provide configurable time schedules feature for programming automatic locking and unlocking of any access controlled doors, as well as activating and de-activating of card holder settings for restricting any access groups from entering certain areas with the pre-programmed time model.
- The ACS shall include validation based on time of day, day of week, holiday scheduling, automatic or manual retrieval of cardholder photographs, and access validation based on positive verification of card/PIN, card, and video.
- The ACS shall allow the creation of up to 255 time models, containing day models/periods and the specific handling of special days, such as public holidays. The time models can be combined with the access authorization at entrances / entrance groups.
- The ACS shall allow the creation of up to 255 access entrance groups, which shall consist of one or more readers. An entrance shall be assignable to several groups. Access entrance groups must be assignable directly to a cardholder, or be combinable with time models using area-time authorizations.

- The ACS shall allow combining of access authorizations with time models. The assigned time model defines the time when an access authorization is active at an entrance / entrance group. Up to 255 areas-time groups can be created.
- The ACS shall provide an easy way of entering cardholders to the database. It shall be possible to enter the badge number manually or by enrolment readers connected to the operator's / administrator's workstations. The enrolment information shall include:
  - i. Badge number
  - ii. Issue date
  - iii. Expiration date
  - iv. Cardholders first name
  - v. Cardholders last name
  - vi. Company
  - vii. Access authorizations
  - viii. PIN code
  - ix. Status fields, such as employee, visitor, guard
  - x. Address fields
  - xi. Personal data
- The ACS shall also support the creation of Individual fields as followed:
  - i. Up to ten fields can be created.
  - ii. The fields can be arbitrarily placed.
  - iii. Field names can be freely chosen.
  - iv. Fields can be defined as mandatory or optional.
  - v. Fields can contain up to 25 characters.
  - vi. Fields are displayed in order of their creation.
  - vii. Each field has a corresponding field in the database and shall be used for searching, selection and sorting.
- The ACS shall provide a standard features for taking photos, scanning, or importing cardholder images for the cardholder database. Stored cardholder images must be displayed automatically in the verification alarm document.
- The ACS shall allow card personalization tool for designing badges. The tool shall allow the importing of bitmaps, text and database fields, such as name or badge number for creating of corporate badge designs printable on a standard card printer that come with a Windows compliant printer driver.
- The ACS shall have anti-pass back feature built-in as a standard feature, in which cardholders are required to follow a proper in/out sequence within the assigned area. Cards shall be used at a designated "in" reader then at a designated "out" reader within the area before the card can be properly used at an "in" reader again. The anti-pass back feature shall support:
  - Support local anti-pass back – allow anti-pass back areas to be configured within the areas that are configured on a single access controller.
  - Support global anti-pass back – allow anti-pass back areas to be configured across multiple access controllers.
  - Support hard anti-pass back – block cardholder access when anti-pass back rules are not followed
  - Support soft anti-pass back – allow a cardholder access when anti-pass back rules are not followed but shall create an alarm.

- The ACS shall support the defining of logical areas where access control points / entrances could be assigned And it will give the list of the people inside that area this may be useful during emergency conditions.
  - The ACS shall support the grouping of access authorizations or access-time authorizations, providing an easy way of assigning frequently used access profiles to employees and visitors.
  - When an authorized card is presented, the reader/controller shall generate an event at the ACS.
  - The operator shall determine if access is granted.
  - The ACS must allow the blocking of cardholders by validity period. The operator shall be able to specify the period for which the person is to be blocked.
  - If a black-listed card is used at a reader, an alarm has to be triggered in the central alarm management and monitoring, displaying all defined and corresponding alarm documents.
  - The ACS shall support the 2 modes of modes of operations, “Card” and “Card + Pin”. The use of additional pin code shall support alarm arming / disarming.
  - The ACS shall support the input of a PIN code for each cardholder. The PIN code shall support up to 4 digits input and the validity period shall be definable.
  - The ACS shall provide duress code alarm feature that generate an alarm in the security room when the cardholders keyed in alarm PIN code. The silent alarm should remain unnoticed to the aggressor, but inform the security officers as appropriate.
  - The ACS shall provide interlocking / mantrap feature to allow management of two or more interlocking doors controlled by two pairs or more of readers (in/out).
  - The ACS shall of duress code alarm input:
  - Increasing the last digit by "1" (e.g. 123457 instead of 123456).
  - The ACS shall provide area balancing / mustering feature, allowing an exact tracking of personnel in the predefined area. In the event of emergency, the system shall generate an area muster list to allow the security manager to track the exact count of people within the disaster area/s so to assist in the evacuation.
  - The ACS shall provide access sequence check feature, allowing authorized cardholder to enter a door or group of doors belonging to an area only when he has already passed another dedicated door.
- a) **Supervisor** – Enables a supervisor to enter without allowing access to others. When the supervisor presents his card during the time zone just once, he gains access but does not enable access for non-supervisory personnel. If the supervisor presents his card twice, he enables access for all non-supervisory personnel as well. After the supervisor presents his card twice to allow general access, he can disable the general access for the time zone by presenting his card again twice consecutively.
- b) **Escort** – Requires a supervisor escort for a non-supervisor cardholder. The supervisor must present his card first, then the non-supervisor must present his card within ten seconds of the supervisor’s card read.
- c) **VIP** - VIP card has the maximum privileges. They override all Access mode restrictions like Disable, lockdown, card and PIN, card or PIN, pin only and card only. VIP cards do not need a supervisor card to gain access.

- d) **Limited Number of Uses** - This will have an option of check box and type the number of times a card can be used at the panel before it expires in the text box provided. Maximum number of uses is 255.
- The ACS shall provide an import / export interface to import cardholder records, from an existing database, into the master database, and to export the master records for further use. The interface shall support the following:
    - i. Support both comma-separated and fixed-field-length format files.
    - ii. Support importing of files with different formats.
    - iii. Support the definition of import/export rules.
    - iv. Support the definition of schedules for automatic importing and exporting.

#### **Access Points Monitoring and Control.**

- The ACS shall support monitoring of access points status, locking / unlocking access points and alarms from various sensors. Monitoring and control shall be achieved through ACS connected to the ACS.
- The card readers used for door access control shall be connected to an Access Intelligent Controller (AIC).
- The AIC shall be an intelligent unit with its own microprocessor, capable of performing access control functions without the needs of interfacing / interacting with the ACS.
- The AIC shall be equipped with all common interfaces such as, Ethernet and RS-485 for connection to the ACS server running the management software.
- The card reader shall read the data encoded on the card being presented and transmit it to the access controller for processing. If access is granted, a relay in the access controller shall operate the electric latch and unlock the door to permit access.
- Card readers connected to the access controller shall be fully configurable for:
  - Access controls of door, lifts (elevators) or car parks.
  - Time attendance “clocking in” and “clocking out” functions
  - Arming and disarming of alarm sensors.
  - Sensing detector with dual line shall be used, so that when the wiring is cut, damaged or short / open circuited, an alarm shall be initiated.
- Electro-magnetic locks with built-in magnetic door contacts or other types of electric door locks shall be employed as the door hardware devices.
- The status of the door (e.g. open or close) shall be fed back to the AIC via the magnetic contacts.
- All doors installed with magnetic contacts and electro-magnetic locks shall be linked to the access controller such that any tampering or intrusion to the doors shall activate an alarm, visually and audibly, at the ACS.
- Operator at the ACS shall be able to unlock / re-lock a controlled door remotely from the ISMS workstation.
- All alarm points must be monitored and controlled by ACS.

- A locally mounted door release push button shall be provided for purpose of exiting at selected doors as defined by the owner or as indicated on the drawings.
- All access doors shall have an emergency break-glass door release installed to unlock the door for exit in the event of emergency. In addition, all dedicated doors along the escape route shall automatically open during fire alarm activation.
- The wiring shall be configured such that in the event of fire, the respective door / group of doors shall unlock automatically.

**Integrated Guard Tour Module.**

- The ACS shall allow the use of existing access reader hardware to be used as guard tour checkpoints.
- The ACS shall allow the grouping of readers to a guard tour sequence. The same logical device shall be allowed to be used more than once in a guard tour.
- The ACS shall support up to 20 programmable guard tours.
- The amount of time required to reach each checkpoint (reader) shall be definable. The entry shall be in military format (00:00).
- The maximum amount of delay (tolerance) for user to reach each checkpoint (reader) shall also be definable.
- The user shall be able to start the guard tour by reading the relevant card at the first reader of the guard tour.
- All violations, such as wrong sequence or timeout, should trigger an alarm in the central alarm management and monitoring.

**ACCESS CONTROL SYSTEM HARDWARE:**

- The quantities of components shall be determined and installed by the contractor based on the requirement to provide a fully operational integrated access control system as per the intent of the specification.
- Communication between components i.e. gateway controller shall be RS485.
- All terminals and controllers must allow for direct Firmware upgrade from the RS485 network connection. The units must be upgradeable during normal system operation, therefore should one unit be in upgrade mode all other units will continue to operate normally. The firmware shall be stored in FLASH memory on the individual units.

**System Controller:**

- The standard controller configuration shall support Up to 64 readers per controller Embedded 32-bit processor
- 128 MB flash memory. 10/100Base-T network connection
- Storage capacity for up to 100,000 cardholders
- Accepts up to 20-digit badge numbers & 8 access group/time zone pairs per badge
- Supports wiegand, proximity, magnetic stripe, barium ferrite. Smart card, most biometric readers and bar code card technologies.
- Custom engineered formats are also accepted.
- The controller is able to perform manual and automatic control functions using add-on modules to connect readers, monitor 2 or 4-state inputs and add output points. Communication between the Main Controller and modules is achieved via an RS485 connection.
- The Controller host communications use a standard TCP/IP protocol on a 10/100Base-T network and are easily integrated into the security management system.
- The controller can be programmed either using its own user interface, or through the Microsoft® Windows®-based interface.

**Door Control:**

- The terminals and remote readers supported by the controller shall be any combination of the following: card only, card and pin, card or pin, pin only, lockdown, disabled, supervisor, escort, limited use card, expire on date, first card rule, snow day rule, time zone toggle and anti-pass back with local/global capability and hard and soft implementation.
- **Inputs:** configure supervised 4-state inputs and unsupervised 2-state inputs. A total of 8 inputs can be configured as supervised 4-state inputs (normally open or normally closed), or 2-state inputs.
- **Outputs:** Provides C relay outputs rated at 1A @ 0-24vdc, 4 LEDs for Power, Status, Transit & receive. Must consist Door strike relay, Single Pole Double Throw (SPDT), Alarm shunt relay, SPDT, Red lamp driver (open collector), Green lamp driver (open collector, Supervised tamper input, Supervised spare input etc.

**Contactless Smart Card Reader.**

- Access control card reader shall be from a global company who is a recognized leader in the access control devices. Card reader manufactured for non-access control applications shall not be acceptable.

- The card reader shall securely read access control data from 13.56 MHz contactless smart cards.
- The card reader shall be optimally designed for use in access control applications by providing:
- Secure access control data exchange between the smart card and the reader utilizing key diversification and mutual authentication routines.
- Universal compatibility with most access control systems.
- Ease of installation through identical wiring methods as legacy 125 KHz proximity readers.
- The ability to read expanded data format lengths up to 144 bits.
- Backwards compatibility with legacy 125 KHz proximity access control formats (E.g. 26-bit, 32-bit, 35-bit, 37-bit, and HID Corporate 1000 formats).
- Optimal read range and read speed for increased access control throughput.
- The card reader provided shall be of ruggedized design, sealed in weatherized UL94 polycarbonate enclosure to withstand harsh environments for both indoor / outdoor used and provide a high degree of vandal resistance.
- The card reader shall comply with the following 13.56MHz-related standards to ensure product compatibility and predictability of performance:
  - ISO 15693
  - ISO 14443A
  - ISO 14443B.
- The card reader shall be configurable to read data simultaneously from one to, at minimum, two of the following cards:
  - HID iCLASS Access Control Sector/Application data
  - ISO 15693 card serial number (CSN)
  - ISO 14443A card serial number (CSN): including MIFARE & DESFire
  - ISO 14443B card serial number (CSN)
- The card reader shall provide the ability to read card access data stored in the secure access control sector / application area of the ISO 15693 HID iCLASS card.
- The card reader shall be fully compliant with Restriction of Hazardous Substances directive (RoHS) restricting the use of specific hazardous materials found in electrical and electronic products. The substances banned under RoHS are lead (Pb), mercury (Hg), cadmium (Cd), hexavalent chromium (CrVI), poly-brominated biphenyls (PBB) and poly-brominated di-phenyl ethers (PBDE).
- The card reader shall provide universal compatibility with most access control systems by outputting card data in compliance with the SIA AC-01 Wiegand standard.
- The card reader shall be available to provide Clock and Data output.
- The card reader shall provide customizable reader behavior options either from the factory, or defined in the field through the use of pre-configured command cards. Reader behavior programming options shall include:
  - a) LED & Audio configurations
  - b) ISO 14443A CSN (E.g. MIFARE/DESFire) output configuration.

- c) Wiegand output spacing and timing.
- d) The card reader shall have the ability to provide consistent optimal read range by implementing an auto-tune function that adjusts for manufacturing tolerances to enhance consistency of performance from reader to reader. Contactless smart card reader shall provide the following typical contactless read ranges:
  - e) Up to 4.75" (12.1 cm) using ISO 15693 HID iCLASS card.
  - f) Up to 2.0" (5.1 cm) using ISO 15693 HID iCLASS Key or Tag
  - g) Up to 2.5" (6.4 cm) using MIFARE/DESFire card (CSN)
- h) The card reader shall be designed for low current operation to enable migration from most legacy proximity applications without the need to replace existing access control panels and/or power supplies. Contactless smart card power requirements shall be:
  - i) Operating voltage: 5 – 16 VDC, reverse voltage protected. Linear power supply recommended.
  - j) Current requirements: 55 mA AVG, 121 mA PEAK @ 12 VDC
- k) Contactless smart card reader shall meet the following environmental specifications:
  - l) Operating temperature: -31 to 150 degrees F (-35 to 65 degrees C)
  - m) Operating humidity: 5% to 95% relative humidity non-condensing
  - n) Weatherized design suitable to withstand harsh environments
  - o) Certified rating of IP55

#### **Cards and Database:**

The card and event buffer capacity shall be 5,000 card capacity and 25,000 event capacity. The firm ware revision shall have on-board flash memory for field firmware revisions and feature expansion. Offline database backup shall be available. Export capabilities for card database, alarms and events. The panel shall support 128 unique card formats and 8 site codes. Maximum card format size shall be 75bit suitable for handling the card format of PIV, TWIC, and FRAC cards. The time zones support will be a minimum of 127 with 128 access levels and 255 holidays.

#### **Electro Magnetic Lock:**

- 600lbs / magnetic lock, Single / Double EM locks should be designed to meet fire/life safety applications by providing an auxiliary locking mechanism that has no moving parts to bind or wear out for trouble free operation. This should ensure inhibited release at all times where they have become extremely prevalent in applications other than fire/life safety. Suitable for access controlled & secure areas within buildings with Single / double leaf doors. The Magnetic Lock should consist Magnet mounted frame onto door frame and a steel plate attached to the top of the door. The will be strongly bonded when magnet get energized and holding the steel plate. Instant release should be possible when power supply is cut-off, in an emergency situation.
- Holding Force – 600 lbs / magnet
- Operating Voltage – 12V / 24V Selectable
- Current Draw – 300-500 mA
- Operating Temperature - -10 to 55 Deg C

#### **Exit Push Button:**

- Exit Push Button with Includes break glass switch assembly use to egress swinging or sliding doors that are electrically or electronically locked. In perimeter protection systems that involve the central control of electric locking devices, an on-site emergency release may be required. The “break



glass” concept may be preferred over the pull station, because it is less vulnerable to misuse or tamper actuation. Shall be Surface mount in a standard 3-gang enclosure. Shall be Compatible with all Fail Safe type electronic locking systems. Shall be Models with LED or audible alarm. Also Clearly marked signage indicating purpose of the release.

**Door Contact:**

The Door Contact will be used for indicating the status of Door is properly closed. The Contact Shall be Surface mount, 5 screw terminals In ABS plastic housing. The door contact shall be EN50131-1 Security Grade 1, Environmental Class II. Housing.

**Access Control Credential**

- The contactless smart card shall function as an access control card, used with access readers to gain entry to controlled portals and to hold identification information specific to the user.
- The contactless smart card shall be a passive device, with an operating frequency of 13.56 MHz, and shall meet ISO 15693 and ISO 14443B2.
- The card shall contain a 26 / 32 / 64 bit unique serial number.
- The contactless smart card shall have 16 Kbits (2Kbytes) EEPROM memory configured with 16 application areas.
- Each application area shall contain a unique 64 bit diversified authentication key to reduce the risk of compromised data or duplicate cards. The contactless smart card and card reader shall require matching keys in order to function together. All radio frequency (RF) communication between card and reader shall be encrypted, using a secure algorithm.
- Wiegand card data, up to 84 bits in length, shall be encoded in Application Area 1 for use with access control systems.
- The contactless smart card will support programming and updating of custom applications after issue, using an appropriate HID iCLASS reader/writer or authorized HID iCLASS enabled reader/writer.
- The contactless smart card shall meet the following physical characteristics:
  - Dimensions, per ISO 7810: 2.125” x 3.375” x 0.030” (53.98mm x 85.60mm x 0.76mm).
  - Weight: 0.20 oz. (5.7 g)
  - Material and construction: PVC card materials. Card surface shall be glossy and of a material compatible with direct to card dye-sublimation or thermal transfer printing. Card construction shall meet durability requirements of ISO 7810.
  - Internal antenna configuration shall allow a single slot punch on the vertical (short) side of card.
  - The card may be marked with an external ID number, either in inkjet or laser-etched numbering, which may match the internal programmed ID number. If the external number does not match the internal number, a cross-reference list is provided to detail the internal/external numbering sequences.
  - Optionally, the card may be printed with custom graphics, may be built to a custom thickness and may contain security and anti-counterfeiting features.
- Contactless smart card shall meet the following environmental specifications:
  - i. Operating Temperature: -40oF to 158oF (-40oC to 70oC)
  - ii. Operating Humidity: 5% to 95% relative humidity non-condensing.

**System Information:**

The system shall support Global Geographic Time Zone support and Daylight Saving Time support. The processor will be 32-bit. The system must be CE and FCC compliant with UL-294 listing.

**Network Ethernet Switch:****a) 24/16 Port unmanaged Layer-2 Switch :**

16/24 port unmanaged Ethernet switch with 16/24 RJ45 autosensing 10/100 ports (IEEE 802.3 Type 10BASE-T, IEEE 802.3u Type, 100BASE-TX, IEEE 802.3ab). This 1U size of switch shall able to mount on in an EIA-standard 19 in. rack or equipment cabinet. The Switch shall able to operate at 100-240 Volt & 50/60 Hz electrical characteristic.

**b) 24port Managed Layer 3 Switch:**

24 port managed Gigabit Ethernet switch with 24 RJ-45 autosensing 10/100/1000 PoE+ ports (IEEE 802.3 Type 10BASE-T, IEEE 802.3u Type 100BASE-TX, IEEE 802.3ab Type 1000BASE-T, IEEE 802.3at, PoE+); Duplex: 10BASE-T/100BASE-TX. 4 dual-personality ports; PoE autosensing 10/100/1000BASE-T or SPF with 2 port expansion module slots. Processor & memory shall be able to match or exceed 128 MB SDRAM, 16 MB flash; packet buffer size: 2 MB. This 1U size of switch shall able to mount on in an EIA-standard 19 in. rack or equipment cabinet. The Switch shall able to operate at 100-240 Volt & 50/60 Hz electrical characteristic.

**SUB HEAD – 27****DATA NETWORKING/LAN AND WiFi SYSTEM****Scope**

The scope of work shall be Design, Engineering, Manufacturing, Inspection, Supply, Installation, testing and Commissioning of Data Networking/LAN and WiFi System.

**Specifications for LAN Cabling Systems**

All user outlets will be identically wired with UTP Cabling system conforming to Category 6 UTP Cabling system TIA / EIA 568-B.1 standards. The UTP Cabling system shall confirm to the full Category 6 Cabling system. Cabling systems confirming only to draft versions of Category 6 standards are not acceptable. Each user outlet shall be provided with one data circuit via one Category 6 cable to the outlet. The outlets shall be surface mount, with shuttered jacks to prevent ingress of dust and foreign matter. The horizontal cable shall be terminated on modular jack panels, placed in wall mounted / floor mounted racks provided with lock-able doors. Factory-crimped workstation and equipment cords shall be provided.

