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CHAPTER-1 CIVIL WORKS

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1.0 DESCRIPTIONS OF CIVIL WORKS

The civil works shall comprise of Site levelling & Grading (Cutting & Filling including associated earth retaining structures), Construction of Manufacturing Block, Testing Bay other Utility & service buildings/Infrastructure, Roads, Drains, sewerage network, Service trenches, Common driveways, Landscaping & Horticulture and other associated works etc., including all finishing works, as per technological scheme.

1.1 CIVIL DESIGN CRITERIA

The structures will be designed conforming to latest relevant Bureau of Indian standard codes of practices and safety regulations. The rules and regulations stipulated in Factory Act; Electricity Act and all other applicable statutory regulations shall be followed. In absence of suitable Bureau of Indian Standard codes and specifications, other relevant international standards and codes shall be used.

In general, design of RCC structure shall be in accordance with provisions contained in IS: 456 while design of steel structure shall go in accordance with IS:800. IS 3370 shall be applicable for water retaining structures. All structures will be designed for the most critical combinations of dead loads, imposed loads, equipment loads, crane loads, piping loads, wind loads, seismic loads and any other loading conditions which can occur during the design life of the structure.

1.2 LOADS & LOAD COMBINATIONS

The following basic load cases will be considered for the civil design:

- a. Dead load
- b. Imposed load
- c. Earth pressure
- d. Wind load
- e. Seismic load
- f. Equipment load
- g. Crane/ monorail load
- h. Hydro static pressure
- i. Temperature load
- j. Surcharge load
- k. Other loads
- l. Load combinations

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a) Dead Loads

Dead loads Consist of the weights of the complete structure with finishes, fixtures, partitions, wall Panels and all equipment, tanks, roofing, piping, cable trays etc. Loads given in IS: 875 (part-1) will be considered for computation of dead loads.

b) Imposed Loads

Imposed Loads in different areas will include live loads, minor equipment loads, erection loads, operational / maintenance loads, etc. The loads considered will not be less than that specified in IS: 875 (Part II). The loads list here under are the minimum loads for the areas involved. Floors and supporting members which may be subjected to heavy equipment loads will be designed on the basis of weight of equipment.

The specific minimum floor live loads are listed below:

Building roofs:

1) Flat Roof:

- i. 1.5 kN/m² for accessible roofs
- ii. 0.75 kN/m² for non-accessible roofs

2) Electrical Building:

- i. Control room: 10 kN/m²
- ii. MCC Room: 15 kN/m²
- iii. Switchgear room: 15 kN/m²

3) Manufacturing & Testing Block/Bay

- i. Ground Floor: - 30 KN/m²
- ii. First Floor: - 20 KN/m²

4) Other Areas:

- i. RCC Floors: 5 kN/m² for offices, laboratories, conference rooms and general floors
- ii. Stairs and balconies: 5 kN/m²
- iii. Chequered plate/gratings: 5 kN/m²
- iv. Walkways: 3 kN/m²
- v. Toilet rooms: 2 kN/m²

Live load reduction will be in accordance with the provisions of IS: 875 and IS: 1893.

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a. Earth Pressure

Earth pressure for all underground structures will be calculated using 0.5 as coefficients of earth Pressure at rest. For retaining wall design, the active earth pressure coefficient will be 0.3. For design of Substructure of pump houses and underground liquid storage tanks earth pressure at rest will be used. For other structures Coefficient of active or passive earth pressure will be used as applicable. Surcharge load will be considered for the design of all underground structures including channels, sumps, cable and pipe trenches, etc. to take into account the vehicular traffic in the vicinity of the structure.

b. Wind Load

Wind load on structures will be calculated as per provisions of IS: 875 (part 3). Structures will be designed for Basic wind speed (V_b) of 47 m/sec. The return period of 50 years to be considered. The wind will be assumed to blow in any direction and most unfavorable condition will be considered for design. Terrain Category 1 shall be considered.