The inter-building backbones shall be installed with outdoor, gel-filled, loose tube, optical fiber cables, fiber type and count as described above. All fiber terminations shall be carried out with SC-Style Connectors, color-coded as per TIA / EIA standards for MM fibers. All terminations shall be placed on rack-mount fiber optic enclosures capable of terminating OSP rated cables.

**UTP Cabling System**

<b>Type</b>	<b>Unshielded twisted pair cabling system, TIA / EIA 568-B.1 addendum Category 6 Cabling system</b>
Networks Supported	10 / 100 Ethernet, 155 Mbps ATM, 1000 Mbps IEEE 802.3ab Ethernet, and proposed Cat 6 Gigabit Ethernet
Warranty	25-year systems warranty; Warranty to cover Bandwidth of the specified and installed cabling system, and the installation costs
Performance characteristics to be submitted for approval before start of work	Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR for 4-conductor channel

**UTP Cable**

Type	Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2
Material:	
Conductors	23 AWG solid bare copper or better
Insulation	Polyethylene
Jacket	Flame Retardant PVC
Pair Separator	Cross-member, fluted Spline.
Approvals	UL Listed
	ETL verified to TIA / EIA Cat 6
Operating temperature	-20 Deg. C to +60 Deg. C
Storage temperature	-20 Deg C to +30 Deg C
Frequency tested up to	Minimum 600 MHz
Packing	Box of 305 meters
Delay Skew	45ns MAX.
Impedance	100 Ohms + / - 15 ohms, 1 to 600 MHz.
Dc Resistance	$\leq 6.658$ Ohms per 100m
Performance characteristics to be submitted for approval before start of work	Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR

**UTP Jacks**

Type	PCB based, Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2
Durability	
Modular Jack	750 mating cycles
Wire terminal	200 termination cycles
Accessories	Strain relief and bend-limiting boot for cable

<b>Type</b>	<b>PCB based, Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2</b>
	Integrated hinged dust cover
Materials	
Housing	Polyphenylene oxide, 94V-0 rated
Wiring blocks	Polycarbonate, 94V-0 rated
Jack contacts	Phosphorous bronze, plated with 1.27micro-meter thick gold
Approvals	UL listed
Performance characteristics to be submitted for approval before start of work	Attenuation, NEXT, PS NEXT, FEXT and Return Loss

**UTP Jack Panels**

<b>Type</b>	24-port, PCB based, Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2
Ports	24
Port arrangement	Modules of 6-ports each, arranged 1port x 6.
Category	Category 6
Circuit Identification Scheme	Icons on each of 24-ports
Port Identification	9mm or 12mm Labels on each of 24-ports (to be included in supply)
Height	1 U (1.75 inches)
Durability	
Modular Jack	750 mating cycles
Wire terminal (110 block)	200 termination cycles
Accessories	Strain relief and bend limiting boot for cable
Materials	

Housing	Polyphenylene oxide, 94V-0 rated
Wiring blocks	Polycarbonate, 94V-0 rated
Jack contacts	Phosphorous bronze, plated with 1.27micro-meter thick gold
Panel	Black, powder coated steel
Approvals	UL listed
Termination Pattern	TIA / EIA 568 A and B;
Performance characteristics to be submitted for approval before start of work	Attenuation, NEXT, PS NEXT, FEXT and Return Loss

**Faceplates**

<b>Type</b>	<b>1-port, White surface box</b>
Material	ABS / UL 94 V-0
No. of ports	One

**Workstation / Equipment Cords**

<b>Type</b>	<b>Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2</b>
Conductor	24 AWG 7 / 32, stranded copper, 100OHMS
Length	7-feet
Boot and Plug	Boot should be Transparent
Plug Protection	Matching colored snag-less, elastomer polyolefin boot
Warranty	25-year component warranty
Category	Category 6
Plug	
Housing	Clear polycarbonate

Terminals	Phosphor Bronze, 50 micron gold plating over selected area and gold flash over remainder, over 100 micron nickel underplate
Load bar	PBT polyester
Jacket	PVC
Insulation	Flame Retardant Polyethylene

### Specifications for Fiber Optic Cabling Systems

#### Fiber optic Cable

<b>Cable Type</b>	<b>6-core, Multimode, 10G Ethernet OM3, Steel Armored.</b>
Fiber type	50 / 125, Laser Grade, 250 micron primary coated buffers
No. of cores	6
Cable Construction	BELLCORE GR 20 / IEC 794-1
Attenuation	
@850nm	3.5 dB / KMng
@1300nm	1.5 dB / KM
Bandwidth	
@850nm	1500 MHz-KM
@1300nm	500 MHz-KM
Network Support	
10 / 100 Ethernet	2000m
155 Mbps ATM	2000m
1000 Base SX	900m
1000 Base Lx	550m without Mode Conditioning launch patch cord.
Tensile rating	1200N
Maximum Crush resistance	3000N
Operating Temperature	-40 Degree C to +60 Degree C

Armor	Corrugated Steel tape Armor
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**Fiber Optic Connectors**

<b>Connector Type</b>	<b>SC-Style, Simplex, Pigtails</b>
Operating temperature	-40 Degree C to +85 Degree C
Durability & color of MM connectors	500 cycles, Beige
Ferrules	Pre-radiused Ceramic Ferrules
Attenuation	Not more than 0.75 dB per mated pair

**Fiber Optic Patch panels**

<b>Fiber optic patch panel</b>	<b>19-inch, Rack mounted Fiber optic patch panel</b>
Height	2 U, 3.5 inches
# of fibers	6, 12, 24 or 48
# of OSP Cables for termination	Minimum 2
Grounding	2 Nos. of earthing lugs, pre-loaded
Cable Management rings	Front and rear cable management rings, pre-loaded
# of 6-port / 12-port adapter plates	4 / 4 Max.
Enclosure Material type	Minimum 16 gauge steel
Approval	UL ,CSA

**Fiber Optic Adapter plates**



<b>Fiber Optic adapter plate</b>	<b>6-port, SC-Style, MM</b>
Attenuation	Max of 0.75 dB per mated pair

**Fiber Optic Patch Cord MM**

Fiber cord type	Duplex ,50/125 micron MM fiber, SC connectors at both ends, should have factory mount ceramic connector at both end
Connectors	Compliance to GR 326, with Ceramic Ferrule
Cable Sheath :	LSZH , with Aramid reinforcement members inside.
Cable Diameter :	2.5x5.1 mm Twin Zip , Buffer : 0.9 mm semi tight
Insertion loss	$\leq 0.3\text{db}$
Fiber cord type	Duplex ,50/125 micron MM fiber, SC connectors at one end and LC at the other ends, should have factory mount ceramic connector at both end
SC Connectors	Compliance to GR 326,
LC Connectors	Compliance to GR 326 ,with Ceramic Ferrule, should have removable duplex clip, with 90° Angled boot
Cable Sheath :	LSZH , with Aramid reinforcement members inside.
Cable Diameter :	1.8 x 3.7 mm Twin Zip , Buffer : 0.6 mm Tight
Insertion loss	$\leq 0.3\text{db}$

**Technical Specification of 24 Port Core Switch**

S/N	Description	Parameters	Compliance
1	<b>General Features for switch</b>		
1.1	Form Factor	19 Inch Rack mountable Ethernet switch.	
1.2	Architecture	Non-Blocking architecture. Must have EAL3 /NDcPP or above common criteria certification.	

1.3	IPV6 Compliance	All Functionalities of Switch shall be IPv6 compliant and it should work on IPv6 Platform without any additional hardware/ software.	
1.4	End of sale	OEM End-of-sale declaration shall not have been released for the quoted model at the time of the bid submission.	
1.5	Latest OS version	The switch shall be supplied with the latest OS version and all the proposed switch should be of same IOS.	
1.6	Feature Availability	All the specified features/parameters/certifications must be available on the Technical Bid opening date. Features /parameters /certifications proposed to be available in near future / on roadmap shall not be considered.	
1.7	Basic Layer-3 Support	Switches must be managed Basic layer-3 type for better broadcast segmentation.	
1.8	Interface Specifications:	Non-blocking architecture	
1.9	Ports	Min 24 x 10 G Based SFP+ port , Min 1 x QSFP+ port , 2x Stacking port comprising 400 Gbps of stacking bandwidth from day 1 ,Min 2xQSFP28 Port from day1	
1.10	SFP Transceivers	All the Transceivers/Modules used to connect the Switches should be from the same OEM/make of the switches only	
1.12	Port status display	Each port must have a dedicated LED for status display.	
2	<b>Hardware Specifications:</b>		
2.1	Back Plane Bandwidth	At least 850 Gbps switching bandwidth	
2.2	Packet throughput	400 Mpps or more for each member switch.	
2.3	MAC Addresses and MTBF	270 K or more,	
2.4	VLANs (802.1q tagged VLAN)	4000 or more Concurrent	
3	<b>Standards and Protocols</b>		

3.1	L2 Loop Protection	IEEE 802.1d Spanning tree protocol	
		802.1s MSTP (Multiple instances of STP)	
		802.1w RSTP (Rapid spanning tree), ), Should support less than 50 Millisecond convergence .	
3.2	Link Aggregation	802.3ad Link Aggregation	
3.3	QOS Support	At least 8 nos of 802.1p Priority Queues per port.	
3.4	IP Multicast	IGMP Snooping	
3.4	Port Mirroring / Span port	Port mirroring must be available.	
4	<b>Routing Features</b>		
4.1	Routing Protocols:	<p>The switch shall have hardware based forwarding for IPv4 &amp; IPv6.</p> <p>Following protocols shall be supported with IPV4: Static routing, PBR, RIPv2, OSPFv2</p> <p>IPV6: PBR, Static routing, RIPng, OSPFv3</p> <p>The switch shall have Dual stack mode to run both IPv4 &amp; IPv6</p> <p>RIP and RIPng ready from day</p> <p>1.MPLS,SyNCE,DCBx.PFC.QCN,ETS</p>	
4.2	Router redundancy	Shall support VRRP for IPV4 and IPV6.	
4.3	Security Features		
4.4	Network Login	MAC and 802.1 X based Login must be available	
4.5	Port Security	MAC Address based Lockdown and Limited Learning	
4.6	Access Control Lists:	L2/L3/L4 IP based, Source port, destination port, MAC based, Time based	
4.7	AAA (authentication, authorization and accounting)	AAA using RADIUS must be available	
5.	<b>Management and Monitoring:</b>		

5.1	Management	Following in-band management methods shall be available:	
		Secure Web based management (On https)	
		SSH based management (SSH v2).	
5.2	Out-of-band management	Following out-of-band management methods shall be available:	
		Serial console port	
		Management ethernet port .Dedicated OOB port	
5.3	Role based Administration	The switch shall support multiple administrator accounts. Each administrator account shall be configurable with the desired level of management privileges.	
5.4	Remote Monitoring	RMON Support	
		RFC 5357 for measuring round-trip performance between two devices	
5.5	Network Management	The switch should support SNMP V2c and V3, XML api and SDN with Openflow	
5.6	Log Management	Syslog shall be supported with multiple syslog destinations.	
5.7	Flow export	Shall support Netflow/IPFIX/sflow for flow exports.	
5.8	Time synchronization	Time synchronization using Network time protocol must be available.	
5.9	Configuration backup & restore	The switch shall have feature of backing up the configuration & restoring a backed- up configuration. Multiple Configuration files must be supported.	
5.10	TFTP/FTP upload and download	Config/image upload and download from TFTP/FTP server shall be available.	
6.	<b>Other Requirements:</b>		
6.1	Interface cables and other features	Console cable and power cable (As per Indian standards) to be provided. All Cables shall be factory-terminated. The Switch Operating System (OS) should mandatorily support individual process (eg ssh , snmp, telnet, dhcp etc) restart	

		to prevent reboot in case of Software Process Crash by running processes on top of Kernel.  Should support AVB to ensure set of standards that provide the means for highly reliable delivery of low-latency, time-synchronized AV streaming services through Layer 2 Ethernet networks	
6.2	Power Supply & FAN	Each switch should be populated with 1 PSU, should have option for RPS.	
6.3	Safety certification	The switch shall conform to IEC-60950/CSA-60950/EN-60950/UL-60950 standard for safety requirements of information technology equipment.CB,CE	
6.4	Environmental conditions	The offered equipment must be able to operate in the following environmental conditions	
		“ Operating temperature: 0°C to 45°C	
		“ Relative Humidity: 10% to 95% Non-condensing	

#### **Technical Specification of 24 Port PoE Switch**

S.No	Features	Specifications	Compliance
1	Port Configuration	24 Nos of 10M/100M/1G RJ45 Port ,4 Nos of 1G/10G SFP+ Port , 1 Nos of DB9 Console Port .	
2	PoE Function	IEEE802.3at (PoE+ 30W) ,IEEE802.3af (PoE 15.4W)	
3	PoE Port	24	
4	Available PoE Power	370W	
5	Switching Bandwidth	128 Gbps	
6	Forwarding Performance	95.232 Mpps	
7	MAC Address	32 K	
8	Jumbo Frames	10056 Bytes	
9	Spanning Tree	IEEE802.1D (STP),IEEE802.1W (RSTP),IEEE802.1S (MSTP)	

10	VLAN	802.1Q VLAN , Port-Based ,Private VLAN , Voice VLAN ,Guest VLAN, Q-in-Q , 802.1v Protocol VLAN , MAC-Based VLAN ,IP Subnet-Based VLAN	
		4K VLAN Entries	
11	IEEE 802.3ad LACP	Dynamic Trunk , Static Trunk	
12		GARP/GVRP , IGMP Snooping , MLD Snooping ,Multicast VLAN Registration (MVR)	
16	L3 Features	Static Route , DHCP Server	
17	Class of Service	Port Based , 802.1p ,DSCP, TCP/UDP Port	
18	Rate Limiting	Ingress , Egress	
19	Priority Queue Scheduling	WRR , Strict Priority	
20	Hardware Queues	8	
21	ACLs	L2/L3/L4 , IPv6 Support	
22	Security	Port Security (MAC-based) , IP Source Guard ,Storm Control ,RADIUS Authentication 802.1x , TACACS+ Authentication ,HTTPs and SSL (Secured Web) ,BPDU Guard ,STP Root Guard ,DHCP Snooping,Loop Protection	
23	DHCP	Client , Relay , Option 66 , Option 67 , Option 82	
24	Event/Error Log	Syslog , SMTP (RFC821)	
25	Management Access Filtering	SNMP , Web , Telnet , SSH	
26	PoE Management	Scheduling ,Auto-Checking ,Power Delay	
29		SNMP (v1, v2c, v3) , RMON ( 1,2,3 & 9 Groups) , Software Upgrade	
32		Configuration Export/Import , Port Mirroring ,	
34		LLDP (IEEE802.1AB)	
35		LLDP-MED (IEEE802.1AB)	

36		CDP Aware ,sFlow ,IPv6 Management , NTP	
40	Device Management	Topology View , Floor View ,Map View , Dashboard ,Traffic Monitoring , Cable Diagnostics	
41	Operating Temperature	0°C to 40°C	
42	Operating Humidity	10 to 90% RH	
43	Storage Temperature	-20 to 70°C	
44	Storage Humidity	10 to 90% RH	
45	AC Input	100V-240V	
46	Certifications	EN61000-4-5 (for RJ45 Port, Surge 6KV) ,CE/FCC Class A	

## Installation Specifications

### UTP Cabling Installation Specifications

#### Telecommunications Outlet & Horizontal cross connect Installation

Cables shall be coiled in the surface-mount boxes if adequate space is present to house the cable coil without exceeding the manufacturer's bend radius. No more than 12" of slack shall be stored.

In addition, each cable type shall be terminated as indicated below:

- i) Cables shall be dressed and terminated in accordance with the recommendations made in the TIA/EIA-568-B document, manufacturer's recommendations and/or best industry practices.
- ii) Pair untwist at the termination shall not exceed one-half an inch for Enhanced Category 5 connecting hardware.
- iii) Bend radius of the cable in the termination area shall not be less than 4 times the outside diameter of the cable.
- iv) The cable jacket shall be maintained as close as possible to the termination point.
- v) Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- vi) Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

**2.1.1.1 Horizontal Distribution Cable & Installation**

- a) Cable shall be installed in accordance with manufacturer's recommendations and best industry practices.
- b) Cable raceways shall not be filled greater than the manufacturer recommended guidelines.
- c) Cables shall be installed in continuous lengths from origin to destination (no splices).
- d) The cable's minimum bend radius and maximum pulling tension shall not be exceeded
- e) Horizontal distribution cables shall be bundled into groups of not greater than 40 cables. Cable bundle quantities in excess of 40 cables may cause deformation of the bottom cables within the bundle.
- f) Cables shall not be attached to ceiling grid or lighting support wires.
- g) Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the <THE CUSTOMER>.
- h) A self-adhesive label or PVC marker ferrules shall identify the Cables. A cable label shall be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the cover plate. Similar label or marker ferrules shall also be placed on a section of the cable near to the patch panel termination.
- i) Unshielded twisted pair cable shall be installed so that there are no bends less than four times the cables outside diameter (4 X cable Outside diameter) at any point in the run.
- j) Pulling tension on 4-pair UTP cables shall not exceed 25-pounds for a single cable or cable bundle. The pathway shall be adequately sized so as not to exceed the 80% cross-section fill of cables. The pathway shall be securely installed in the facility.

**2.1.1.1.1 Fiber optic Cabling Installation Practices**

- a) Backbone cables shall be installed separately from horizontal distribution cables.
- b) Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits or in separate innerducts within conduits.
- c) Where backbone cables and distribution cables are installed in a cable tray or wireway, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.
- d) Fiber slack shall be neatly coiled within the fiber termination panel. No slack loops shall be allowed external to the fiber panel(s).
- e) Each cable shall be individually attached to the respective termination panel by mechanical means.
- f) The cables strength member(s) shall be securely attached the cable strain relief bracket in the panel.
- g) Each fiber cable shall be stripped upon entering the termination panel and the individual fibers routed in the termination panel.
- h) Each cable shall be clearly labeled at the entrance to the termination panel. Cables labeled within the bundle shall not be acceptable.
- i) Dust caps shall be installed on the connectors and couplings at all times unless physically connected.

**Installation acceptance Testing Specifications**

Installed UTP Cabling System shall be tested with TIA / EIA 568 Level III hand-held testers. Each installed UTP drop shall be tested as per the latest revisions of TIA / EIA 568-B.1 Cat 6 specifications. Length, Wire Map, Attenuation, Pair-to-pair and PowerSum NEXT, ELFEXT and



PS ELFEXT, Return Loss, Delay Skew, ACR and PS ACR shall be tested and results provided to <THE CUSTOMER> in soft format on a CD.

Installed Fiber optic links shall be tested for attenuation at 850nm and 1300nm for MM fibers, using TIA / EIA 526-14A test procedures and Power Meter and Power Source. SM fiber links shall be tested for attenuation at 1310nm as per TIA / EIA 526-7 using power meter and power source.

### **Warranty Specifications**

The contractor shall provide warranty for the installed cable plant from the OEM equipment supplier. Contractor shall ensure that the OEM norms for supply, installation, testing and documentation as specified by the OEM supplier shall be adhered to, provided those are in line with TIA / EIA standards and tender requirement specifications. The warranty shall be provided by the OEM vendor and shall be administered in India. The duration of the warranty shall be for a minimum of 25 years and shall cover the system performance, application assurance and the costs of the supply of components and installation.

### **Documentation Specifications**

The successful bidder shall after completion of the installation, submit a detailed documentation of the cable plant. The documentation shall cover, in the minimum, the following

- a. As-built diagrams of the campus Network, with building and floor wise distribution of users and connectivity
- b. Test results for UTP and Fiber links
- c. Consolidated BOM with manufacturer's part Nos. and quantities used
- d. Warranty certificate from OEM supplier

## **WiFi SYSTEM**

### **Internet and MPLS Router**

#### **Generic Requirements**

- The Router should be modular in architecture with multicore processor. Router should have 4 nos. of 10/100/1000 Base-T ports out of which 4 nos. should have SFP based ports option. Router should have 1x RJ-45 and 1xUSB console port.
- Router should have 1:1 redundant internal and field replaceable power supply.
- Router should have at least 2 open slots for additional LAN/ WAN modules other than asked ports.
- Should have capabilities to seamless upgrade/replacement (without interrupting running processes and services )all modular interfaces supported by router like Channelized E1/T1, V.35, G.703 and Gigabit Ethernet modules to accommodate field upgrades
- The router should have minimum 8GB DRAM active and 8 GB Compact Flash from day one
- Router should have a minimum throughput of 500 Mbps or more with all services enabled

- Router should have DES, 3DES and AES Standards. Should support IPSec with IKEv2 and Suite-B Encryption. Router should support 3K GRE and IPSec Tunnels.
- Router should support static Routes, OSPFv2, OSPFv3, BGP4, MBGP, BFD, Policy based routing, IPv4 and IPv6 tunneling. Router should support 750K IPv4 and IPv6 routes.
- Router should support IGMP v1/v2/v3 and PIM multicast routing
- The Router should have MPLS and Zone Based Firewall feature from Day 1
- Shall have 802.1p class of service and marking, classification, policing and shaping.
- Router should support SSHv2, SNMPv2c, SNMPv3 and NTP
- Routers should support AAA using RADIUS and TACACS+
- Should support extensive support for IP SLA and best path selection for metrics like delay, latency, jitter, packet loss to assure business-critical IP applications.
- Router should support monitoring of network traffic with application level insight with deep packet visibility into web traffic, RTP-Based VoIP traffic and cRTP
- Router shall have traffic load balancing capability on dual WAN Links based on based on advanced criteria, such as reachability, delay, loss, jitter and bandwidth utilization.
- Router shall have capability to add on demand IPSec VPN tunnels to multiple remote locations dynamically without changing the configuration.
- Router shall conform to UL 60950 or IEC 60950 or CSA 60950 or EN 60950 Standards for Safety requirements of Information Technology Equipment.
- Router shall conform to EN 55022 Class A/B or CISPR22 Class A/B or CE Class A/B or FCC Class A/B Standards for EMC (Electro Magnetic Compatibility) requirements.
- Router/Router's Operating System should be tested and certified for EAL 3/NDPP or above under Common Criteria Certification
- Router should be IPv6 Certified/IPv6 logo ready

## **NG Firewall**

### **Generic Requirements**

#### **General Hardware and Interface requirements**

- The appliance based security platform should be capable of providing minimum 2 Gbps of Multiprotocol real world FW, IPS and Application Visibility throughput in a single appliance from day one.
- The appliance should have minimum 8 no. of 10/100/1000 Base-T Gigabit Ethernet ports and 4 x 1 Gigabit SFP Ethernet ports.
- The appliance hardware should be a multicore CPU architecture with a hardened 64-bit operating system to support higher memory
- Firewall should support stateful failover of sessions in Active/Standby and Active/Active mode

**Performance Requirements**

- Firewall Should support DES, 3DES, AES IPSec VPN throughput of minimum 750 Mbps
- Firewall should support minimum 1000 concurrent IPSec VPN peers.
- Firewall should support at least 500,000 concurrent sessions
- Firewall should support at least 10,000 connections per second

**Routing Protocols**

- Firewall should support static Routes, OSPFv2, OSPFv3 and BGP4
- Firewall should support PIM Multicast routing

**Firewall Features**

- Firewall should support for Layer 3 and Layer 4 stateful firewall features, including access control, network address translation, and stateful inspection.
- Firewall should support creating access-rules with IPv4 & IPv6 objects simultaneously
- Firewall should provide application inspection for DNS, FTP, HTTP, SMTP, ESMTP, LDAP, MGCP, RTSP, SIP, SCCP, SQLNET, TFTP, H.323, SNMP etc.
- Firewall should be able to create access policies based on the User/group info from the Active Directory either through clientless or agent based mechanism.
- The Firewall should have an inbuilt URL filtering functionality with minimum of 75 pre-defined categories. The solution should support creation of custom URL categories for allowing/blocking specific destinations as required by the organization
- Should Support TLS/SSL Decryption without affecting the system performance.
- Uses the global footprint of security deployments for more comprehensive network protection. Global threat intelligence delivers regularly updated threat intelligence feeds for near-real-time protection from zero-day malware.
- Should be able to enforce access policy with 500 commonly used applications while providing granular access control. Application recognition should be based on signatures, heuristics, and content scanning, removing the need to tie applications to ports.

**VPN Features**

- Firewall should support RFC 6379 based Suite-B Cryptography Suites/algorithms like AES-GCM/GMAC support (128-, 192-, and 256-bit keys), ECDH support (groups 19, 20, and 21), ECDSA support (256-, 384-, and 521-bit elliptic curves) for enhanced VPN security.
- Firewall should support latest IKEv2 standards for supporting SHA-2 256, 384 & 512 bit message integrity algorithms in hardware to ensure there is no performance bottleneck & higher security.

**IPS Features**

- The proposed solution should support an option to include URL filtering for enforcing Internet content filtering so as to reduce web born threats and improve productivity.
- Should support Reputation- and category-based URL filtering offering comprehensive alerting and control over suspect web traffic and enforces policies on more than 280 millions of URLs in more than 80 categories.
- The solution must be capable of passively gathering details unique to mobile devices traffic to identify a wide variety of mobile operating systems, mobile applications and associated mobile device hardware
- Should support more than 3000 application layer and risk-based controls that can invoke tailored intrusion prevention system (IPS) threat detection policies to optimize security effectiveness.

**System Management and Administration**

- Firewall should support SSHv2, SNMPv2c, SNMPv3 and NTP
- Firewall should support AAA using RADIUS and TACACS+

**Regulatory Compliance**

- Firewall shall conform to UL 60950 or IEC 60950 or CSA 60950 or EN 60950 Standards for Safety requirements of Information Technology Equipment
- Firewall shall conform to EN 55022 Class A/B or CISPR22 Class A/B or CE Class A/B or FCC Class A/B Standards for EMC (Electro Magnetic Compatibility) requirements.

**Evaluation Compliance**

- Firewall/ Firewall's Operating System should be tested and certified for EAL 4/NDPP or above under Common Criteria Certification or FIPS Level 2 Certifications
- Firewall/Firewall's Operating System should be IPv6 Certified/IPv6 logo ready

**Wireless LAN Controller****Generic Requirements**

- Must be compliant with IEEE CAPWAP standard for controller-based WLANs.
- WLAN Controller should have license for asked access points in a single 1 RU chassis from day One. Controller should be scalable to minimum 150 AP in same hardware and minimum 3000 clients.
- WLAN controller must have atleast 2 x 10/100/1000 Base-T auto sensing uplink interfaces.
- Should have minimum 2 Gbps DES, 3DES/AES based encryption throughput.
- Must support 1:1 redundancy models
- Must support an ability to dynamically adjust channel and power settings based on the RF environment

- Must support coverage hole detection and correction that can be adjusted on a per WLAN basis.
- WLC should support L2 and L3 roaming of IPv6 clients
- WLC should support First hop security features in IPv6 network like Router Advertisement guard, DHCPv6 guard and IPv6 source guard
- WLC should support IPv6 access control lists and guest-access functionality for IPv6 clients.
- Should adhere to the strictest level of security standards, including 802.11i, WPA2, WPA, WEP, 802.1X with multiple Extensible Authentication Protocol (EAP) types, PEAP, EAP-TLS, EAP-TTLS
- Should support Management frame protection for the authentication of 802.11 management frames by the wireless network infrastructure
- Controller should have rogue AP detection, classification and automatic containment feature
- Controller should be able to detect attacks like Broadcast de - authentication, NULL probe, Well entreated from day one for all access points
- Should provide a snapshot of Air quality/RF in terms of the performance and impact of interference on the wireless network identifying the problem areas.
- Should provide real-time charts showing interferers on a per-radio, per-channel basis.
- Must support 802.11e and WMM
- Should have Voice and Video Call Admission and Stream prioritization for preferential QOS
- To deliver optimal bandwidth usage, reliable multicast must use single session between AP and Wireless Controller

## **Wireless Access Point (Indoor)**

### **Generic Requirements**

- Access Points proposed must include radios for 2.4 GHz and 5 GHz with 802.11ac Wave 2.
- Must have a robust design for durability, without visible vents.
- Mounting kit should be standard from OEM directly.
- Must support 3x3 multiple-input multiple-output (MIMO) with two spatial streams
- Must support data rates Upto 300 Mbps on 802.11n and 867 Mbps on 802.11ac
- Must support up to 22dbm of transmit power in both 2.4Ghz and 5Ghz radios.
- Must have 1 nos. of 10/100/1000 Base-T with PoE/PoE+ powering port and one management console port.
- Must have minimum 16 SSIDs.
- Should support detecting and classifying non Wi-Fi wireless transmissions.
- Should support radio resource management for power, channel, coverage hole detection and performance optimization.
- Must operate as a sensor for wireless IPS.
- Access Points must support a distributed encryption/decryption model.
- Must be plenum-rated (UL2043).
- Should support 802.11e and WMM.

## **1G UTP MODULES**

### **Generic Requirements**

- Connector types RJ45
- Should Support 1000Base-T on CAT-5e/CAT6 UTP
- Should be from same OEM of switches.

## **10G SMF MODULES**

### **Generic Requirements**

- Connector types LC
- 10G Base-LR
- Support 10 Gbps upto 10 KM on SMF
- Should be from same OEM of switches.

**SUB HEAD – 28****~~VOICE COMMUNICATION SYSTEM (DELETED)~~****Scope**

The scope of work shall be Design, Engineering, Manufacturing, Inspection, Supply, Installation, testing and Commissioning of IP Communication system catering Voice requirement inside the building.

**Technology**

The communication server should provide converged IP communication solutions for Analog users & IP Users configured in the system with Future Expandability. PRI & CO Trunk lines to be provisioned.

<b>Building Name</b>	<b>Total Lines</b>	<b>TYPE – 1 IP Instruments</b>	<b>TYPE – 2 IP Instruments</b>	<b>TYPE – 1 Analog Instruments</b>	<b>TYPE – 2 Analog Instruments</b>	<b>PRI Lines</b>	<b>CO Lines</b>	<b>Future Expandability</b>
Station & Signal Building	100	12	8	50	30	1	5	Upto 200
Office Building	50	6	4	25	15	1	3	Upto 100

The system should offer the maturity and broad range of Enterprise features with high reliable software architecture and security functionalities. The Communication Server has to combine the advantages of worlds (TDM and IP) with networking, carrier access and the flexible connection of analog, TDM- and IP-phones, and support for mobile WLAN- and DECT devices and soft phones with in one system.

**Support for Multiply Telephony Applications**

The communication server should offer a rich set of phones, mobility choices, unified communications and standards based integration with business critical applications and systems

The hardware should be modular and the software structured so that the system can be easily adapted to the continually developing requirements of communication services.

The offered system must have the ability to record and analyze traffic measurement data so that the quality of the communication network can be checked.

**Design & Functional Requirements**

The communication server being provided should act as the core hardware of the voice solution being offered. Master slave combination in processor is not acceptable. Documentation of the same to be

provided.

There should not be any change in the basic equipment of the communication server while expanding from minimum capacity to maximum capacity.

**Redundancy** - System shall have minimum redundancy of CPU (Processor), Main Memory & Secondary Memory (Hard Disk), Tone generator, Main power supply, shelf power supply, ringer power supply units, shelf controller etc. by way of duplication (multiple modules). In case main CPU fails the established call shall not get disconnected, the redundant CPU shall take over seamlessly and provide the system function. No single point of failure and no dropping of established calls even during changeover of duplicated cards

The processor being offered should be responsible for fundamental system control functions and also for ADP processing (including controlling the buses in the backplane.)

The processor needs to have at least the following interfaces:

- 1 \* VGA port for maintenance
- 2 \* USB host slots (for taking backups)
- 8 \* 10/100/1000 LAN interface connections for redundant configuration. The LAN interfaces should support IPv4 and IPv6
- 1 \* OLED display
- 2 \* LED's for proving status of processor board
- 1 \* LED for HD activity for displaying below properties / updates of system
- Call Control and call processing status in "7 segment display" notation
- Host status i.e. CPU & memory load, temperature and FAN speed
- Kernel version and system uptime
- MAC ID and IP address of the processor
- IP address of the inbuilt management tool
- It should be possible to insert a SATA 2.5" hard disk onto the processor

The communication server should come with a HDD tray inbuilt onto which 2 \* SATA Hard disks can be mounted and configured in Soft RAID 1.

The communication server should be equipped with a Management and control module. This module is used as a fault and clock signalling board in the communication server.

The management and control module should provide the below functionalities:



- a) Speed control and regulation for fan trays
- b) Power Failure Transfer
- c) Alarm interface
- b) Front reference Clock

**The features listed below are all required for system call processing and basically should be available to all analogue subscribers**

- Rejection of DID calls, if free, busy or incompletely dialled
- Special audible tones(like voicemail, call forward) after lifting the handset if features have been activated
- Reaching certain extensions in incoming traffic
- Transmit DTMF signals to public networks
- Multiple trunk group for reaching exchange and/or tie-trunks
- Multiple trunk group using code dialling
- Auto-timed diversion of incoming calls
- Technical measures to prevent connections
- Different ringing for internal, exchange, emergency, deadline and direct calls
- Closed numbering
- Prevention of DID to certain extensions
- Toll/code restriction in exchange and trunk-to-trunk traffic
- Music or a brief announcement for calls on hold
- Presetting digits
- Digit repetition

### **Open numbering Plan**

It must be possible to freely assign subscriber numbers and connection locations. The call numbers can be of any length up to seven digits. It must be possible to convert, say, directly dialled call numbers; it must also be possible to assign several call numbers to one subscriber. Also

when the exchange number (exchange code + local network code + exchange access + extension number) of an internal subscriber is dialled by another internal subscriber, it should be possible to set up the connection as an internal call

**Virtual numbering Plan**

It must be possible to reproduce, several identical or itself overlapping, call number plans within a system

**Toll/code restriction on exchange traffic**

Toll/code restriction releases exchange call numbers in accordance with the class of service of the subscriber. It must be able to evaluate up to 22 digits per voice, fax and data service. Subscribers with local access should also be permitted to reach long distance areas by the assignment of up to 6 partial toll accesses

**Toll/code restrictions on dedicated connection calls**

Toll/code restriction releases call numbers for the private network in accordance with the class of service for the traffic via the dedicated connections. It must be able to evaluate up to 22 digits for each voice, fax and data service, each subscriber being able to obtain toll accesses with different call number groups.

**Preventing illegal connections**

Using the entries in a connection matrix, traffic relations within and between groups of subscribers and trunks can be released or blocked as required.

**Hot-line service (immediate)**

It is possible to set up extensions so that when the handset is lifted a connection to a programmed destination is set up (hot-line).

**Hot-line service (after pause)**

Extensions can be set up so that after the handset is lifted, a connection is set up to a programmed destination if no dialling takes place within 20 seconds or only partial dialling takes place

**Transmit DTMF signals**

Special devices, which can be controlled by DTMF signalling, can be dialled up via outgoing external lines. To do this, both the digital dialling information for digital or IP- telephones and the pulses from analogue pulse dialling telephones must be converted to DTMF signalling.

**System call forwarding**

A central call forwarding system shall be programmed and activated. The call forwarding system should support following types of call forwarding to be activated in arbitrary combination:

- system call forwarding for all calls
- system call forwarding in case of busy line: only internal calls
- system call forwarding in case of busy line: only exchange calls
- system call forwarding in case of no answer: only internal calls
- system call forwarding in case of no answer: only exchange calls
- system call forwarding in case of incoming call protection: only internal calls
- system call forwarding in case of incoming call protection: only exchange calls

A variable call forwarding entered by the user is prior to the system call forwarding. In case of deactivation of the variable call forwarding by the user the system call forwarding is still active.

### **Remote-controllable night service**

Subscribers with the appropriate authorization must be able to activate night service variants that have been set up both locally and on a network-wide basis.

### **Attendant intercept with different code numbers**

It must be possible to specify 00 to 09 as intercept code numbers so that incoming exchange calls to tenant services for several users can be distinguished at the switchboard position or be appropriately distributed if several switchboard positions are involved. In conjunction with the intercept code number it should be a possible to display a company name on the switchboard console.

### **Call data registration, external outgoing**

The system should store a call data record (CDR) for each connection so that it is possible to assign charges for outgoing exchange calls to the originator. The CDR should contain at least the following data:

- calling party number
- external destination number
- Date
- day of the year
- time at which call starts
- call duration
- call charge units

- costs indicated on the display
- serial number of the CDR
- number of the trunk circuit
- The CDRs stored on the system can be called and processed by the analysis unit.

**Call data registration, external incoming**

To bill telephone services, a CDR should be stored at the relevant connections for incoming calls as well. The CDR should contain at least the following data:

- external originating number
- internal called party number
- Date
- day of the year
- time at which call starts
- call duration
- serial number of the CDR
- number of the trunk circuit
- The CDRs stored on the system can be called and processed by the analysis unit.

**Call data registration, network-wide**

It should be possible to store call charge data records for calls within the network so that telephone system costs within the network can be assigned to the originating parties. When the data records stored on the system have been processed by the analysis program, it is possible to apportion the costs for the operation of the telephone system equitably.

It should also be possible to store call charge data records for internal calls so that the telephone system costs can be assigned to the originating parties. When the data records stored on the system have been processed by the analysis program, it is possible to apportion the costs for the operation of the telephone system equitably.

**Volume control for the voice service**

Because of the combined use of analogue and digital telephones, and because of the use of analogue and digital lines in the connection paths, the volume may vary considerably from call to call. No matter what the type of call, and under certain circumstances, the size of the network, approximately the same volume

should be ensured by connecting amplifying or attenuating networks on a call-by-call basis.

### **Group call**

In case of an incoming call parallel ringing into a user group must be supported (three devices). One of the three devices has to be a GSM-phone.

### **Subscriber features**

#### **Standard package subscriber functions**

The features listed below are prerequisites for extension subscriber communication and basically should be available to all analogue, digital or IP subscribers:

- call forwarding with a fixed/variable destination
- class of service switchover
- Direct call and direct call key function
- add-on conference
- multiple conference with up to 8 participants
- restriction of internal traffic
- call interception
- call transfer after answering
- call transfer before answering
- accept call
- speed dialling – individual and system
- toggling between two calls
- consultation hold
- call back - no answer
- call back – busy
- hunt group, linear
- hunt group, cyclic

- synchronised recorded announcement if not
- Available
- deadline set-up
- relocation of terminals
- saved number redial
- station transfer security
- day of the week, date and time in display
- PIN for personal identification
- Recall enable/block

**Add-on conference**

Extension subscribers can add on a third subscriber to their conversation. The added-on subscriber can also be removed at any time. One or two external subscribers can be added on during an add-on conference.

**Multiple conference**

The extensions can successively add on up to six further subscribers, who can also be external, to the original two participants. Every subscriber of a conference can act independently. The subscribers of the conference have the possibility to go on consultation hold or to do explicit call pickup to add a new subscriber to the conference as long as the maximum subscriber number is not reached yet. The conference can be put on hold to perform another function. It should be possible to have multiple eight part conferences in the system simultaneously

**Direct calling**

Pressing a button, subscribers with a digital or IP- telephone can call a programmed internal subscriber. The direct call is indicated to the called party by means of a special ringing signal. The direct call button has an LED which comes on when the direct call destination is busy. If the key is nevertheless pressed, the direct call destination is alerted by means of a call waiting signal. It should be possible to set up a maximum of 30 direct call keys for a digital subscriber. If there are several subscribers it must be possible to set up one subscriber as a direct call destination.

**Team call pickup**

Subscribers in a pickup group can take calls for another team member at their own telephone. Analogue, digital or IP- telephones can be included in a team.

**Directed call pick up**

Directed call pick up of calls from other work points can be activated by either pressing the according function key or by dialling a prefix and the extension number.

### **Call forwarding with variable destination**

In addition to call forwarding with a fixed destination, the subscribers should also have call forwarding with variable destination which they can program themselves.

- The user should have the chance to choose out of the following variable call forwarding possibilities:
- activation of a variable call forwarding with one
- destination for all calls
- activation of a variable call forwarding with different
- destinations for internal and exchange calls
- activation of a variable call forwarding in case of
- busy line or no answer
- It should also be possible to determine within the system how may call forwarding operations be able to be chained together; a maximum of 10 should be possible. When the maximum permissible number of chaining that has been set is reached, the call should be aborted. The number of chaining should also be counted in the case of network-wide call forwarding. In this case, the connection of line sections is not permitted. Instead, the call must always be cleared down in the direction of the originating system and set up again in the other direction.
- If required, it should also be possible to activate and program call forwarding from the switchboard position.