c. Seismic load

Seismic load shall be considered as per zone-II of latest IS Code, i.e., IS:1893-Part 4. The importance factor of relevant Industrial Buildings and structures shall be considered as per the above code unless specifically mentioned.

d. Equipment Load

Static and dynamic loads of major equipment will be based on the manufacturer's data of the specified equipment and will be considered in design in addition to the live load. However, where the uniform floor live load adequately accounts for the equipment moving weight, the weight of such equipment as a dead load is not to be considered e.g., switchgear and control room floors are usually designed for a live load that includes the equipment weight.

Foundations and fixing arrangements for Equipment which generates vibration, shall be designed to prevent transfer of such vibrations to the adjoining structures.

e. Crane and Monorail load

Crane girders and supporting columns will be designed for vertical and horizontal forces (including impact forces) as per crane vendor's data. All crane loads and monorail loads will have their design loads increased by impact factor as given in IS:875.

f. Hydrostatic pressure

Design and Construction of liquid storage structures shall comply with the requirements of IS 3370 (Part-1): 2009. All structures required to retain liquids shall be Designed for both the Full

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and Empty conditions, and the assumptions regarding the arrangements of loading shall be such as to cause the most critical effects.

g. Temperature Load

Expansion joints will be provided at every 45 m for concrete buildings/ structures as per IS: 456 which take care of the temperature loads. Where expansion joint is not possible to provide, the building will be designed for temperature loads.

h. Surcharge Load

All underground structures will be designed for a surcharge load of 2 t/sqm. Earth pressure at rest shall be considered in the design of underground structures while calculating lateral earth pressure.

i. Other Loads

Stresses imparted to structures due to differential settlements, Variation of water table, erection and maintenance loads, creep and shrinkage shall also be considered in design of all structures.

j. Load Combinations

The individual members of the frame will be designed for the worst combination of forces. Permissible stresses for different load combinations will be taken as per IS: 875 (Part-V) and other relevant IS codes. Wind and seismic forces will not be considered to act simultaneously. Load factors will be based on the factors given in the relevant codes of practice. Crane / monorail load will not be considered during seismic condition.

The structure/building shall be designed for various combination of loads to ensure safety and economy in the design. Combination of loads shall be as per IS:875 (Part-5)-1987 and IS:1983(Part-4)-2016. For Limit state of Collapse and Limit state of serviceability load combinations shall be as per IS: 456-2000. Crane load combination shall be as per IS:875(Part-2)-1987.

1.3 DESIGN METHODOLOGY FOR RCC STRUCTURES

1. General

All designs of RCC structures will be carried out by limit state method as per IS: 456 except for water retaining structures, which will be carried out by working stress method as per IS: 3370.

Design strength of materials and design loads will be calculated using appropriate partial safety factors over characteristic strength and characteristic loads as per relevant IS Codes. Reinforcement detailing will be as per IS: 5525 and SP: 34.

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2. Foundations

The attached soil investigation report which was carried out for the preparation of DPR may be referred to preliminary design which is for bidding purpose only. During the detail design engineering the EPC contractor has to do the new soil investigation report which is of Moderately weathered (Grade III) to slightly weathered (Grade II) fine- to medium-grained quartzite (Layer-IA) is encountered from the existing ground surface. Therefore, shallow foundations may be adopted at depths of 0.6 m to 1.0 m within Layer-IA to safely support the superstructure loads.

Field data and laboratory test results from all borehole locations indicate that the strength of the rock underlying the proposed foundation level is very high and well above typical design requirements. Accordingly, a safe bearing pressure of 40 t/m² may be considered for footings of various sizes placed at depths of 0.6 m to 1.0 m below the existing ground level.

As no groundwater table was encountered in the explored boreholes, foundations resting on the rocky stratum are less susceptible to chemical attack. Chemical analysis of a water sample collected from approximately 90 m depth from a nearby submersible pump indicates that the water is non-aggressive. Hence, no special cement or concrete treatment is required.