### **Call deflection**

#### **Subscriber control of forwarding**

Authorized subscribers should have the possibility to override call forwarding at a called destination.

### **Park to System**

A station or an attendant user should be able to place a trunk or station connection into a system park slot. Once parked the call should be retrieved by the same station that parked the call or another station. After having parked the call the station or the attendant user can make another call.

### **Single class of service switchover**

Each extension subscriber can be assigned two classes of service. The subscriber can toggle between the two classes of service himself, protected by a procedure.

**Class of service switchover**

Class of service for an extension group can be switched over on an individual basis from the switchboard position or at a certain time by the system.

**Speed dialling-individual**

Extension subscribers should have an individual call number memory for a max. of 30 internal or external destinations that are retrievable by pressing a function key. The destinations are entered and modified by the subscribers themselves. Manual suffix dialling after outcall must also be possible. It must be possible to set up the feature for all subscribers.

**Speed dialling – system**

Extension subscribers and attendants should have – by pressing a function key – access to a central call number memory which can be divided up into a max. of 16 speed calling lists. Each subscriber can be authorized to use two lists each of which contains up to 1000 destination numbers. Suffix dialling after outcall must be possible. All subscribers should be able to use speed calling-system.

Memory capacity: 16.000 destination numbers.

**Chaining of central speed dialling entries**

A user should be able to carry out several functions with one central speed call. With this, the chaining contains a sequence of digits which are usually carried out on the keypad. Up to 10 system speed call entries can be chained together.

**Call interception**

Authorized extension subscribers should be able to register the call number of a caller. It must be possible to set up this feature so that all calls for the authorized subscribers are registered or only those calls marked with a code number by the subscriber. It must be possible to print out the call number of the caller in the case of internal calls, calls via dedicated connections with identification and ISDN exchange calls.

**Disconnection**

Authorized extension subscribers and attendants should be able to go beyond call waiting/busy override and disconnect a call, if a suitable signalling method is available on the previous call path. In the case of subscriber busy, the call can be disconnected to effect one's own further call set up and, if the dedicated connection trunk is busy, a connection can be disconnected.

**Personal identification number**

The PIN is used to identify the subscriber to the communications system at his own telephone or someone else's. The PIN number, which can have up to 12 digits, is entered manually or by inserting a chip card in the case of digital telephones with a card reader. If entry is made on one's own telephone, the individual



class of service is switched over. If the entry is made on someone else's telephone, the person entering the PIN number can use it like his own telephone – this also includes the key assignment. Call charges that accrue at someone else's telephone are assigned to the call number of the person who has entered the PIN number.

**Destination keys**

Subscribers with digital or IP- feature telephones can dial a programmed internal or external destination by pressing a key. It should be possible to set up destination keys for each telephone. Further destination keys can be supplied by means of an add-on device. The destinations can be stored and modified by the subscriber himself

**Relocating terminals**

It should be possible to move digital telephones within the area covered by a system without any administrative procedures at the operating terminal. This should be done by entering a logoff code and the PIN before unplugging. In the new room or area, the logon code and the PIN are entered after the device has been plugged in again. The terminal/device should then operate as it did originally.

**Electronic mailbox**

Extension subscribers should be able to become owners of an electronic mailbox. Voice and non-voice service messages are left in this mailbox. Activated automatic call back - no answer and voice messages fax messages, if the mailboxes are configured appropriately, can also be implemented.

When a subscriber with an analogue telephone lifts the handset, a recorded announcement tells him if any messages are waiting. Subscribers with a digital or IP- display telephone also have a mailbox lamp with LED which indicates if there are any messages. The subscriber can display any entries for any service with the scroll function. He must be able to output specific messages and implement specific call backs.

**Call waiting – terminating**

Subscribers with digital or IP- telephones with display should be able to override an ongoing call for a waiting call. In the busy state, the calls receive the call connect signal, the subscriber receives an alerting tone and the caller is shown on the display. Without terminating the existing call, it should be possible to take the waiting call and toggle between the two calls.

The caller should hear a special free signal to be informed about his call waiting.

**Deadline set-up**

Extension subscribers can enter a deadline time on their telephone for the next 24 hours. The system will then call them at this time. Subscribers with digital or IP- telephones can enter several deadlines. If the deadline call is not acknowledged, it is repeated after 5 minutes. If there is again no acknowledgement, the deadline call is cleared.

**Call charge display or elapsed time display on digital or IP- telephones**

When a call that incurs charges is being made, the display on digital or IP- telephones should indicate the accruing charges, the charge units, or the elapsed time. Every subscriber should be able to decide whether the accruing charges, the charge units, or the elapsed time is shown on the display. If there is simultaneous communication involving several charge incurring calls (consultation hold, conference) and the accruing charges are chosen, the sum of the charges is shown on the display.

**Intercom Feature – Voice calling**

Subscribers with a digital or IP- telephone can voice call other digital subscribers if their phones are equipped with open listening and hands free talking without the called party needing to lift the handset. Subscribers can permanently or temporarily protect themselves from voice calling by means of an appropriate procedure.

**Intercom Feature – Hands free answering**

Subscribers with a digital or IP- telephone are voice-called and their telephone is equipped with hands free talking, their microphone is turned on automatically to permit hands free answering.

**Intercom Feature – Speaker call one-way**

Subscribers should be able to initiate a speaker call, which provides a one-way connection to a single destination of their choice.

**Intercom Feature – community group call**

Subscribers with digital or IP- telephones of a defined communication group (max. 100 members) should be able to call each other without dialling the full extension number, to establish a normal connection.

**Intercom Feature – community group speaker call – two-way**

Subscribers with digital or IP- telephones of a defined communication group (max. 100 members) should be able to call other members of the same group directly by shortened dialling. Speaker and microphone of the subscriber should – if available – be activated automatically.

**Intercom Feature – Speaker call – One-way - Broadcast**

Subscribers should be able to initiate a speaker call with a one-way connection to multiple (max. 40) destinations, simultaneously. The speakers of the phones – if available – should be activated automatically. The first user to answer the announcement via going off-hook, could converse to the announcer and all other speakers will be deactivated.

**Call log**

Call log has to be provided for subscribers with digital or IP- telephones. Both incoming calls (20 entities) and call attempts and outgoing calls (10 entities) and abandoned calls are entered in the call journal. The user can simply page through the list and use the entry to set up an outgoing call.

**Data Security for digital or IP-telephones**

On leaving the workplace, it must be possible for the user to lock the telephone or feature functions and key data for dialling aids against unauthorized use.

**Display telephone book**

Optional: subscribers with a digital or IP- display telephone who do not have their own PC with ETB at the workplace should be able to access a centrally maintained telephone book. The dialling pad or an add-on device with alpha keys is used to enter names. After a partial entry, names are shown on the display and it is possible to scroll backwards and forwards in the list. The call is set up by pressing a key.

Other functions supply facilities like personal telephone books and call journals for each subscriber.

**Executive/secretary function**

Digital or IP-based executive and secretary telephones are assigned special features of an executive/secretary system by the system administration, for example:

- forwarding of executive calls to the secretary
- Telephone
- call waiting at the secretary telephone for calls
- for the executive
- executive/secretary pickup group
- ringing transfer key for direct signalling at the
- executive telephone when there are calls for the
- Executive
- direct call executive/secretary
- secretarial function transfer at the secretary
- Telephone

- The telephones which are included in an executive/secretary system have a special function-oriented key layout.

### **Integral two-way hands free intercom system function**

Subscribers with digital or IP- telephones can voice call other subscribers with digital telephones if their telephones are equipped with open listening and hands free talking; the called subscriber does not need to lift the handset.

If the voice-called subscriber has hands free talking, he can reply directly via the integral microphone. It must be possible for subscribers to override voice calling temporarily or permanently by activating an appropriate function.

### **Integrated key telephone system function**

The integrated key function makes it possible to specifically access several lines from several telephones. Within a defined group of telephones, the assignment of lines should be user-selectable. Following features should be implemented.

- Line preference (primary line, incoming line, calling line, no line)
- Exclusive and manual hold
- Privacy (automatic/manual choice)
- I-use signalling of used line
- ringer cut-off
- LED signalling (free, in use, ringing state, on hold)
- Bridging

### **Direct dial up to trunks or subscribers**

This feature should allow the direct dial to a terminal without been re-routing via system applications. The feature eases the manual hardware oriented (positional) dial up of analogue and CAS trunks, of B-channels in digital trunks as well as analogue ports. This should allow faster diagnostics and access to ports with bottlenecks.

### **Controlled station-to-station restriction**

### **Recorded announcements**

Connecting recorded announcement devices, it should be possible to play appropriate texts to callers when certain switching states arise. The texts should be played with the correct timing, i.e. from the beginning. It should be possible to play back recorded announcements in the following situations:

- required subscriber busy
- required subscriber - no answer
- redial request – destination busy
- redial request – destination does
- not answer
- company announcement and greeting text for
- calls to the switchboard position
- waiting announcement for call to the switchboard
- position - no immediate answer
- waiting announcement for call to hunting group
- no immediate answer
- It should be possible to control the announcements individually via a connection matrix. A maximum of 64 different texts should be available and it should be possible to connect a recorded announcement simultaneously to up to 50 callers.

### **Technical Specifications of Analog Media gateway Card/Module**

The analog gateway being proposed should have the capability of registering 24 subscribers

The analog gateway being proposed should support CLIP functionality

The analog gateway should generate its own ringing voltage (71Vrms) and should not require any external ring voltage generator

The gateway should have at least 2 LED's on board which shows the status of the hardware

The power supply that is required by the board should be supplied by the backplane of the shelf in which it is being inserted

The subscriber line resistance should be at least 1500 ohms including the terminal with 300 ohms

Using a cross section of 0.6mm the gateway should support subscribers at a distance of 12.6 km

The gateway should support V.90 (56k) modems with data transmission up to 50 Kbps

The gateway being proposed should support the following analog devices:

- a) Announcement Recorder
- b) DTMF analog single line telephones
- c) Fax machines
- d) Modems
- e) Music on hold equipments

#### **Technical Specification of ISDN PRI gateway Card/ Module**

The ISDN PRI gateway being proposed should support both load wares i.e. E1 and CAS.

In case the gateway doesn't support both load wares then vendor has to provide a separate gateway for CAS.

It should be possible to terminate both Cu and fiber on the gateway

Each module should support 2 x E1's

#### **IP Gateway Module for IP Interface Module**

The IP gateway that is being proposed should act as a common gateway.

It should be possible to use the same gateway for registering IP subscribers, program IP trunking channels and SIP trunking channels

In case the same IP gateway cannot be used for trunking purpose and subscriber registration purpose then vendor needs to provide additional IP gateway for trunking purpose

It should be possible to register atleast 230 IP subscribers on a single IP gateway module

The gateway should provide atleast 60 IP to TDM conversion channels

#### **IP Phone (Type1)**

The proposed IP phone should Comply to the following features:

- 12-part keypad
- fixed graphical two line display, 205 x 51 monochrome
- 3 navigator keys
- message waiting with LED
- speaker with LED
- Integrated Ethernet switch PoE Class 2 LAN Interface (10/100 Mbps)

- 8 free programmable keys;
- open listening
- dialling with cradled handset
- full duplex hands-free speaking
- wall mountable

### **IP Phone (Type2)**

The proposed IP phone should Comply to the following features:

12-part keypad

Tillable graphical 6-row display 5.1”; 240X128 pixel; monochrome.

optical call alert, status LED

6 free programmable touch keys;

two layer/shift functionality

pushbuttons:

-redial

-drop/release

- call forwarding with LED

- mute with LED

- speaker with LED

- +/- keys

- message waiting with LED

- menu with LED

- Headset with LED

5-way navigator keys

connector for cordless (121 TR9-5\*) and headsets with cord (121 TR9-5)

open listening

full duplex hands-free speaking

dialling with cradled handset

Linux Operating System

Integrated Ethernet switch PoE Class 2 LAN Interface (10/100 Mbps)

**Analog Phone Instruments (Type 1 Analog Phone)**

LAN Interface

3 repertory keys

10 speed dialling numbers

Last number redial

Saved last number redial

Notebook function (storage of telephone number during the call)

Manual pause

Dual-tone ringer, volume adjustable in 2 steps (high,low)

Mute

Pulse or tone dialling, temporary Switch-over possible

Recall key (2 flash times switchable)

Hearing aid compatibility conforming to CCITT P.37

Wall mounting option

**Analog Phone Instruments (Display) (Type 2 Analog Phone)**

The proposed CLIP Display Analog Phone should comply to the following features:

FSK & DTMF Dual Mode

Open listening and hands free talking

Handset volume adjustable

Mute function (with melody)

50 entries for CLIP

Real Time Clock



Pre-dialling function

Call back function

Last 5 numbers redial

Notebook function

10 repertory keys

### **Exchange Earthing**

The EPABX system & its accessories shall be grounded to a common ground point to prevent interference from the external & internal sources. Earthing electrode shall be as per the relevant applicable standard/B.S. 3043 (latest) for EPABX MDF/IDF and batteries. The earthing material shall be as per the applicable IS/Internationally applicable standards. Required earth pits for earthing shall be made by contractor for EPBAX system, power supply unit and MDF / IDF. Earthing shall be done as per the ITU recommendation.

### **MDF/IDF ( Main Distribution Frame/Intermediate Distribution Frame )**

Suitable MDF/IDF shall be provided for termination of the extension, trunk lines The MDF/IDF shall be housed in self standing/wall type metal frame. The termination strips shall be disconnection type provided with isolation facility

Suitable protection shall be provided against induced voltages and currents due to lightning, high voltages line etc on Trunks only. The devices shall provide prompt isolation and protection from accidental high voltage power contact and safe guard the equipment against any damage.

### **Un interrupted Power Supply Unit with Batteries**

**3 KVA UPS with SMF batteries to provide back up of 2 hours for EPABX system.**

### **Technical Specifications of PC to be used for IP Console and Call Billing & Maintenance software**

The desktop PC for PC based Operator Console & Call billing software shall meet the following as minimum:

- Intel Core-i3 processor
- Licensed MS Window with Anti Virus provisioning or Linux
- 2GB DDR-3 1333 MHz SDRAM
- 160 GB hard drive
- DVD+/-RW

- 17-inch LCD monitor
- USB Mouse and keyboard
- Ethernet 10/100 adapter with RJ-45 connector

**TECHNICAL SPECIFICATION  
MISCELLANEOUS**

**SECTION - 11**

## **1.0 Automatic Swing & Slide Gates Accessories**

### **1.1 Automatic Swing gate operator**

The Contractor shall supply, install and commission the Automatic Swing gate operator which should be electrically approved for single/double doors, housed in an aluminum housing of dimensions being H95 x W90 x L515.

The Equipment shall incorporate the following features:

- a) Operation: Heavy Duty internal and external door operator continuous duty with manual operation with and without mains power. Suitable for both hinge and pivot type doors.
- b) Mounting: Bulkhead/Transom/Structural plate for operator fixing
- c) Arm Configuration: Scissor Arm (Push-outward opening) , Slide Arm (pull-inward opening)
- d) Opening Function: 24V DC Brushless motor or manual override adjustable back check on both to eliminate mechanical door stops and prevent damage to hinges by wind loads.
- e) Closing Function: Adjustable closing torque, adjustable closing speed and latch speed to overcome door seal pressure, sticky lock etc.
- f) Push To open: Manual override with auto close.
- g) Opening Speed: Adjustable 2-6 seconds.
- h) Closing Speed: Adjustable 2-10 second
- i) Hold Open Time: Adjustable to 30sec.
- j) Control Circuit: Microprocessor controller with Built-in switch mode power supply.
- k) Interface Options: Access control, Biometric system, Fire alarm, building management and security system interface (by others)
- l) Control Functions: Standard Three position switch
- m) Actuation Options: Movement sensors, touch pads, card readers, push button switches, Remote control etc.
- n) Safety: Adjustable torque safety stops with auto close

- o) Warranties: Door Operator is to be covered by a two year warranty against any manufacturing defects only. All Warranties to take effect upon date of handover
- p) Maintenance: Contractor will provide service and maintenance for 2 years by qualified service technician periodically to ensure longevity and safe, trouble free operation.
- q) Communication with IBMS :Interface ability with Biometric system, Fire Alarm, Security system and IBMS
- r) Equipment must comply with BIS specification

## **1.2 Automatic Sliding Door Operator**

The Contractor will supply, install and commission Automatic bi-parting operator model door operators which would be electrically approved and, fully housed in an extruded aluminium housing of height 145mm and width 190mm..

The equipment shall incorporate the following features:

- a) Drive – section notched, belt design.
- b) Motor - Continuously rated heavy duty DC motor capable of 24 hour operation with no thermal shut down.
- c) Door Weights – Must be tested and certified for 1 million cycles of combined door weights of up to 360kgs
- d) Gear Box - Self Lubricating fully sealed maintenance free gearbox.
- e) Stainless Steel running track for rollers, covered by a lifetime warranty
- f) Actuation - by “Micro wave” sensor with range sensitivity and detection pattern adjustment.
- g) Option: Actuation & Safety – through integrated sensor combination “presence and micro wave sensors”. Automatic reversing if obstructed during closing sequence with fully adjustable sensitivity settings.
- h) Controller - Solid state microprocessor controller with hall-effect positional encoder.
- i) Reset feature - Intelligent self-diagnostic with calibrating software.

- j) Door Type Options:- The Glass door leaf must be hung from within the track and shall not use patch fittings or top rail for hanging the door. Glass clamping plate (Hanger bar) integrated inside track profile.
- k) Locking Options:- Electric locking integrated inside motor unit. No requirement of additional EM lock unit.
- l) Control Functions:-Standard-‘Device Manager’ fully programmable coded Mode Touch pad.
- m) Warranties –Door Operator is to be covered by a two yearwarranty against any manufacturing defects. The stainless steel running track for rollers is to have a lifetime warranty. All Warranties to take effect upon date of handover.
- n) Maintenance- Contractor will provide service and maintenance for 2 years by qualified service technician periodically to ensure longevity and safe, trouble free operation.
- o) Communication with IBMS : Interface ability with Biometric system, Fire Alarm, Security system and IBMS
- p) Equipment must comply with BIS specification

**2.0 — ~~Smart Garbage Compacter Bins~~(NOT APPLICABLE)**

**2.1 These Compacter bins are special construction automated bin to be placed in outdoor and indoor areas and provide following features**

- a) Dynamic routing  
The solution optimizes waste collection routes and a schedule based on real-time and historical data, provides predictive analytics to enable decision making ahead of time, and offers consultation on waste bin allocations.
- b) Cost reduction  
Smart waste logistics solution reduces waste collection frequency dramatically, which enables you to save on fuel, labor, and fleet maintenance costs. All together the solution to reduce operational costs by upto 80%.
- c) CO<sub>2</sub> reduction  
Collecting garbage is a very pollutant heavy proposition. Our solution offers you the means to have fewer trucks on the road for less time, which means less green house gas emissions, less noise pollution, and less road wear.

**2.2 Specifications**

- a) Minimum Product Dimension
- b) Bin Volume:-120Litre    120L Compacted Trash    600L Un-compacted Trash Materials
- c) ROHS compliant
- d) Acrylic cover for advertisement panels
- e) Galvanized steel sheet metal construction for both interior and exterior structure
- f) Polyester powder coating for optimal durability and weather protection

### **2.3      Compaction Feature (minimum specs)**

- a) Compaction Force: Upto 700kgf
- b) Cycle Time: Approximately 40 seconds
- c) Motor Size: 1/6-HP DC geared motor
- d) Drive System: Geared motor with unique X-frame drive
- e) Control System: Smart micro controller-based automated system

### **2.4      Power and Electronic Control**

- a) System Voltage:12 Volts DC
- b) Power Consumption:15Wh/day
- c) Battery: Spill-proof, sealed lead-acid storage    120L:12V46Ah battery
- d) PV panel: Crystalline silicon solar module    120L:50W PV panel ( only for outdoor)
- e) Polycarbonate protective cover for PV panel
- f) 3-color LED status indicator lamps
- g) Hybrid-powered (solar + plug-in) option

### **2.5      Safety Features**

- a) CE approved
- b) Hand detection safety sensors
- c) Fire detection temperature sensor
- d) Access locks for front door, top cover and side covers
- e) Mounting brackets

### **2.6      Design Features**

- a) A1/A2 size advertisement frame with acrylic cover
- b) LED backlight for A1/A2 size advertisement
- c) LCD monitor
- d) Wi-Fi router
- e) Customizable silk screen wraps

### **2.7      Product Dimension**

- a) Size (H\*W): 95

## 2.8 Sensor Parameter

- a) Measurement Technology :- Ultrasonic / Sonar
- b) Range: 30-400cm (12"- 157")
- c) Accuracy: +/-4cm (1.57") for solid material and +/-1cm (0.39") for liquids
- d) Resolution: 1cm (0.4")

## 2.9 Data Management

- a) Accessibility: 24/7 access through Facility Management mobile and web interface
- b) Indicates Container fill level, container internal temperature (optional) GPS Coordinates

## 2.10 Software

- a) Updateable and configurable remotely

## 2.11 Environment Reliability

- a) Enclosure Rating:- IP 67
- b) Impact Rating LIK 10
- c) Operational Temperature:- 30-+80 degree

## 2.12 Power

- a) Battery Type:- 3.6V high Performance Lithium battery
- b) Battery Life: 10+ Years

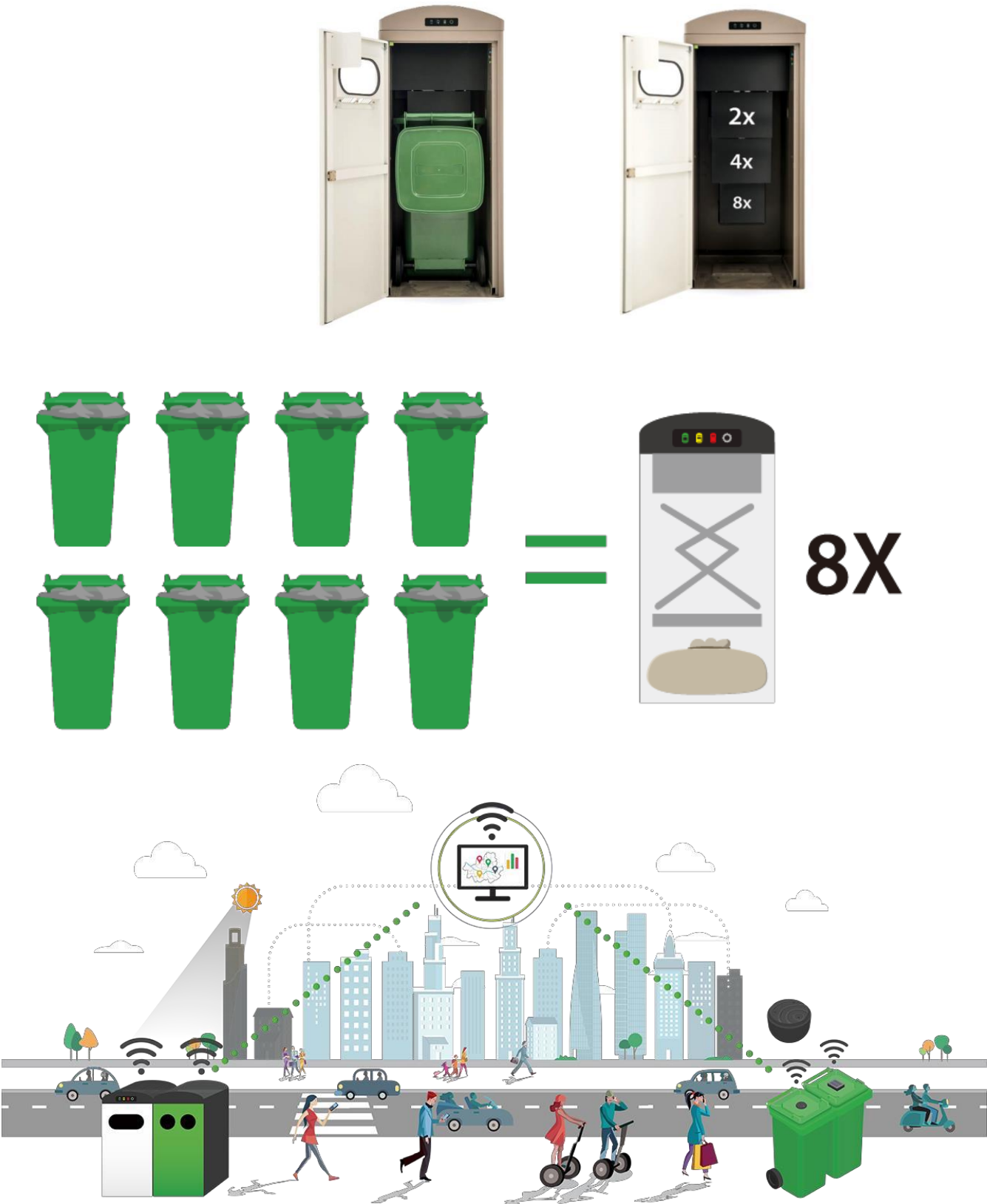
## 2.13 Physical Characteristics

- a) Material: High Impact ABS/Polycarbonate
- b) Installation:- Mounting Bracket

Representative image, do not represent actual product







Waste collection gets smarter, greener and more efficient than ever.

### 3.0 Boom Barriers

- i) Aluminum cast sole plate.
- ii) Anodized aluminum frame.
- iii) Lacquered aluminum housing panels (selection of 4 colors). lacquering providing an excellent protection against corrosion.
- iv) Aluminum cast hood, locked by key.
- v) Oval aluminum arm of app section 80 x 54 mm, lacquered white (RAL 9010) with red reflective strips.
- vi) Drive shaft, diameter app 30 mm, fitted on a geared motor and a lifetime lubricated bearing
- vii) Automatic opening in case of power failure (AVR).
- viii) Electromechanical assembly including:
  - a) Reversible three-phase asynchronous gear motor, ensuring protection of the mechanism in case of forced lifting of the arm due to fraudulent action. Maintaining the arm in its 2 extreme positions (open and closed), is achieved by the frequency converter.
  - b) Frequency converter ensuring progressive accelerations and dampened decelerations, for movement without vibrations, reversal of direction without jolts (reopening) and increased protection of the mechanism.
  - c) Electronic limitation of the electromechanical assembly torque allowing immediate stopping of the arm during closing in case of an obstacle
  - d) Analog position sensor indicating the high and low positions and allowing control of the gear motor.
  - e) Balancing of the arm by means of a compensating spring, according to the weight of the arm.
- ix) Varnished electronic control board offering inputs, outputs and relays adjustable:
  - a) Adjustable opening and closing speed.
  - b) Arm position status (open or closed).
  - c) Swing-off arm sensor.
  - d) Technical fault information report.
  - e) Human/Machine interface to change or adjust the electronic control board parameters
  - f) HTML interface

- x) Socket for presence detector (2 loops)
- xi) Electrical power supply During motion: 150W max. At rest: 44W
- xii) Motor Free passage (L) Opening time Adjustable between 1,2 and 3s  
(*Allowing the passage of 1500 vehicles/h*)
- xiii) Operating temperature Between -10 and +60°C. 95% max, without condensation
- xiv) CBF Mean cycles between failures - 5.000.000, when respecting recommended maintenance
- xv) Weight App 50 kg (*without arm*) Arm: from 1,6 to 3, 2Kg
- xvi) IP Conform to European standards IP55
- xvii) Arm swing-off + arm swing off detection.
- xviii) Rubber protection profile.
- xix) Electromechanical holding arm position in case of power failure (*SR*).
- xx) Tip support (*Standard, adjustable, electromagnetic or electrolockable*)
- xxi) Hood & door intrusion information - Dry contact communicates to IBMS.
- xxii) Key switch on housing (*Automatic / locked open / locked closed*).
- xxiii) Vehicle detection loop.
- xxiv) Presence detector for detection loop.
- xxv) Photoelectric cell for closing-safety.
- xxvi) Cell assembly on housing.
- xxvii) Cell support post.
- xxviii) Ultrasonic detector under boom + protection cover.
- xxix) Extension card for inputs, outputs and Presence detector connector.
- xxx) Totaling counter (*without or with Reset*).
- xxxi) LED function pictograms on hood (*red, green and orange*).

- xxxii) Arm LED lighting
- xxxiii) LED traffic lights ( $\varnothing 100$  or  $\varnothing 200$  mm)
- xxxiv) Support post for traffic lights.
- xxxv) Acoustic alarm 100dB ( $\pm 5$ ) (*Fixed inside the housing*)
- xxxvi) Traffic sign  $\varnothing 300$  mm (*STOP, One way*).
- xxxvii) Raised base

#### **4.0 Automated Window Accessory for Smoke extraction**

- 5.1 Supply, installation, testing and commissioning motorized control for automatic opening of side hung windows to open outside in case of fire emergency.
- 5.2 Actuator/motor should be with the die-cast Aluminum casing with chain in stainless steel links and chain to exit in central position of the actuator. The stroke length shall be as per the design of windows.
- 5.3 It should have continuous and complete control of the window with real-time feedback.
- 5.4 It should connect directly to Smoke Ventilation Control Panels equipped with batteries.
- 5.5 It has to be fully compatible with IBMS
- 5.6 The protection class shall not be less than IP30 and with power input of 24VDC to operate.
- 5.7 The actuators shall comply with European Standards EN 1210-2.
- 5.8 In case of Emergency, any control must be overridden for immediate window opening of the window
- 5.9 The system shall also comprise of hardware as friction hinges, pull in blocks etc complete as per require
- 5.10 Smoke ventilation control panel should allow smoke and heat extraction in case of fire, granting anyway single or multiple window.
- 5.11 The control panel, should have back up batteries to allow to control automatically the windows opening or closing by 24 Vdc actuators.
- 5.12 Opening for smoke extraction shall be controlled by smoke detectors, emergency push buttons or fire alarm systems or building management systems (IBMS) by “free potential - normally closed” inputs.

5.13 The smoke ventilation control panels shall comply with European Standards EN 12101 part 9 / part 10.

5.14 The panel and motors need to continuously give feedback of its health on IBMS and support in predictive maintenance.

**5.0 Signage and Digital Signage System**

i) The Contractor to design, supply, install & commission non –digital signage systems for following areas

- a) Way finding for vehicles and people entering the station and office complex to cover all roads and areas for effective guidance
- b) Signage for shops, restaurants, other public amenities
- c) To mark various utilities like Toilets, restaurants, other services

ii) The Contractor to design, supply, install & commission digital signage systems for following areas

- a) Digital signage of app size 1800mmX 600mm – single side and both side lit as per application for B1 and B2 car parking to indicate various directions for driving and indicating and alerting for Exit and non Exit areas
- b) Digital signage for all Lift lobbies and Corridors in station building and office complex
- c) All the digital signage to be programmable to show context in clear readable format and to be able to be programmed from either master control room or from individual Facility Manager in Buildings
- d) Status of all digital signage to be mapped on IBMS

## **Technical Specification**

### **Barricading**

#### **Section - 12**

### **Barricading Work**

1. The Contractor shall be required to keep the Site as Safe and Secure as possible at all times, including the Erection of Site Perimeter Hoarding, which shall also deter trespassers both adult and children alike, as per the Approval of the Employer.
2. Barricading of 12 m height shall be provided with structural steel framework including foundation etc. with Hi-Rib Profiled Sheeting of appropriate cover width and Crests manufactured out of Hi Tensile Colour Coated Galvalume Steel having colour coating of Regular Modified Polyester Coated finish as per AS:1397/ASTM 792. The sheet shall have wide pans with small 2/3 stiffening ribs for effective water shedding and special male/female ends with full return legs or side laps for purlin support. Sheet should have protective guard film of 25 microns minimum to avoid scratches during transportation and should be supplied in single length upto 12 metre or as per site geography.
3. The Contractor shall provide a solid 12 m high securely erected Barricade including Lights over Barricades at night around the perimeter of the Site as per the Approval of the Employer, with Agreed and Guarded Access and Egress Points for both personnel and vehicles.
4. At each entrance to the Site, the Contractor shall erect a large Billboard warning all persons who enter the Site that they are required to wear the Appropriate Personal Protective Clothing and that no Unauthorized Access is allowed.
5. Wherever the Barricade borders on Pedestrian Footpath, Lightings shall be provided to illuminate the Pedestrian Routes. The Positioning of the Barricade Line shall not reduce the Width of Pedestrian Footpath to less than 900mm.
6. Site Perimeter Barricade shall be washed at least once a month and repainted at least annually.
7. The Site Barricade shall need to be inspected on a regular basis in order to ensure that the Integrity of the Fencing is maintained at all times as far as practicable.
8. After Completion of work Barricades and other traffic diversion boards shall be removed by the Contractor.

### **~~Foot Over Bridge (FOB)~~ – Not Applicable**

1. All works shall be executed as per latest RDSO's specifications for FOB and as per direction of

Engineer – in – Charge.

2. In items of works related to Structural and architectural & civil finishes section, execution of work shall be carried out in accordance with Section – 2 and Section – 3 of this document i.e. Technical Specification for Structural Work and Architecture & Civil Finishes.
3. For Roofing Work, below mentioned Technical Specification may be followed:

Roofing may be provided with Precoated Galvalume Iron profile sheet or Aluminum Sheet roofing or Polycarbonate roofing for lighting purposes as per Drawings.



**Section – 13**  
**List of Approved Makes**

**Approved Makes**

1. Approved Makes List mentioned below will form the part of Technical Specification as Section – 13.
2. The contractor will use one of the approved makes as approved by Consultant/Engineer – in – charge.
3. For materials/equipment/ to be used in items of work for which approved makes are not given herein, the makes of such materials /equipment shall be as decided by Consultant/Engineer – in – charge.
4. If any major equipment is using a small component of make other than that given as a standard component with the equipment, the same shall be accepted subject to approval of Consultant/Engineer – in – charge.

**LIST OF APPROVED MAKES**

<b>STRUCTURAL &amp; CIVIL</b>		
<b>S.No</b>	<b>Equipment/Material</b>	<b>Approved Make/Manufacturer</b>
1.	Ordinary Portland Cement	ACC/ Ultratech/ J. K Cement/ Lafarge/ Ambuja Cement/ L&T/ Shree
2.	White Cement	Birla Cement/ J. K White/ La Farge/ Sealix
3.	Reinforcement Steel (TMT – Fe500)	SAIL/ Tata Steel/ RINL/ Jindal Steel & Power Ltd/ JSW Steel Ltd
4.	Structural Steel/M.S. Tube	TATA/ JSW Steel Ltd/ SAIL/ Jindal Steel & Power Ltd/ RashtriyaIspat Nigam Ltd/APLApollo
5.	Plasticizer, Super Plasticizer, Admixtures, Other construction chemicals	M.C.Bauchemie/ Fosroc/ Pidilite/ CICO/ Sika/ BASF/ Asian Laboratories/ Ultracon, Technonicol/Thermax/Master Bond/ Zerodrip/ Nerolac/Berger/HomePride
6.	Waterproofing Compound (Crystalline) / Waterproofing Self Adhesive (HDPE) Membrane / EPDM Waterproofing Membrane / PU Elastomeric Membrane (spray applied) for Deck Waterproofing	Fosroc/ Pidilite/ Carlisle/ Fire Stone, Soprema, Technonicol.Flowcrete/Thermax/Zyseal/Penetron/ Nerolac /Berger/HomePride

S.No	Equipment/Material	Approved Make/Manufacturer
7.	Glasswool Insulation	UP Twiga/ Poly Glass/ Owens Corning
8.	Rock Wool Insulation	Lloyds/ Roxul Rockwool/ Grodan
9.	Swellable Bar	Pidilite/ Fosroc/ MYK Schomburg/Soprema/ Thermax/Zerodrip/Zyseal/Penetron
10.	Polycarbonate Sheet	GE Plastic/ Gallina/ Danpalon/Greenpro/Polyalloy
11.	Decking Steel Sheet/Galvulume Sheet for roofing, cladding, sandwich panel	TATA Steel/ Lloyds/ JSW/ A-One Industries/APLApollo/Polyalloy
12.	Shuttering Ply	Archid/ Century/ Kitply/Kanchan/Ceilux/National Ply/ Polyalloy/Reynoarch/Greenply
13.	Rebarring Chemical	Hilti/ 3M India/ Birla
14.	Fire Sealant	Hilti/ 3M India/ Fischer/Nippon Paint/Alstone
15.	Parallel Threaded Couplers (Compliant to IS:16172:2014)	Dextra/ Halfen Moment/ G-Tech/ SNTP Technologies
16.	Extruded Polysterene Board	STP/ Supreme/ Ownes corning/ Shalimar
17.	AAC Block	Aerocon/ Builtech/ Instablock/ J K / Magicrete
18.	AAC Mortar	Ferrouscrete/ Ultratech/ JK,
19.	Moisture Resistant Board	Greenlam/ Duro/ Merino/Ceilux/ Kitply
20.	Veneered Particle Board	Duro/ Greenlam/ Kitply/Century/ Green Panel/ Ceilux/Greenply/National Ply
21.	Laminated Particle Board / Laminates	Greenlam/ Century/ Novapan/ Archid/Greenpanel/ Jayna/Virgo/ Ceilux/National Ply/Greenply/Kitply

S.No	Equipment/Material	Approved Make/Manufacturer
22.	Flush door shutters / Factory made paneled door shutters	Century/ Green/ Duro/ Archid/Greenpanel/ Jayna/Doorky/ Ceilux/National Doors/Polyalloy/ Polywood-Dynasty/Prominace/Kitply
23.	Toilet Cubicles	Merino/ Greenlam/ Dorma/T-Line/Virgo/ Ceilux
24.	Hardware for Fire Check Door	Dorma/ AssaAbloy/ Hafale/Dorset/ASES/Becker FS/Kalos/Bhawani Fire/Indian-Fire
25.	Plywood / Veneer/Laminate	Greenlam/ Century/ Archid/ Duro/Archid/ Jayna/Virgo/ Ceilux/National Ply/Greenply/Kitply
26.	Melamine Polish	Asian Paints Melamine Gold/ Nerolac/Wudfin of Pidilite/ Timbertone of Akzonobel (Dulux) /Neel Gagan Pigments/Berger
27.	Expansion Joint – Modular	C.S/ Hercules/ Z-Tech/ Vexcolt/ Deevin/ Sainfield/Kohinoor/Frano World/DECG/Kron
28.	Polyster Powder Coating Shades	Nerolac/ Berger/Akzonobel
29.	Silicon based water repellent / Weather Sealant	G. E Plastics/ Dow Corning/ Pidilite/MYK Schomburg/Thermax/Nippon Paint/Zyseal/Nerolac/ Berger/Alstone
30.	Poly-Sulphide Sealant	Fosroc/ Pidilite/ Sika/ Laticrete/Thermax/Master Bond/Nippon Paint/Zyseal/Nerolac/Berger/Alstone
31.	Wall Putty	Birla Wall Care/ JK White/ Saint Gobain/Sealix/ Ferrouscrete/ Berger/Sakarni/Neel Gagan Pigments /Nerolac/HomePride
32.	Curing Compound	Fosroc/ Sika/ Cico/ STP/ Pidilite/ BASF/ Asian Laboratories/Sakarni/Thermax/Zerodrip/Zyseal /Nerolac/Berger
33.	Oil Bound Washable Distemper	Asian Paints/ Akzonobel Dulux/ JK Maxx/Berger/ ICI/ Nerolac/Sakarni/Neel Gagan Pigments/Nerolac
34.	Acrylic Distemper	Berger/ Asian/ Dulux/Nerolac/JK Maxx/Sakarni/Neel Gagan Pigments