3. Liquid Retaining Structures

RCC water retaining structures will be designed as un-cracked section in accordance with IS: 3370 (Part I to IV) by working stress method.

Substructure of pump houses, water channels etc. will be designed as cracked section in accordance with as per IS: 3370 (Part I to IV) by working stress method.

All water retaining / storage structures will be designed assuming liquid up to the height of wall irrespective of provision of any over flow arrangement.

4. Machine Foundations

The design of machine/equipment foundation will be as per IS 456 and IS 2974. All machine/equipment foundations and structures subject to vibrations will be suitably proportioned so that amplitude and frequency of the foundation /structures are within permissible limits. Dynamic analysis will be carried out to calculate natural frequencies in all modes including coupled modes and to calculate vibration amplitudes. Frequency and amplitude criteria as laid down by the relevant codes or machine manufacturers will be satisfied. Minimum reinforcement will be governed by IS: 2974 and IS:456.

If equipment is to be supported on building structures, floors, etc. suitable vibration isolation will be provided by means of springs, isolation pads, etc. and such vibration isolation system

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will be designed suitably. Pumps will be supported on conventional framed / block type RC foundations.

All such foundations will be separated from adjoining parts of building and other foundations. Joints at floor / slab will be suitably sealed.

5. Increase in Stresses

Where stresses due to wind (or seismic) are combined with those due to other loads, the allowable stresses in concrete and reinforcement steel will be increased as per IS code provisions. Bearing capacity of the soil will be increased by 25% under seismic or wind load condition.

6. Stability of Structures

Design will be checked against buoyancy due to the ground water during construction and maintenance stages for structures like underground storage tanks, pits, trenches etc. Minimum factor of safety of 1.2 against buoyancy will be ensured considering empty condition inside and ignoring superimposed loading. For purpose of calculating downward load due to any over burden, only the mass located vertically above the projected area of the base slab will be taken into consideration.

All building sub-structures will be checked for sliding and overturning stability during both construction and operating conditions for various combination of loads, Factor of safety for these cases will be taken as mentioned in IS: 456 and other latest relevant IS codes. However, following minimum factor of safety will be followed:

- a) Factor of safety against overturning due to wind, seismic or another lateral load will be 1.4 minimum
- b) Factor of safety against sliding will be 1.4 minimum.
- c) Factor of safety against uplift due to hydrostatic forces will be 1.2 and due to any other loads will be 1.5.

Stability of the structure will also be investigated for loading conditions during construction, repair or other temporary measures. Lower factor of safety will be used for such loading conditions as per relevant IS codes. In cases where dead load provides the restoring force, only 0.90 times characteristic dead load will be considered. Imposed loads will not be considered as restoring force.

7. Fire

A Structure or Structural element required to have fire resistance should be designed to possess an appropriate degree of resistance to flame penetrations, Heat transmission and failure. Minimum requirements of concrete cover and member dimensions for

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normal-weight aggregate concrete members have to ensure a fire resistance of 2.0 hours as per IS 456-2000. The General requirements for Fire resistance of a Structures shall be as per provisions given in IS:1642-2013.

8. Durability

The buildings/structures are situated in Bhopal, Madhya Pradesh. The region, experiences a moderate climate with relatively less exposure to severe environmental conditions compared to coastal areas, the environmental exposure condition for the RCC can be considered as "Moderate" (as per Cl. 8.2.2, IS: 456-2000). According to Table 5 of IS: 456:2000, the minimum grade of concrete in such conditions is M20, with a minimum cement content of 300 kg/m³ and a maximum water-cement ratio of 0.50. However, the grade of concrete adopted is M25 grade. Adequate concrete cover to reinforcement shall be provided as per the requirements in Table 16 of IS 456:2000, ensuring proper compaction and workmanship throughout the construction process.