S.No	Equipment/Material	Approved Make/Manufacturer
35.	Premium Acrylic Emulsion paints	Dulux/ Nerolac/ Asian Paints/ Berger/ JK Maxx/Sakarni/Neel Gagan Pigments
36.	Cement Primer	BP White (Berger)/ Decoprime WT (Asian)/ JK Maxx/Akzonobel (Dulux)/ Nerolac/Sakarni/Neel Gagan Pigments/Nerolac
37.	Steel /Wood Primer	Akzonobel (Dulux)/ Nerolac/ Asian Paints/ Berger/ Jenson & Nicholson/Neel Gagan Pigments
38.	Textured Exterior Paint	Akzonobel (Dulux)/ Asian (Apex Ultima)/ Nerolac (Excel)/ JK Maxx/Ultra Tech/ Spectrum/ Berger/Sakarni/Neel Gagan Pigments
39.	Synthetic Enamel Paint	Akzonobel (Dulux)/ Asian (Apolite)/Nerolac (Synthetic Enamel))/ JK Maxx/Berger/Sakarni/Neel Gagan Pigments
40.	Epoxy Paint	Nerolac/ Asian Akzonobel (Dulux)/ JK Maxx/ FOSROC/ ICI/Flowcrete/Neel Gagan Pigments/ Berger
41.	Epoxy Flooring	BASF/ FOSROC/ Flowcrete/Neel Gagan Pigments/ Thermax/Tessella/Zyseal/Berger/HomePride
42.	Fire Paint	Asian/ Jotun/ Akzonobel/Soprema/Neel Gagan Pigments/Nippon Paint/Berger
43.	Heat Resistant Tiles	Swastik/Thermax/ Dalal Tiles/AGL/Simero /Sunhearrr/Varmora
44.	Gypsum Plaster	Ferrous Crete/ Elite (90)/ Ultratech/Sakarni/Sealix/ Neel Gagan Pigments
45.	Pre-Cast GRC Jali	Unistone/ Dalal Tiles Industries/ KK
46.	Stainless Steel	Salem Steel/ Jindal Alloys/ SAIL
47.	Welding Electrodes	Advani/ Oerlikon/ Modi/Kron
48.	Stainless Steel Hardware	Dorma/ Hafale/ Geze/ Godrej/Doorky/Dorset/Kalos

S.No	Equipment/Material	Approved Make/Manufacturer
49.	Ultrafine Fly ash	Ashtech/Adani/L&T
50.	High Pressure Lamintes (HPL)	Virgo/Marino/Fundermax/Greenlam/Alutuff/Reynoarch/Pioneer
51.	Wooden/Steel Furniture (Hard/Soft)	Godrej/Durian/ Evok/Polywood-Dynasty or Equivalent/

### CEILINGS

S.No	Equipment/Material	Approved Make/Manufacturer
1.	False Ceiling – Gypsum/GRG	Saint Gobain/ Boral Lafarge/ India Gypsum/ DIAMOND/Sakarni Gipskarton/RK Ceilings/Ceilux /Royal-Kraft/Anakon
2.	False Ceiling – Metal/Mineral Fibre	Saint Gobain/ Armstrong/ Hunter Douglas/ Unimet/Sakarni Gipskarton/RK Ceilings/ Ceilux/DIAMOND/Royal-Kraft/Anakon/Reynoarch
3.	Gyp Board	Saint Gobain/ Lafarge/ Boral/DIAMOND/Sakarni Gipskarton/Ceilux
4.	Open Cell Ceiling	Armstrong/ Durlum/ SAS/ Hunter Douglas/ DIAMOND/Sakarni Gipskarton/RK Ceilings/Ceilux/ Royal-Kraft/Anakon/Reynoarch
5.	Baffle Ceiling	Armstrong/ Durlum/ Hunter Douglas/Sakarni Gipskarton/RK Ceilings/Ceilux/DIAMOND/Royal-Kraft /Anakon/Reynoarch
6.	Acoustical Tile False ceiling	Armstrong/ Lafarge/ Himalaya Acoustic/ Decosonic/ DIAMOND/RK Ceilings/Ceilux/Royal-Kraft/Anakon
7.	Acrylic Solid Surfaces	Hanex/ L.G-Hymac/ Dupont/Ceilux

### FLOORINGS

S.No	Equipment/Material	Approved Make/Manufacturer
1.	Mosaic / chequered Tiles	Bisazza/ NITCO/ Unitile/ Dalal Tiles Industries/ Orientbell/Simero/Sunhearrt
2.	Ceramic tiles / Glazed Tiles	Kajaria/ Somany/ NITCO/AGL/ H&R Johnson/ Orientbell/Hindware/Cera/Tessella/Simero/Sunhearrt/ Varmora/Anakon
3.	Vitrified Tiles (Antiskid / Matt / Glazed)	Somany/ Kajaria/ NITCO/AGL/ H&R Johnson/ Restile/Orientbell/Hindware/Cera/Tessella/Simero/ Sunhearrt/ Varmora
4.	PVC Flooring	Armstrong/ Tarkett/ LG/ Responsive/Polyalloy
5.	Paver Block & Kerb Stone	NITCO/ Unitile/ Ultra/ Dalal Tiles Industries
6.	Tile / Stone Adhesive/Tile Grout	Pidilite/ Ferrous Crete/ MYK Laticrete/ Fosroc/ BASF/Neel Gagan Pigments/Hindware/ Thermax/Master Bond/Sealix/HomePride/Varmora/ Reynoarch/Berger
7.	Dash / Anchoring Fasteners	Hilti/ Fisher/ Bosch/Kron
8.	Floor hardener	Ironite/ Fosroc/ Hardonite/Laticrete/Thermax/ Tessella/Berger

### GLAZINGS

S.No	Equipment/Material	Approved Make/Manufacturer
1.	Anodised Aluminum Hardware (Heavy Duty)	Hardima/ Alualpha/ LGF Sysmac/ Hindalco/ Everite/Kalos
2.	Aluminum Structural Members – Windows, Glazing and Partitions	Jindal/ Indalco/ Hindalco/ Nalco/ Bhoruka/Kalos
3.	Glazing Structural / Suspended / Skylight	Saint Gobain/ Pilkington/ Glaverbal/Kalos
4.	Clear / Float / Frosted Glass / Mirror	Saint Gobain/ AIS/ Pilkington/ MODI

S.No	Equipment/Material	Approved Make/Manufacturer
5.	Glass Spider Fittings	Dorma/ HAFAL/ OZONE/Dorset/Kalos
6.	Stainless Steel Railing, Accessories etc in Grade SS 304	Dorma/ D-line/ Jindal/ Ozone/ Geze/Doorky/ Dorset/Kalos
7.	Hermitically sealed performance glass Toughened Glass	Saint Gobain/ Guardian Glass/ Pilkington/ Modiguard
8.	Fire rated vision Panels	Pilkington/ SCHOTT/ FERILITE/ Saint Gobain/ Glaverbel/Bhawani Fire/Indian-Fire
9.	Aluminium composite Panels	Reynobond/ Aluco Bond/ Alpolic/Alumaze/Virgo/ Windfall/Alutuff/Eurobond/Aludecor/Reynoarch/ Pioneer
10.	Insulated Aluminum panels	Luxalon/ Qbiss/ Hunter Douglas/Windfall/Eurobond/ Aludecor
11.	Ceramic panel Cladding	Hunter Douglas/ Neolith/ Terreal/Ceilex
12.	Aluminum Louvers	Hunter Douglas/ Colt/ Kawneer/Alumaze/Ceilux/ Alutuff/Polyalloy/Eurobond/Aludecor/Reynoarch/ Pioneer
13.	G. I Steel door frame	Synergy Thrislington/ Shakti/ Navair/Pacific/ APLApollo/Prop/ Bhawani Fire/National Doors/ Polyalloy/Indian-Fire
14.	Friction Stay Hinges	Dorma/ Dorset/ LG Sysmac/Dorset/Kalos
15.	EPDM Gasket	Hanu/ Osaka / Alps/ Anand
16.	Glass Processor for making DGU / Toughing	Art N Glass/ Kaenat Glass/ GSC (Noida)/ ASAHI/ SEJAL/ Gold Plus
17.	Mirror Glass	Atul/ Modi Guard/ Saint Gobain
18.	UPVC Doors & Windows	Fenesta/ Wintech/Aluplast/APLApollo/VEKA/ Windfall/DNV/National Doors/Poyalloy/Polywood /Prominance



S.No	Equipment/Material	Approved Make/Manufacturer
19.	Polysulphide sealant	Wacker/ Dow Corning/ GE/Nippon Paint/Berger/ Alstone
20.	Silicone /Weather Sealant	Wacker/ Dow Corning/ GE/Nippon Paint/Berger/ Alstone
21.	Window Blinds	Deck/Hunter Duglus/Arrowlux/Dedcor

### HARDWARE

S.No	Equipment/Material	Approved Make/Manufacturer
1.	Nuts / Bolts & Screws	GKW/ Hilti/ Atul/Kalos
2.	Door Closer	Dorma/ Hettich/ Godrej/ Everite/Doorkey/ Dorset/ ASES/Kalos
3.	Die Cast Patch Fittings	Dorma/ AssaAlboy/ Geze/ Hettich/ Ozone/Dorset/ Kalos
4.	Fire rated doors	Iclean/ Promat/ Shakti/ Navair/Doorkey/Pacific/ASES/ Windowtech/Supreme/Bhawani Fire/National Doors/Indian-Fire/Kitply
5.	Floor Springs	Dorma/ Hettich/ Geze/ Dorset/ Everite/Doorkey/Kalos
6.	SS Mortise lock with one dead bolt and pair of SS handles steel grade – SS304	Dorma/ Hafele/ Godrej/ Dorset/Doorkey/Kalos /ASES
7.	SS Mortise latch & lock with six levers and pair off SS handles steel grade – SS304	Dorma/ Hafele/ Godrej/ Dorset/Doorkey/Kalos
8.	SS Tower bolt	Dorma/ Hafele/ Godrej/Doorkey/Dorset/Kalos
9.	SS Butt hinges with ball bearing grade – SS304	Dorma / Ingersoll Rand/ Godrej/Doorkey/ Dorset/ ASES/Kalos

S.No	Equipment/Material	Approved Make/Manufacturer
10.	Magic Eye	Dorma / Ingersoll Rand/ Godrej/Doorky/Dorset/ Kalos
11.	Stainless Steel sliding door bolts	Ingersoll Rand/ Godrej/ Hafele/Doorky/Dorset/Kalos
12.	Pull handle back to back of length 150mm of steel Grade-SS304	Godrej/ Ozone/ Geze/Doorky/Kalos
13.	Pull handle, single side of length 150mm of steel Grade – SS304	Godrej/ Ozone/ Geze/Doorky/Dorset/Kalos
14.	Aluminium level handles	Hardima/ Everite/ Godrej/Kalos
15.	Lever handle in SS 304 finish	Dorma/ Godrej/ Hafele/Doorky/Dorset/Kalos

**PLUMBING & SANITARY**

S.No	Equipment/Material	Approved Make/Manufacturer
1	G.I / M. S Pipe	Tata/ Jindal (Hisar)/ Surya Prakash/APLApollo/ Prop steel
2	G. I Fittings	Unik/ KS/ Zoloto/ R-Brand/ Surya/ Prop steel
3	SS Pipe and Fittings	Jindal/ Tata/ VIGA/J-Press/Alfa Press/Aquinox India
4	HDPE/OPVC Pipes	Reliance/ Jain Irrigation/ Oriplast/ Vertex/ West Well/ Supreme/ Vectus/APLApollo/Prop/SFMC
5	DI/OPVC Pipes	Electrosteel/ Jindal/ Tata Ductura/APLApollo
6	DI Fittings	Kartar/ Electrosteel/ Kalinga
7	CI Fittings	Neel/ Kartar/ Electrosteel

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<b>S.No</b>	<b>Equipment/Material</b>	<b>Approved Make/Manufacturer</b>
8	CI Double flanged sluice valve	Kirloskar/ Sondhi/ Kejriwal/ IVC/Prop
9	Float Valve	IVC/ Leader/ Zoloto/ KSB/Prop
10	UPVC/OPVC Pipe and Fittings	Astral/ Supreme/ Finolex/ AKG/ Surya Prakash/ Vectus/APLApollo/Prop/Prince/SFMC
11	Centrifugally Cast (Spun) Iron Pipes & Fittings	NECO/ SKF/Electrosteel/RPMF/RIF
12	Centrifugally Cast (Spun) Iron (Class LA) Pipes	NECO/Electro Steel/ TATA/RPMF
13	Centrifugally Cast (Spun) Ductile Iron Pipes & Fittings	Electro Steel/ Jindal (Hissar)/ Kalinga/RPMF
14	C. I Manhole covers, Frames & GI Gratings	NECO/ RIF/ BIC/ SKF/RPMF/Polyalloy
15	SFRC Manhole covers & gratings	KK/ OCR/ PARGATI/ T-CON
16	Gun Metal Valves, Globes	Kartar/ Castle/ Zoloto/Prop
17	CP Brass Fittings	Jaquar/ Kohler/ Parryware/ Hindware/ Grohe/Euronics /Cera/Hife
18	Sanitary Fittings & accessories	Hindware (Italian collection)/ Kohler/ ROCA/ Duravit/ Somany (French Collection) /Euronics/Cera/Hife
19	Water Meter	Prima/ Zoloto/ Leader/ Capstan/Prop
20	Brass Stop & Bib Cock	Zoloto/ San/t L&K/ Leader/ Astral/Cera/Prop

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<b>S.No</b>	<b>Equipment/Material</b>	<b>Approved Make/Manufacturer</b>
21	PVC/OPVC Pipe & Fittings	AKG/ Supreme/ Finolex/ Surya Prakash/ Vectus/APLApollo/Prop/Prince/SFMC
22	CPVC/OPVC Pipes & Fittings	AKG/ Astral/ Supreme/ Finolex/ Surya Prakash/ Vectus/APLApollo/Prop/Prince/SFMC
23	Non Return Valve (Check valve) 1/2" to 11/4"	Zoloto/ Sant/ Leader/Prop
24	Brass Ferrules	Dhawan Sanitary Udyog/ Kalsi/ Annapurna
25	Polythylene water storage tank	SINTEX/ POLYCON/ SPL/ VECTUS/Prop/Prince/ SFMC
26	Insulation for hot water pipes	KAIFLEX/ ARMAFLEX/ CAREFLEX/ Lloyd
27	Insulation for external/exposed hot water pipes	KAIFLEX/ ARMAFLEX/ CAREFLEX
28	Pipe protection for external water supply pipes	PYPKOTE/ ARMAFLEX/ MAKPOLYKOTE
29	Stainless Steel Sink	Neelkanth/ Nirali/ Jayna/ Cera/Kalos
30	Stone ware pipes	Perfect/ Hind/ Burn/ RK
31	Gully Traps	Perfect/ Hind/ Burn/ RK
32	RCC Pipes (NP-2)	Lakshmi/ Sood & Sood/ Jain & Co./ Pragati Concrete
33	Atactic Polypropylene	STP/ HTL/ Hydro Tech/ Pidilite
34	Ball Valves / wafer type valves	Zoloto/ Leader/ AIP/Prop

S.No	Equipment/Material	Approved Make/Manufacturer
35	Ball Cocks	GPA/ Sant/ L&K/Prop
36	Water Heater	Racold/ Venus/ Jaquar/ Havells
37	Air Release Valves	Sant/ Leader/ Zoloto/Prop
38	Pipecoat	IWL Ltd/ Pypkote/ STP
39	PICB Valve	Danfoss/ Frese/ Oventrop/ Spirotech/ Reflex/Prop
40	Expansion Tank	Anergy/ Emerald/ Spirotech
41	Paracoat BPC	Paramount/ Pidilite/ Indiana Polycoat

**FIRE FIGHTING**

S.No	Equipment/Material	Approved Make/Manufacturer
1	M. S Pipe	Tata/ Jindal Hissar/ Surya Prakash/ SAIL/APLApollo/Prop Steel
2	G. I Pipes	Jindal Hissar/ Surya Prakash/ SAIL/ TATA/APLApollo/ Prop Steel
3	Forged Fittings	SS/ VS/ True Forge
4	Ball Valve / Gate Valve (Gunmetal)	Sant/ Leader/ Zoloto/ CIM/Prop
5	Butterfly Valve	Zoloto/ Kirloskar/ Leader/Prop

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S.No	Equipment/Material	Approved Make/Manufacturer
6	Air Pressure Valve	Anergy/ Flemco/ Castle/ SKS/ Leader/Prop
7	C. I Double flanged sluice valves	Kirloskar/ Zoloto/ Sant/ IVC/Prop
8	C. I Double flanged Non-return valves	Kirloskar/ Zoloto/ Leader/ IVC/Prop
9	Dual Plate / Wafer Type Non-return valves	Kirloskar/ Zoloto/ Leader/ IVC/Prop
10	Fire Extinguishers	Zenith/ Minimax/ Superex/ Ceasefire/ Newage/ Safe Fire/ASES/Tri-Parulex
11	First Aid Hose Reel Drum	Superex/ Newage/ Safex/ Safe Fire/Tri-Parulex
12	Thermo Plastic Hose Reels for Drums	Superex/ Newage/ Safex/Tri-Parulex
13	R.R.L Hose & C.P Hose	Superex/ Newage/ Eversafe/ Safe Fire/Tri-Parulex
14	Branch Pipe, Nozzle, Coupling etc.	Superex/ Newage/ Eversafe/ Minimax/ Lifeguard/ Safeguard/ Safe Fire/Tri-Parulex
15	Landing Valves	Superex/ Newage/ Eversafe/ Safe Fire/Prop/ Tri-Parulex
16	Fire Brigade Connections	Superex/ Newage/ Eversafe/ Minimax/ Safe Fire/ Tri-Parulex
17	Fire Fighting Equipment not covered elsewhere	Superex/ Newage/ Eversafe/Tri-Parulex
18	Hose Box	Superex/ Newage/ Eversafe/Tri-Parulex

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<b>S.No</b>	<b>Equipment/Material</b>	<b>Approved Make/Manufacturer</b>
19	Sprinkler & Rosette Plates	Tyco/ Viking/ HD/ Spray Safe/ASES/Pyrox/ Tri-Parulex
20	Motors for Fire Pumps	Siemens/ Kirloskar/ Crompton/ ABB/KCJ
21	Fire Pumps	Kirloskar/ Mather & Platt/ Grundfos/KCJ
22	Electrical Switch Gears	As per electrical makes
23	Power and Control Cables	As per electrical makes
24	Electrical Control Panel	As per electrical makes
25	Voltmeter & Ammeter	As per electrical makes
26	Indicating Lamp and Selector Switches	As per electrical makes
27	Y-Type / Pot / Suction Strainer	Kirlosakar/ Leader/ Zoloto/ Tyco/ Advance/Prop
28	CT	As per electrical makes
29	MCCB / MPCB / MCB	As per electrical makes
30	Contractors/ Times, Overload Relays/ Starter	As per electrical makes
31	Foot valve with Strainer	Kirloskar/ Leader/ Zoloto/Prop
32	Flexible Connector (Drop) for Sprinkler	Easyflex/ Viking/ Newage/Pyrox
33	Flow Switches	System Sensor/ Honeywell/ Potter/ Tyco

S.No	Equipment/Material	Approved Make/Manufacturer
34	Annunciation panels	PCD/ Agni/ Tricolite/ Adlec/Tri-Parulex
35	Single phase preventor	As per electrical makes
36	Inspector Test valve	Viking/ Tyco/ HD/Prop
37	Pre-Fabricated Structural supports and clamps	Chilly/ Hitech/ Camry/ Easyflex/Kron
38	Pressure Gauge	Emerald/ Fiebig/ H.Guru/ Danfoss/Prop
39	Alarm Valve	Viking/ Tyco/ HD/Prop/Tri-Parulex
40	Dash fasteners	Hilti/ Fischer/ Fasteners India/Kalos
41	Welding Electrodes	Advani/ Essab/ Mangalam/Kron
42	Anti-vibration Pads & suction & delivery flexible pipe connectors	Easyflex/ Resistoflex/ Dunlop
43	Reinforcement Steel/ Structural Steel/ Steel Plates	SAIL/ Tata Steel Ltd/ RINL/ Jindal Steel & Power/ JSW Steel Ltd. /APLApollo
44	Clean Agent Fire Suppression System for entire room flooding	Fire Trex/ Sevo System/ Safe Fire/ Tyco/ASES/ Tri-Parulex
<b>PUMPS AND WATER TREATMENT SYSTEM</b>		
S.No	Equipment/Material	Approved Make/Manufacturer
1	Pumps	GRUNDFOS/ Xylem/ WILLO/ KSB/KCJ