1.4 CONCRETE MIX

The cement used for below ground structures (including foundations) and above ground structures in contact with deleterious material, will be Portland Slag cement conforming to IS:455. For above ground structures not in contact with deleterious material, the cement will be Portland Pozzolana Cement conforming to IS 1489: Part 1: 2015.

The proportion for nominal mix of concrete will be as per Table 9 of IS: 456:2000. Nominal mix in concrete will be allowed for grades up to M 15 only and all other grades of concrete will be with Design Mix concrete in accordance to IS 456:2000 and SP 23.

The concrete grade used for different structures will be as follows:

M- 5	Fill concrete
M- 7.5	Levelling course below foundations, trenches and underground structures
M- 10	Foundation below concrete block wall, RR masonry walls
M-20	<ul style="list-style-type: none"> Base plate encasement, encasement of structural steel work, block area paving, screed concrete, non-structural Flooring etc. Pavement around buildings including plinth protection work, damp proof course below concrete block work etc.
M-25	Reinforced concrete work for foundations, framed structure, slab Structural flooring etc. (Except Equipment foundations, Water retaining structure, etc.)
M-30	Reinforced concrete work for Equipment foundations, Water retaining structure, Roads, etc.

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Minimum cement content, maximum water cement ratio and minimum grade of concrete will be considered as per IS: 456.

1.5 CEMENT

a. PPC:

Cement used shall be Portland pozzolana Cement confirming to 1489 (Part) - 1991 (Latest revision). The total fly ash content shall be minimum 30% by weight of cement. If 30% is not achieved from PPC cement, additional Fly ash conforming to grade I of IS 3812 (Part-1) only to be used. This is to meet "GRIHA-Green Building" requirement. Cement shall be fresh when delivered. The Contractor shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer.

b. OPC:

Ordinary Portland Cement (OPC) 53 Grade, adhering to IS 269:2015, may designated for shoring and water-retaining structures due to its high strength (minimum 53 MPa at 28 days, 27 MPa at 3 days) and durability. It must meet IS standards for setting times, fineness, and soundness to ensure dense, impermeable concrete. Chemical properties should comply with limits to prevent corrosion, sulphate attack, and alkali-aggregate reaction. A water-cement ratio not exceeding 0.45 and appropriate cement content as per IS 456:2000 & IS 10262:2019 are required to minimize permeability, thermal cracking, and shrinkage in such structures.

Note: To the extent possible use of PPC cement to be preferred without compromising the project timeline. For reasons unavoidable, Use of OPC cement can be permitted for structural concrete with the approval of BEML authorities.

1.6 REINFORCEMENT

Reinforcing bars for concrete will be "TMT bars with strength requirements conforming to IS: 1786-1985" of Grade Fe 500D.

1.7 AGGREGATE

These shall conform to IS: 383 Specification for Coarse and Fine Aggregates from Natural Resources including M-sand. Unless specified otherwise, 20mm nominal size graded aggregate will be used for all structural concrete works.

1.8 GROUTING

Crushing strength of the grout will generally be one grade higher than the base concrete. Minimum grade of grout will be M 30. Nominal thickness of grouting will be at least 50mm for columns and pedestals of major equipment. For secondary posts, stair and ladder base, etc. grouting will not be less than 25mm thick.

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For machine foundations the grout will be ready mix flow able, non-shrinkable grout.

1.9 Waterproofing treatment

All the buildings RCC roof structure shall receive polyurethane (PU) waterproofing treatment as per manufacturer's specification. Integral waterproofing compound as per manufacturer's specification shall be used in the screed concrete. Crazy ceramic tile flooring over screed concrete shall be laid.

1. Polyurethane (PU) waterproofing

Polyurethane (PU) waterproofing is a high-quality liquid-applied seamless membrane ideal for exposed roofs, balconies, and water-retaining structures. It features over 80% solid content, a tensile strength of 1.5–3.0 N/mm², and an elongation exceeding 400%. The substrate must be cured for at least 28 days with moisture below 5%, cleaned, and repaired before application. An epoxy/PU primer is applied first, followed by two coats of PU membrane at a total consumption of 1.4–1.5 kg/m², achieving a thickness of 1.2–1.5 mm. Reinforcement is added at critical areas, and a UV-resistant top coat is used for exposed applications. Proper curing and traffic conditions must be observed, with all materials adhering to manufacturer specifications and QA/QC procedures.

2. Integral waterproofing

Integral waterproofing compounds for screed concrete must be ISI marked and conform to IS 2645:2003, containing chloride-free and sulphate-free additives to reduce permeability and prevent corrosion. The admixture should be added according to the manufacturer's guidelines, typically 100–200 ml per 50 kg of cement, not exceeding 3% by weight. It is essential to mix the liquid admixture with gauging water before combining it with cement, sand, and aggregates, ensuring mechanical mixing for 2–3 minutes. The substrate must be cleaned and in a Saturated Surface Dry (SSD) condition before applying a cement slurry bonding coat mixed with the waterproofing compound. The screed, composed of a 1:4 or 1:5 cement-sand mortar, should be 15 mm to 25 mm thick, sloped towards drainage to prevent water stagnation. It should also be compacted, levelled, and cured for 7–10 days to ensure durability and impermeability.

1.10 Foundation bolts and insert plates

Anchor bolts will be designed for working stress, in tension and shear and for required embedded length in concrete. Shear and crushing strength of concrete will also be checked. Increase in allowable stress for loading including seismic and wind loads will not be permitted in design of anchor bolts.

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Insert plates will be designed/checked for shear and bending moment. All lugs will be checked for tension. Bond strength of concrete will also be checked. Lugs using steel bars will preferably be fillet welded to the plate to transfer full strength of the lug.

Steel templates will be used for fixing bolts in position in all types of foundations. Foundation bolts and pockets will be pre-fabricated before placing them in position.

Tolerance for formed and concrete dimension will be as per IS: 456:2000.

1.11 PCC PAVING

PCC paving of grade M20, 100mm thick laid over 150mm thick compacted soling/Hard core/sand or murrum filling will be provided around all building as plinth protection to a width of 1000 mm.

The construction involves laying PCC pavements with 100 mm thick M20 concrete over a 150 mm sub-base of approved hard-core, sand, or murrum, following IS standards. The site must be cleared, excavated, and compacted in layers for proper density. Formwork should ensure alignment with a slope for drainage. M20 concrete will be and laid uniformly, compacted with vibrators, and finished smoothly. Dummy grooves at intervals of 1.5 m to 2.0 m will control cracking, and joints will be maintained at wall interfaces. Curing will last 7 to 14 days to ensure strength, with quality control including checks for compressive strength and thickness compliance as per IS 456.

1.12 ROADS AND DRAINS.

The road shall be designed as per IRC/MORTH recommendations and as per the CBR specified in the soil investigation report.

7.0 M wide Internal roads and approach roads (with & without median) & 4.0M wide peripheral roads are with 1.0m wide berm on either side are considered.

RCC storm water drains are considered; minimum width of the drain shall be good enough for manual cleaning of drain.

Plant roads are to be invariably designed and constructed as rigid pavement with suitable expansion joints, camber and slope.

Street lights of referred specifications are to be provided along the road to maintain proper illumination. In addition, high mast / flood lights are to be placed at road junctions, roundabouts and strategic locations as per requirements for proper illumination. Street light poles can be planned either along-side of the road or along the median of the road

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1.13 RCC Trench

RCC covered trench of adequate width and depth is required to be constructed for routing of power cables, control cables, instrument cables, communication cables and various pipes (Gas, water, treated waste water etc.)

Proper slope & drainage provisions are to be made in design and construction of these trenches to avoid water accumulation inside the trench.