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S.No	Equipment/Material	Approved Make/Manufacturer
2	Submersible Drainage Pumps	KSB/ GRUNDFOS/ Crompton/KCJ
3	G. I / M. S Pipes	TATA/ JINDAL HISSAR/ SAIL/APL Apollo/Prop steel
4	G.I. Fittings	UNIK/ Zoloto/ SS/Prop steel
5	Ball Valves	ARCO/ SANT/ ZOLOTO/Prop
6	Butterfly Valve	KSB/ SKS/ AUDCO/Prop
7	C.I double flanged sluice valve	ZOLOTO/ SANT/ CASTLE/ KARTAR/Prop
8	Non Return Valve	ZOLOTO/ SANT/ CASTLE/ KARTAR/Prop
9	Y – Strainers	ZOLOTO/ SANT/ CASTLE/ KARTAR/Prop
10	Float Switch	NOLTA/ DANFOSS/ HONEYWELL/Prop
11	Pressure Gauge	FIEBIG/ H. GURU/ Dan foss
12	Dosing system	MILTON ROY/ ASIALMI/ GRUNDFOS
13	Liquid Level Controllers / Liquid Level Indicator	ADVANCE/ HONEYWELL/ DANFOSS/Prop
14	Filter / Softner	Ion Exchange/ Renaissance Aqua/ Pentair/ Watcon
15	Salt Saturator	Ion Exchange/ Renaissance Aqua/ Pentair/ Watcon
16	Water Meter	Kent/ Marshall/ Sant
17	Screen / Fine Screen	jash/Ecologix/wastech/Huber

STP & BIO WASTE COMPOSTER		
S.No	Equipment/Material	Approved Make/Manufacturer
1	Micro filtration-MF	Wastech/ Priemer Tech/Hydrocon
2	G. I Pipes	TATA/ JINDAL HISSAR/ Sail/APLApollo/APLApollo/ Prop steel
3	G.I. Fittings	UNIK/ Zoloto/ SS/Prop steel
4	UPVC pipes	SUPREME/ JAIN PIPES/ AKG/ VECTUS/APLApollo/Prop/Prince/SFMC
5	UPVC pipe Pressure Fittings	CEPEX/ ASTRAL/ AKG/ VECTUS/APLApollo/Prop/ Prince/SFMC
6	Pre-Fabricated Structural supports and clamps	CHILLY/ EASYFLEX/ CAMRY/Kron
7	Paints	ASIAN PAINTS/ BERGER/ NEROLAC/ JK Maxx/Neel Gagan Pigments/Kamdhenu
8	Gunmetal Fullway Valve	Zoloto/ Sant/ Castle/Prop
9	Ball Valve	ARCO/ CIM/ Castle/Prop
10	Butterfly Valve & NRV	Zoloto / SKS/ KSB/Prop
11	C. I double flanged sluice valve	KIRLOSKAR/ LEADER/ SANT/Prop
12	C. I Disk Type non return valves (65mm dia and above – Dual plate type)	KIRLOSKAR/ LEADER/ SANT/Prop

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<b>S.No</b>	<b>Equipment/Material</b>	<b>Approved Make/Manufacturer</b>
13	C. I Strainer more than 65mm dia	LEADER/ SANT/ CASTLE/Prop
14	PVC Valves	CEPEX/ ASTRAL/ Audco/Prop/SFMC
15	C. I /D.I. Manholes cover	NECO/ KARTAR/ SKF/Greenpro/Polyalloy
16	Filter feed pump	GRUNDFOS/ ITT/ WILO/KSB/KCJ
17	Hydro-Pneumatic Pumping Systems (Flushing, Soft and garden hydrant)	GRUNDFOS/ ITT/ WILO/KSB/KCJ
18	Submersible Sump Pumps for collection chamber, qualization tank, Plant room drainage, Filter backwash sump	KSB/ GRUNDFOS/ Crompton/KCJ
19	Pressure Transmitters / Hydrostatic Level Indicators	WIKA/ SIEMENS
20	Pressure Gauges	FIEBIG H./ GURU/ WIKA
21	Dosing System	ASIA LMI/ MILTON ROY/ GRUNDFOS
22	Pressure sand & Activated carbon filter	M.S. Prefabricated
23	Air Blowers	EVEREST/ BETA/ ABL
24	Ultra Violet Disinfection for Treated Effluent	ALPHA UV/ SUKRUT/ NEOTEC
25	Air Diffusers	BOBKAY/ MM AQUA/ REHAU

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<b>S.No</b>	<b>Equipment/Material</b>	<b>Approved Make/Manufacturer</b>
26	MBBR media for Aeration tank	MM AQUA/ PP AQUA/ TECPRO
27	Dosing Pumps	MILTON ROY/ ASIA LMI/ GRUNDFOS/KCJ
28	Sludge Pumps (Centrifugal)	Kirloskar/ GRUNDFOS/ ITT INDUSTRIES/KCJ
29	Sludge Pumps (Screw)	ROTO/ UT PUMPS/ Stork/KCJ
30	Tube Settler media	MM AQUA/ PP AQUA/ TECPRO
31	Centrifuge	HILLER/ ALPHA/ HUMBOLDT WEDAG
32	Pressure Gauge	H. Guru/ FIEBEIG/ WIKA
33	Level Gauge	H. Guru/ FIEBEIG/ WIKA
34	pH Meter	Hach/ Toshniwal/ IONIX
35	Conductivity Meter	Hach/ Toshniwal/ IONIX
36	DO Meter	Hach/ Toshniwal/ OAKTON
37	TDS Metre	Hach/ Toshniwal/ OAKTON
38	Bio Waste Composting Machine	Brisanzia/ GEM India/ Solar Umpire/ WMC
39	Control Sysytem/ PLC	As per Electrical makes
40	Power & Control Cables	As per Electrical makes
41	STP/ETP	Rohanta Infra Solutions/Rohtas Rumar/Aggrawal Constuction/ Thermax/Ion Exchange

HVAC SYSTEM		
S.No	Equipment/Material	Approved Make/Manufacturer
1	Water Cooled Centrifugal / Screw Chillers	Daikin-Mcquay / JCI-York / Carrier / Trane / Dunhambush
2	Automatic Tube Cleaning System	Same make of Chiller or as per Chiller Manufacturers Standard
3	Chiller Plant Manager with Energy Optimizer	Same make of Chiller or as per Chiller Manufacturers Standard
4	Pumps	Armstrong / Grundfoss / Xylem -ITT / KSB/ Kirloskar / Beacon / Mather & Platt/KCJ
5	Pumps with Variable Speed Pumping System	Armstrong / Grundfoss/ Xylem -ITT/KCJ
6	Cooling Tower (CTI certified)	Bell / Paharpur / Flowtech / Advance / Mihir
7	Electric Hot Water Generators	KEPL / Rapid cool / Emerald / Enmax / Sandhu
8	Air Handling Units & Cooling Coil etc.	Zeco / Edgetech / VTS / Flaktwood / Systemair
9	Fan Coil Units with Fans	Sinko / Zeco / Edgetech / VTS / Flaktwood / Daikin / Carrier/ Trane
10	FCU Copper Connection Set/FCU Link	ATS (CSI) / Oventrop / CIM
11	Heat Recovery Exchanger/Ventilator/ Wheel	Ostberg (Enventus) / DRI / Flaktwoods / BryAir

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<b>S.No</b>	<b>Equipment/Material</b>	<b>Approved Make/Manufacturer</b>
12	Evaporative Cooling Unit (Air washer)	Zeco / Waves / Edgetech / VTS / Humidin / Roots / Ambassador
13	Cellulose Pad for Air washer	Munters (Celdek) / Glacier or equivalent
14	Pump for Air washer	Kirloskar / Beacon/KCJ or equivalent
15	Dry Scrubber	Ryder / Trion / Espire / Zeco / Edgetech / VTS
16	Air-cooled Split AC Units	Daikin/ O General/ Hitachi/ Mitsubishi/ Toshiba/ Carrier
17	Air cooled package units	Voltas/ Bluestar/ Hitachi
18	VRF System	Daikin / O General / Mitsubishi / Toshiba / LG / Hitachi / Trane
19	Chilled Water (Hydronic) Cassette Units	Caryaire/ Carrier/ Johnson Control
20	Inline Fans	Kruger/ Nicotra/ Greenheck/ Ostberg/ Caryaire/ Ruskin Titus (Lau)/ Airflow
21	Propeller Fans	Crompton/ Khaitan/ GEC Alsthom/ Bajaj/ GE/ Systemair/ Caryaire
22	Centrifugal Fans/ Fan section	Kruger/ Greenheck/ Comferi/ Wolter/ Nicotra/ Systemair/ Ostberg/ Flaktwood
23	Axial Flow Fans	Kruger/ Systemair/ Greenheck/ Wolter/ Nicotra/ Flaktwood
24	Variable Frequency Drive	Siemens/ Danfoss/ ABB/ Schneider/ L&T

S.No	Equipment/Material	Approved Make/Manufacturer
25	VAV / CAV Boxes	Trox/ System Air/ Titus/ Honeywell/ Johnson Control/ Belimo/ Flaktwoods
26	Air Filters for Air-conditioning System	Thermadyne / Spectrum/ Camfil Farr/ American Air Filter/ Purolator/ Anfilco / Pure Air/ Mackmark / Purafil / Dyna / Promark - Sevcon
27	Air Curtain Unit	Mitsubishi/ Toshiba/ LG/ Carrier/ Bluestar/ Voltas
28	GI/ MS Piping	Jindal-Hissar / TATA / SAIL/APLApollo/Prop Steel
29	Refrigerant Copper Pipes	Mandev Tubes/ Rajco Metal/ Mehta Tubes (Max Flow)/ Kwalitiy Tubes (Raj State)/ Totaline
30	PVC / uPVC pipe	Polypack/ Supreme/ Prop/Astral/ Finolex/APLApollo/ Prince/SFMC
31	Anchor Fastener	HILTI / Fischer / Cannon / Kron/Wurth
32	Pipe Supports / clamps	Easyflex/ Resistoflex/ Diamond/ Kron/Hilti/ Hiraarosio
33	Pipe Supports-PUF	Llyod insulation/ Melanpur/ Beardsell/ Seven Star/ Kalos
34	Welding Rods	Advani-Oerlikon/ ESAB/ Ador/ Modi / L&T/Kalos
35	2-Way Pressure Independent Balancing & Control Valve (AHU / FCU)	Siemens/ Danfoss/ Oventrop /Belimo/ Honeywell/ Johnson Control/ Schneider/ Anergy /Prop
36	Butterfly Valves (Water Duty)	Castle/ Advance / Audco/ Lahry Instrumentation / L&T/ Zoloto/ KSB/ Jayhiwa/ Sant Jalandhar/Prop

S.No	Equipment/Material	Approved Make/Manufacturer
37	Motorized Butterfly Valve	Honeywell/ Belimo/ Danfoss/ Siemens/ Schneider (t.a.c.)/ Anergy/ Lahry Instrumentation/Prop/ Tri-Parulex
38	Balancing Valves (Water Duty)	Advance/ Audco/ Lahry Instrumentation / L&T/ Honeywell/ Danfoss/ Belimo/ Flowcon/ Castle/ Sant Jalandhar/ Oventrop/Prop
39	Check Valve/Foot Valve/Sluice Valve/NRV	Advance / Audco/ Leader/ Castle/ Lahry Instrumentation / L&T/ Zoloto/ KSB/ Honeywell/ Danfoss/ Kirloskar/ Sant/Prop
40	Globe/Gate Valve	Audco/ Advance/ Danfoss/ L&T/ KSB/ Zoloto/ Leader/ RB/Prop
41	Y- Strainer	Zoloto/ Audco/ Lahry Instrumentationv/ Emerald/ Rapid cool/ Advance/ Sant Jalandhar/ Leader/Prop
42	Pot Strainer	Emerald/ VTM/ Lahry Instrumentation/ Rapid Cool/ Sant Jlandhar/ Procedyne
43	Suction Guide with Strainer	Anergy/ Armstrong/ Emerald/ DS Engineering
44	Ball valves (With & W/o strainers)	Audco/ KSB/ Lahry Instrumentation/ Advance/ L&T/ Zoloto/ Sant/ Rapid Control/ Honeywell/ Emerald/ Rapid cool/ RB/ Leader/ Danfoss/ RC /Prop
45	Flexible Pipe Connection	Resistoflex/ Easyflex/ Diamond/ Dunlop/ Kanwal/ Mason/ Weico/ Areaflex/ Cori
46	Water Flow Switch	Honeywell/ Danfoss/ Belimo/ Emerald/ Rapid Cool/ Rapid Control/ Anergy/ Johnson Control/ Schneider (t.a.c.)/ Atmos/ Seimens/Prop



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S.No	Equipment/Material	Approved Make/Manufacturer
47	Pressure / Temperature Sensors / Differential Pressure Switch / Airflow Switch	Honeywell/ Danfoss/ Belimo/ Emerald/ Rapid Cool/ Rapid Control/ Anergy/ Johnson Control/ Schneider (t.a.c.)/ Atmos/ Seimens
48	Thermostat with speed switch for FCU	Honeywell/ Johnson/ Siemens/ Schneider/ Danfoss/ Balimo/ Sauter/ Atmos
49	Pressure Guges	H.Guru / Feibig / Warree/ H.D/ BRC/ Emerald/ Taylor/ Wika/ Switzer/ Forbes Marshal/ Baumer
50	Thermometers	H.Guru / Feibig / Warree/ H.D/ BRC/ Emerald/ Taylor/ Wika/ Switzer/ Forbes Marshal/ Baumer
51	Thermostat /Humidistat	Honeywell/ Johnson Control/ Siemens/ Schneider/ Danfoss/ Balimo/ Omnicron
52	Room Thermostat	Honeywell/ Johnson/ Siemens/ Schneider/ Danfoss/ Balimo
53	Automatic Air Vent	Anergy/ Rapid Cool/ Emerald/ CIM/ Amtrol/ Honeywell/ Danfoss/ Lahry Instrumentation/ Oventrop
54	Purge Valve/ Plug Valve/ Drain Valve	Audco/ Advance/ Anergy/ Zoloto/ Rapid Cool/Prop
55	Vibration Isolators	Resistoflex/ Easyflex/ Diamond/ Dunlop/ Kanwal
56	BTU Meter	Belimo / Seimens / Honeywell / Shenitech / Endress + Hauser / Adept
57	RH Sensor	Belimo/ Seimens/ Honeywell/ Omnicron
58	GI/GSS Sheets	SAIL/ TATA Steel/ Jindal/ ESSAR/ LLOYD/APLApollo

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<b>S.No</b>	<b>Equipment/Material</b>	<b>Approved Make/Manufacturer</b>
59	Aluminium Sheets	Balco/ Nalco/ Hindalco/Virgo
60	MS Sheets	Balco/ Nalco/ Hindalco/APLApollo
61	Factory Fabricated Ducts	Rolastar / Zeco / Ductofab / Technofab / GPS Spiro / Camduct/ Nutech/ Ecoduct
62	Factory Fabricated Spiral Ducts	Rolastar / Zeco / Ductofab / Technofab / GPS Spiro / Camduct/ Nutech/ Ecoduct/ Spiral Tubes/ Atco/ Seven Star/ Lloyd/ Western Duct
63	Pre-insulated Ducts	Pal/Zeco/ ALP/ Kingspan/ Spiro / UP Twiga/ Caryaire/ Atco
64	Duct Dampers/ Grills/ Diffuser/ VCD/ Collar Damper/ Louvers / Jet Nozzles etc.	Caryaire / Systemair/ Conaire/ Dynacraft/ Airflow (mapro)/ Ruskin Titus/ Trox
65	Damper Actuator	Belimo/ Siemens/ Danfoss/ Honeywell/ Scheneider
66	Fire Dampers / Smoke Dampers	Trox/ Greenheck/ Ruskin Titus/ Systemair/ Caryaire/ Conaire/ Airflow/Tri-Parulex
67	Flexible Duct Connection	Airflow/ Pyroguard/ Rolastar/ UP Twiga/ Caryaire/ Ruskin Titus/ Atco/ Nutech
68	Sound Attenuator	Trox/ Caryaire/ Ruskin Titus/ Kruger/ Nicotra/ Greenheck/ System Air
69	Resin bonded Glass Wool Insulation	UP Twiga / Owens Corning / Kimmco / K-flex
70	Closed Cell Nitrile Rubber Insulation	Armacell / Thermaflex / A-flex / Paramount, K-flex / Vedoflex / Aeroflex / Aerolam Insulation

S.No	Equipment/Material	Approved Make/Manufacturer
71	Expanded Polystyrene (TF Quality)	Beard Sell / Styrene Packings
72	Resin bonded Glass Wool Acoustic Insulation	UP Twiga / Owens Corning / Kimmco / K-flex
73	Insulation Adhesive	Pidilite/ Foster (Childers) Products/ CISBOND/ Henkel/ Master Bond/Nerolac
74	Duct Support	GPL / Gripple / Easyflex Zip-Clip / HILTI
75	PUF Saddles	Lloyds / Beardsell / Malanpur
76	V Belts /Pulleys	Dunlop / Funner
77	Anchor / Fastener	Fischer / Gripple / Rawlplug / HILTI / Kron/Power Fastener
78	Fire Sealant	BTHM Engineering/ Birla 3M/ HILTI/ Promat/ OBO/ Mccoy/Nippon Paint
79	Fire Wrap/Board/Paint	Birla 3M/ HILTI/ Promat/ Lamebar/ ICI/ Asian/ JK Maxx/Nerolac/ Berger /Neel Gagan Pigments/ Nippon Paint
80	CO / CO2 Sensor	Seimens / Omicron / Johson / Honeywell / Conaire
81	Variable Frequency Drives	Danfoss / ABB / Seimens / Fuji / L&T Yaskawa
82	Electrical Items	SAME AS ELECTRICAL WORK

### ELECTRICAL SYSTEM

S.No	Equipment/Material	Approved Make/Manufacturer
1	11 KV HT Panel with 11kV Vacuum Circuit Breaker (VCB)	L&T/ ABB / Schneider/ Siemens/ Precision <b>(Only OEM factory fabricated will be accepted. Channel Partner will not be accepted)</b>
2	Transformer (Dry Type)	ABB/ Siemens/ Voltamp/Schneider/Power Star/ Kirloskar/Crompton Greaves
3	DG Set - Assembler	Engine OEM
4	DG Set - Alternator	Stamford/ Leroy Somer/ Toyo Denki/ KEC
5	DG Set - Engine	Cummins/ Mitsubishi/ Perkins/ Volvo/Caterpillar/MTU
6	TTA Panel (Main LT Panels with accessories)	L&T/ ABB/ Schneider/ Siemens/ Legrand/C&S/HPL <b>(Only OEM factory fabricated will be accepted. Channel Partner will not be accepted)</b>
7	LT Panels (Other than main LT Panels) / Synchronizing Panel / Capacitor Panel with accessories	Same as above and Tricolite/KEPL/Advance Panel & Switchgear/ C&S(CX)/Adlec / Neptune/ SPC Electrotech/ Trisquare/ Milestone/Precision/ASES/ Global Electrical
8	Power/Auxillary Contactor / Capacitor Duty Contactor	ABB/L&T/Schneider/Siemens
9	ACB	L&T (U-Power Omega)/ Siemens (3WL) /Schneider (Nw Masterpact)/ ABB (Emax)/ Legrand/ C&S (WINMSTER-III)/HPL
10	MCBs / RCCB/Isolaters /RCBO / Change over switch/ ELCB	Legrand/ L&T/ Schneider/ABB/ Siemens/C&S/HPL
11	MCCB	L&T (D-sine)/ Siemens (3 VL)/ABB (T-max) / Schneider (NSX)/Legrand/C&S (Winbreak)/Legrand/ KCJ/HPL

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S.No	Equipment/Material	Approved Make/Manufacturer
12	MPCB	L&T/ Siemens/ ABB/ Schneider/ Legrand C&S/KCJ
13	Automatic Transfer Switch (ATS)	Socomec /ABB/ Schneider/C&S/HPL
14	Auxiliary relays compatible with PLC etc.	Siemens/ L&T/ ABB/ Areva/ Schneider/HPL
15	Batteries	Exide/ Amaron/Amaraja
16	Battery Charger	Uptron/Volstat Electronics/Statcon/AE/Kukreja
17	Brass compression Gland (Heavy duty)	Commex/ Gripwell/ Dowell/Kron
18	Bus bar	Jindal/ Hindalco/ Indal
19	DLP Trunking	MK Honeywell/ OBO Betterman/ Legrand/Norpack
20	Bus Duct , rising mains,end feed unit, tap-off box (plug-in type)	L&T/Siemens/ Schneider/ C&S/Legrand/Precision/ Global Electrical
21	Cable Lugs & Glands	Dowell/Comet/Siemens/Electromac/Braco/Kron
22	Capacitor Bank (ISI Marked)	L&T/ Siemens / Schneider/ ABB/EPCOS ( <b>Only OEM will be accepted. Channel Partner will not be accepted</b> )
23	Detuned Reactors	L&T/ Siemens / Schneider/ ABB/EPCOS
24	Compression Gland and Lugs/ thimbles	Dowell/Comet/Siemens/Electromac/Braco/Kron
25	Contactors	ABB/ L&T/ Schneider/ Siemens