Trenches are to be covered with pre-cast RCC covers or MS-fabricated covers with proper lifting arrangements.

1.14 Sewerage Network

Sewerage network shall consist of house manholes, Sewer line connecting house manhole to main manholes and finally main sewer line terminating at STP intake chamber.

The sewerage network shall be designed to ensure self-cleansing velocity in the sewer.

Heavy duty GRP manhole covers shall be provided. Wherever, depth of man hole is more (more than normal man height) Plastic encapsulated steel rung/FRP/GRP steps shall be provided. The distance between two consecutives manholes should not be greater than 30 meters

1.15 Codes and Standards

The following Indian Codes and Standards shall be generally used for design of civil and structural works. In all cases, the latest revisions with amendments, if any, shall be followed. For work not covered by Indian standards, other International Standards, as applicable shall be followed. In case where either Indian or International standards, are not applicable, good engineering practice, as approved by the Owner shall be followed.

LIST OF IS CODES & STANDARDS

a) Concrete	
IS 456: 2000 (Reaffirmed 2021)	Plain and Reinforced Concrete - Code of Practice.
IS 3370 (Part 1): 2021	Code of Practice for Concrete Structures for the Storage of Liquids – General Requirements.
IS 3370 (Part 2): 2021	Code of Practice for Concrete Structures for the Storage of Liquids – Reinforced Concrete structures.
IS 3370 (Part 4): 2021	Code of Practice for Concrete Structures for the Storage of Liquids – Design Tables.

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IS:875 (Part 1) – 1987 (Reaffirmed 2018)	Code of Practice for Design Loads (Other than EQ) for Buildings and Structures – Dead Loads.
IS:875 (Part 2) – 1987	Code of Practice for Design Loads (Other than EQ) for Buildings and Structures – Imposed Loads.
IS:875 (Part 3) – 2015 (Reaffirmed 2020)	Code of Practice for Design Loads (Other than EQ) for Buildings and Structures –Wind Loads.
IS:1893 (Part 1) – 2025	Criteria for Earthquake Resistant Design of Structures – General Provisions and Buildings.
IS:1893 (Part 2) – 2014 (Reaffirmed 2019)	Criteria for Earthquake Resistant Design of Structures – Liquid retaining Tanks.
IS :4326 – 2013 (Reaffirmed 2018)	Code of Practice for Earthquake Resistant Design and Construction of Buildings.
IS : 13920 : 2016 (Reaffirmed 2021)	Ductile Detailing of Reinforced Concrete Structures subjected to Seismic Forces – Code of Practice.
b) Standard Publications & Hand books	
SP : 22 - 1982	Explanatory Handbook on Codes for Earthquake Engineering.
SP : 24 - 1983	Explanatory Handbook on IS 456 – 1978.
SP : 16 - 1983	Design Aids for Reinforced Concrete to IS 456 – 1978.
SP : 34 - 1987	Hand book on Concrete Reinforcement and Detailing.
SP : 6 (Part 1 to 7)-1964	Hand book for Structural Engineers.
SP : 7	National Building Code of India.
c) Foundations	
IS : 1080 – 1985 (Reaffirmed 2021)	Code of Practice for Design and Construction of Shallow Foundations in Soils (Other than Raft, Ring and Shell).
IS : 2974- 1982 (Part 1) (Reaffirmed 2018) IS : 2974- 1982 (Part 2) (Reaffirmed 2018) IS : 2974- 1982 (Part 3) (Reaffirmed 2020) IS : 2974- 1982 (Part 4) (Reaffirmed 2020) IS : 2974- 1982 (Part 5) (Reaffirmed 2018)	Code of Practice for Design and Construction of Machine Foundations.
IS : 6403 – 1981 (Reaffirmed 2021)	Code of Practice for Determination of Bearing Capacity of Shallow Foundations.
IS : 11089 – 1984 (Reaffirmed 2021)	Code of Practice for Design and Construction of Ring Foundation.