S.No	Equipment/Material	Approved Make/Manufacturer
26	Control fuse base with HRC fuse / HRC Fuse	L&T/ Siemens/ ABB/ Schneider
27	Digital Energy Meters including Dual Source Energy Meters	L&T/ Socomec/ Schneider/ Secure/ Siemens/ ABB/ Neptune
28	Measuring Instruments (Digital Type)/ MFM/KWH meter	L&T/ Socomec/ Schneider/ Secure/ Siemens/ ABB/ Neptune
29	Multi-function Meter	L&T/ Socomec/ Schneider/ Secure/ Siemens/ ABB/ Neptune
30	APFC relays (Microprocessor based compatible with PC & PLC)	Siemens/ L&T/ ABB/ Schneider/HPL
31	PLC	Siemens/ L&T/ ABB/ Schneider
32	CT/ PT's	L&T/ Kappa/ Matrix/ AE / Pragati/Global Electrical
33	Compact HT Switchgear/ RMU	Siemens/ L&T/ ABB/ Schneider
34	Protective relays (Microprocessor based compatible with PC & PLC)	Siemens/ L&T/ ABB/ Areva/ Schneider/HPL
35	Digital Numerical Relays	L&T/ ABB / Siemens/ Schneider/ Areva/HPL
36	Voltmeter & Ammeter	Schneider/ Neptune/ Rishabh/ Conserve
37	HDPE Pipe	DURA-LINE / REX / CARLON/ EMTELLE/PROP/ APLApollo/Prince/SFMC
38	Overload relay single phase preventer	ABB/ L&T/ Siemens/ Schneider/HPL

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S.No	Equipment/Material	Approved Make/Manufacturer
39	Power Capacitor	L&T/ Siemens / Schneider/ ABB/EPCOS ( <b>Only OEM will be accepted. Channel Partner will not be accepted</b> )
40	Indicating Lamps & Push Buttons	Siemens/ L&T/ ABB/ Schneider/ C&S
41	Relay / Contractors/ Timers /Starters and Control Panel	Siemens/ L&T/ Schneider/ ABB/HPL
42	Selector Switch	Siemens/ L&T/ Schneider/ABB
43	Surge Diverter	ABB/ Siemens/ Emerson/ Legrand
44	Trivector - Meter (Digital type) only for SEB supply	Socomec/ L&T/ Secure/ Siemens/Schneider
45	Insulated Rubber Mat	Premier Polyfilm Ltd/ DL Miller & Co Ltd/ Commercial Enterprises/RMG Polyvinyl India Ltd.
46	Hand Gloves & Rubber Mat	Premier Polyfilm Ltd/ DL Miller & Co Ltd/ Commercial Enterprises/RMG Polyvinyl India Ltd./Kron
47	G.I./Cu. Strip & earthing material	Bharati/ Indiana/ Slotco/Kron/Global Electrical
48	DB's / Pre-wired DB's	Legrand/ L&T/ Schneider/ABB/ Siemens/Precision/C&S
49	Isolators	Siemens/ L&T/ ABB/ C&S/ Socomec/Schneider
50	Modular Switches/ Socket outlets and wiring accessories with moulded cover plate	MK Honeywell (wraparound plus) / Siemens (Delta)/Legrand (mylinc)/ L&T (Oris)/ Havells (Crabtree-Athena)/ABB (Lumina)/C&S (Primo)/KCJ (Fullon)
51	Under Floor Boxes	Legrand/Applican/OBO Betterman/ MK Honeywell

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<b>S.No</b>	<b>Equipment/Material</b>	<b>Approved Make/Manufacturer</b>
52	Industrial Socket Outlets	ABB/ L&T/ Legrand/ Siemens/ Schneider
53	Data/Telephone/TV Outlets	Legrand/Systemax/ Belden/ Simone/ MK Honeywell/ Havells
54	HT Cables (11 KV)	Gloster/ Havells/ Finolex/ KEI/Polycab/ Paramount/ DICABS/Nicco
55	LT Cables (Power & Control)	Gloster/ Havells/ Nicco/ Finolex/ KEI/Polycab/Rallison/ RR Kable/AKG/Paramount/DICABS/Nicco
56	Fire Survival Cables	KEI/ Polycab/ Havells/ Rallison/RR Kable/AKG/ Paramount/KCJ/DICABS/Nicco
57	PVC insulated FRLS Copper 1.1 KV grade flexible wires	Havells/ Polycab / Finolex/ RR Kable/ Batra Henlay/ Grandlay/AKG/ Paramount/DICABS
58	Optical Fiber Cable	Finolex/ Belden/Delton/ Skytone/Paramount
59	Coaxial Wires	Finolex/ Delton/ Skytone/ L&T/ KEI/Gloster/Paramount /KCJ
60	Cat 6 Cable	Finolex/Delton/Skytone/Beldon/Polycab/AKG/KCJ/ Paramount/Nicco
61	HT Jointing Kit & Termination Kit	Reychem/ Xicon/ 3M
62	LT Jointing Kit	Reychem/ Xicon/ Birla-3M
63	LT Termination Kits	Raychem/ Birla/ 3M
64	Gas Flooding System for Panels	Fire Trex/ Sevo System/ Safe Fire/ Tyco/Tri-Parulex



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<b>S.No</b>	<b>Equipment/Material</b>	<b>Approved Make/Manufacturer</b>
65	Internal LED Light Fixtures	Philips/ Wipro/ Lighting Technology/ KCJ/ Regent/ Trilux
66	External LED Light Fixtures	Philips/ KCJ/ Dissano/ Schreder Lighting Technology/ Trilux
67	External Lighting Poles	Bajaj Electricals/Keselec/ KCJ/ K-lite
68	Aviation Obstruction Light (LED Type)	Bajaj Electricals/Actos/ KCJ/ Binay
69	Cable Tray/ Race ways / Floor trunking / wall channels	BEC/ MK Honeywell/ OBO Bettermann/ Legrand/ Steelcraft/ MEM/AKG/Polyalloy/Global Electrical
70	MS Conduit & Accessories (ISI Approved)	BEC/ AKG/ Steelcraft
71	PVC Conduit & Accessories (ISI Approved)	BEC/ Norpack/ Polypack/
72	Ceiling /Exhaust/Wall fans	Crompton/ Usha/ Orient/ Bajaj/ KCJ/ Havells
73	Maintenance Free Earthing	OBO Betterman/Furse/Kron/ Erico/Global Electrical
74	UPS	Socomec/ Schneider/ Siemens/ABB/ Numeric/Prostarm
75	Variable Frequency Drive	L&T/ Siemens/ABB/ Schneider
76	Solar PV System	Havells Solar / MosaerBaer/ Emvee Solar/ Bhel/ Cleanmax Solar/ Solon/ Andromeda/Tata Power Solar/ Prostarm
77	Exit Signages	Legrand/MK/System Tek/Prolite/ASES/Tri-Parulex

S.No	Equipment/Material	Approved Make/Manufacturer
78	Central Battery System for Emergency Lighting	Technoware/Emangilite/Kukreja
79	G.I. Pipes (ISI Mark)	Tata/Jindal/Prakash/APLApollo/Prop Steel
80	Crimping Lugs/ Thimbles	Dowell/Comet/Siemens/Electromac/Braco/Kron

### LIGHTENING PROTECTION SYSTEM

S.No	Equipment/Material	Approved Make/Manufacturer
1	Lightening Protection System	OBO Betterman/ Furse/ Erico/Kron

**NOTE: The lightning Protection System shall be as per IS standards, IEC 62305, NBC-2016 and the material must be tested/certified as per VDE and IEC 62561.**

### FIRE ALARM SYSTEM

S.No	Equipment/Material	Approved Make/Manufacturer
1	Fire Alarm Panel	Tyco / Honeywell/ Edwards/Notifier/ASES/Henrich
2	Repeater Panel	Tyco / Honeywell/ Edwards/Notifier/ASES/Henrich
3	Graphic Software	Tyco / Honeywell/ Edwards/Notifier/ASES/Henrich
4	Multi Sensor Detectors, Beam Detectors, Smoke Detectors, Heat Detectors	Tyco / Honeywell/ Edwards/Notifier/ASES/Henrich

S.No	Equipment/Material	Approved Make/Manufacturer
6	Manual Call Point	Tyco / Honeywell/ Edwards/Notifier/ASES/Henrich
7	Monitor Module	Tyco / Honeywell/ Edwards/Notifier/ASES/Henrich
8	Control Module	Tyco / Honeywell/ Edwards/Notifier/ASES/Henrich
9	Hooter with Strobe	Tyco / Honeywell/ Edwards/Notifier/ASES/Henrich
10	Fault Isolator	Tyco / Honeywell/ Edwards/Notifier/ASES/Henrich
11	Fire Fighter Telephone Station	Tyco / Honeywell/ Edwards/Notifier/ASES/Henrich
12	Junction Boxes	Customized/ASES
13	Response Indicator	Agni / Equivalent/ASES
14	Speakers	Bosch / Ateis/JBL/Bose/ASES/Henrich/Canscorp
15	Amplifier	Bosch / JBL / Philips/ASES/Henrich/Canscorp
16	Microphone	Bosch / JBL / Philips/ASES/Henrich/Canscorp
<b>Note: All fire alarm components/ Panels shall be UL &amp; FM listed &amp; conform to NFPA standards.</b>		

### CCTV SYSTEM

S.No	Equipment/Material	Approved Make/Manufacturer
1	LCD Monitor	Sony/ Panasonic/ LG / Samsung

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S.No	Equipment/Material	Approved Make/Manufacturer
2	Cameras with weather proof housing	Johnson Controls / Axis / Pelco / Impulse/Honeywell/ BOSCH/Henrich
3	VMS / NVR & Recording System	Johnson Controls /Axis/Pelco /Impulse/Honeywell/ BOSCH/Henrich
4	GI Poles	ISI Mark
8	Switches	Cisco/ Juniper/ Extreme
9	Junction Boxes	Customized
10	Server Rack	Valrack / D-link / Molex
11	Power Distribution Panel	Customized

**Note: All cameras shall be UL listed.****LIFTS**

S.No	Equipment/Material	Approved Make/Manufacturer
1	Lifts	Mitsubishi/ OTIS/ Kone / Schindler/Hi Look
2	Stack Car Parking System	RR PARKON/ PARI/ WOHR

**ACCESS CONTROL SYSTEM**

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S.No	Equipment/Material	Approved Make/Manufacturer
1	Access Controller	Johnson Controls / Axis / Lenal
2	Access Software	Johnson Controls / Tyco/Axis / Lenal
3	Card Readers	HID/Johnson Control/ Axis
4	Electromagnetic Locks	CISA / Faraday / Algatec / Bell
5	Magnetic Contact	Assay Abloy / SDC / GE / System Sensor
6	Emergency Glass Break	Assay Abloy / SDC / GE
7	Panic Push Button	Assay Abloy / SDC / Securitron / Rosslare
<b>Note: All access controllers shall be UL listed.</b>		

**EPABX & TELEPHONE SYSTEMS**

S.No	Equipment/Material	Approved Make/Manufacturer
1	Data/ Telephone cable (2/4 /10 / 20/ 50/ 100 PAIR CABLES)	DELTON/ FINOLEX/ Polycab/Legrand/Nicco
2	EPABX,VOICE MAIL, IP TELEPHONE	UNIFY/CISCO/Tadiran/ Alcatel/Henrich
3	ANALOG TELEPHONES	AVAYA/PANASONIC/BITTEL/CISCO/ EUROSET/ UNIFY/Tadiran/Henrich
4	IPABX Server and Gateways	UNIFY/CISCO/Tadiran/ Alcatel/Henrich

S.No	Equipment/Material	Approved Make/Manufacturer
5	MDF/IDF	KRONE,LEGRAND,DLINK
6	Telephone tag block/Jack Panel/ Face Plate	Krone/ Phoenix/ Wago/ Beldon/ Panduit/ Huwaei/ Legrand/Amp/Henrich
7	VOICE BOX – RJII	KRONE/ TVS/ FINOLEX
8	Ethernet Switch	CISCO/ Juniper/HP
9	Conference Systems	Bosch/Televic/Ahujasons/Brahler/Canscorp

#### DATA NETWORKING & WIFI

S.No	Equipment/Material	Approved Make/Manufacturer
1	Active Components	CISCO/ Juniper/Extreme
2	Ethernet Switch / Indoor & Out WIFI device/ Transreceivers	CISCO/ Juniper/Extreme
3	Routers	CISCO/ Juniper/Extreme
4	Server	IBM / Dell/ HP/CISCO/Henrich
5	Firewall	CISCO/ Juniper/Extreme
6	Passive Components – Cat 6/Cat 6A/ Patch panel/ Patch Cord/ Information outlets/ Optical fiber Cable/ Fiber patch cord/ pigtails/ LIU/ Adapters/ Connectors/ Mounting Rack & Asscoiated Items	LEGRAND/ SYSTIMAX/ BELDEN/ AMP/ SIEMON/ R&M

S.No	Equipment/Material	Approved Make/Manufacturer
7	DESKTOP PC	DELL/ IBM/ HP

### PARKING MANAGEMENT SYSTEM

S.No	Equipment/Material	Approved Make/Manufacturer
1	Electromechanical Boom Barrier	Somfy/Magnetic/Kaba/FAAC/Gunnebo
2	Photocell for Safety	O&O/Magnetic/Kaba
3	Loop Detector for Auto Closing	Somfy/Magnetic/Kaba
4	RFID Reader	Kaba/ Somfy/Magnetic
5	RFID Tags	Magnetic/ Somfy/ Kaba
6	Vehchile Access Controller	Somfy/Magnetic/Kaba
7	LPR Camera	SACS/Dahua/Hikvision/BOSCH
8	GI Poles	ISI Mark
9	Automatic Ticket Dispensor	Somfy/Magnetic/Kaba
10	Manned Payment System	DELL/Somfy/HP
11	Display at Entry Gate Of Building	Custom
12	Parking Management Software License & Server	Somfy/Magnetic/Kaba

S.No	Equipment/Material	Approved Make/Manufacturer
13	Server Computer System for PMS & PIDS with OS & Database	DELL/ IBM/ HP
14	Managed Ethernet Switches	Cisco/ HP / Juniper
15	UPS	Socomec/ Schneider/ Siemens/ Prostarm

### SECURITY SYSTEM

S.No	Equipment/Material	Approved Make/Manufacturer
1	X Ray Baggage Scanners	ECIL-RAPISCAN / GARRETT / KRYSTALVISION / SMITH / BEL
2	Door Frame Metal Detector (DFMD)	ECIL-RAPISCAN / GARRETT / ELEKTRAL / METEOR / CEIA
3	Hand Held Metal Detector	ECIL-RAPISCAN / GARRETT / ELEKTRAL / FISHAER / CEIA

### BUILDING MANAGEMENT SYSTEM

S.No	Equipment/Material	Approved Make/Manufacturer
1	Complete Building Management System Solution (Integrators)	Johnson Control (Metasys), Honeywell (Building Manager), Trane (Tracer Evo), Siemens (Desigo), Schneider (Struxureware)/AZBIL
2	CENTRAL CONTROL STATION	DELL/ IBM/ HP
3	ACMV Controls	Siemens/ Johnson Cnotrols / Honeywell (Comfort Point)



S.No	Equipment/Material	Approved Make/Manufacturer
4	BUILDING MANAGEMENT SYSTEM WEB-BASED SERVER SOFTWARE (With Unlimited User License)	Johnson Controls Metasys/Trane Treacer Ensemble / Honeywell (Comfort Point)/AZBIL
5	ENERGY MANAGEMENT SOFTWARE (With Unlimited User License)	Johnson Controls Metasys/Trane Treacer Ensemble / Honeywell (Comfort Point) /AZBIL
6	PROGRAMMABLE & APPLICATION SPECIFIC CONTROLLER (DDC)	Johnson Controls/Siemens PX Series/ Honeywell (Comfort Point)/ Trane (Tracer Evo) /AZBIL
7	WEB SERVER ENGINES (NETWORK / SUPERVISORY CONTROLLERS)	Johnson Controls/Siemens/ Honeywell (Comfort Point)/ Trane (Tracer SC) /AZBIL
8	Immersion type temperature sensors	Siemens/ Honeywell/ Johnson Controls/ Greystone/ Trane/AZBIL
9	Differential Pressure Switch - Water	Johnson Controls/ Honeywell / Greystone/AZBIL
10	Differential Pressure Switch - Air	Trane/ Johnson Controls/ Honeywell / Greystone /AZBIL
11	Duct mount temperature & RH sensor	Siemens/ Honeywell/ Trane/ Johnson Controls /AZBIL
12	Duct Humidity sensor	Johnson Controls/ Siemens/ Honeywell/AZBIL
13	Room Humidity sensor	Johnson Controls/ Siemens/ Honeywell/AZBIL
14	Damper Actuator	Honeywell/ Carrier/ Johnson Controls/AZBIL

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<b>S.No</b>	<b>Equipment/Material</b>	<b>Approved Make/Manufacturer</b>
15	CO Sensor	Honeywell/ Greystone/ GE/ Johnson Controls/AZBIL
16	CO2 Sensor	Trane/ Johnson Controls/ Honeywell / Greystone/ AZBIL
17	Current Relay	Johnson Controls/ Honeywell/ Kele/AZBIL/HPL
18	Water level Switch	Kele/ Sontay/ Johnson Controls/ Filpro/ Vekeselar
19	Water Pressure Sensor/Transmitter	Johnson Controls/ Siemens/ Honeywell/AZBIL
20	Duct Static Pressure Sensor	Trane/ Johnson Controls/ Siemens/ Honeywell/
21	Water Flow Switch	Honeywell/ Siemens/ Carrier
22	Flow Meters	Landis &Gyr / Kele / Sontay / Forbes Marshal
23	Ultrasonic BTU Meters	Kamstrup / Sontay / Landis &Gyr
24	PH / Hardness Analyser	HACH/ ABB/ Kele/ Triton
25	3 Way motorized Valves	Johnson Controls/ Landis &Gyr / Belimo/Prop
26	Flameproof Level Switch	Kele/ Vekeselor/ Filpro
27	Outside Air Temperature Sensor	Honeywell/ Siemens/ Johnson Controls/Trane/AZBIL
28	Voltage / Current / Power Factor Transducer	L&T / ABB / Honeywell / Johnson Controls/AZBIL
29	Room Temperatuer Sensor	Johnson Controls/ Honeywell / Sontay

S.No	Equipment/Material	Approved Make/Manufacturer
30	Communication Cables / Signal Cable/ Control Cable	As per Electrical Makes
31	MS/PVC conduits	As per Electrical Makes
32	CAT 6 cable	As per Electrical Makes

**INTEGRATED PASSENGER DISPLAY AND ANNOUNCEMENT SYSTEM**

S.No	Equipment/Material	Approved Make/Manufacturer
1	Displays	As per RDSO list of approved makes
2	Software	As per RDSO list of approved makes
3	Announcement System	As per RDSO list of approved makes

**MISCELLANEOUS**

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<b>S.No</b>	<b>Equipment/Material</b>	<b>Approved Make/Manufacturer</b>
1	Waste Compacter bins	Universal e cube/ Big Belly Solar/ Schonbach
2	Automation System for Window	UCS/ Window Master/ Essmann/ Rivalu/ Securistyle
3	Boom Barriers	Came/ Nice/ Beninca
4	Water Mist Fire Protection System	Fogtech/Tri-Parulex
5	Nitrogen Injection Fire Protection System	CTR/Tri-Parulex

**LANDSCAPE WORK**

<b>S.No</b>	<b>Equipment/Material</b>	<b>Approved Make/Manufacturer</b>
1	Water Body Vendors	Ripple Engineering/ Premium Pools/ Watcon Water Specialist
2	Irrigation Products	StitchwellQualitex/ Irrigation Products International/ Jain Irrigation SYstems