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CHAPTER-2 STRUCTURAL STEEL WORKS

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2.0 General Description

Steel structures will be designed to meet the technological requirements along with the functional, strength and serviceability requirements for all the units considered for design.

The sheeting for roof shall be double skin sandwich panel and side cladding shall be of color coated galvalume sheets

Adequate louvers and translucent sheeting will be provided in the building as per the technological and functional requirement.

The thickness of structural elements will not be less than 8mm (except for webs of rolled sections and the gutter). An allowance for corrosion is kept for structures exposed to outside atmosphere. In case of load bearing welds, the thickness of fillet welds shall be as per codal provision or as mutually agreed as per the design requirement.

All staircases will have a minimum width of 800 mm formed from chequered plates or open grid panels. The slope of staircases will be preferably within 36 to 40 degrees. Handrails of platforms will be of circular tubes. The top rail will be 1.1 m above platforms level. The top rail, knee rail & the posts will be circular tubes and toe guards will be of steel plates or 4mm thick (i.e.: skelp plate).

2.1 Design Basis

The design of all the structural members shall be as per the stipulations set out herein, with due consideration given to all local and state regulations governing such as works including stipulations of Indian standards and codes of practice.

The method of design shall be based on limit state concept. The structure shall be designed to safely withstand all loads liable to act on it. It shall also satisfy serviceability requirements such as limitations on deflection.

All relevant limit states shall be considered in design to ensure adequate degree of safety & serviceability. In general, the structure shall be designed on the basis of most critical limit state and shall be checked for other limit states.

2.2 Design Life

The intended Design life of all the Structures including foundations considered shall be: 50 years.

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2.3 Design Approach

The fundamental principle of controlling the Design and Construction of the buildings shall be to ensure that functional performance is maintained at all times throughout the entire design life of the structure.

It is recognized that for the following scenario's the 'functional performance criterion' is not the main design criterion:

Severe earthquakes, for which the non-collapse criterion in the event of the Maximum Considered Earthquake (MCE) is adopted;

Temperature loads, for the change of axial elongation & the effect of the temperature is considered in the load combinations.

This shall be achieved through a combination of using the best quality control standards for materials and workmanship during Construction and adequate detailing during design.

2.3.1 Seismic Design

The seismic design of the buildings shall be as per general provisions given in the IS: 1893-2016. The design approach adopted in this code is to ensure that structures possess at least a minimum strength to withstand minor earthquakes without damage; to resist moderate earthquakes without significant structural damage though some non-structural damage may occur; an aims structures withstand a major earthquake without collapse.

2.3.2 Wind Design

The Effect of Wind on the structure as a whole shall be determined by the combined action of external and internal pressures and friction acting upon it. The design of the Buildings, Structures and their Components related to wind loads, shall be as per provisions given in the IS: 875 (Part-3) - 2015.

The following are the parameters considered for wind intensity calculation:

K1 = Risk Coefficient for All general buildings & Structures as per Table-1

K2 = Terrain factor with respect to height of building as per Table-2

K3 = Topography Factor as per Cl 6.3.3.1

K4 = Importance Factor for Cyclonic Region as per Cl 6.3.4

Kd = Wind directionality Factor for Cyclone affected Area as per Cl 7.2.1

Ka = Area Averaging Factor as per Table-4

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K_c = Combination Factor as per Cl 7.3.3.13

Design Wind Speed (V_z) = $K_1 * K_2 * K_3 * K_4 * \text{Basic Wind Speed}$

$P_z = 0.6 V_z^2$

Design Wind Pressure (P_d) = $K_d * K_a * K_c * P_z$

External Pressure as per clause 7.3.3. (Table 5 & 6)

Internal Pressure as per clause 7.3.2

Dynamic Effects of Wind

The importance of the Wind induced Oscillations or Excitations along wind and across wind direction shall be investigated in the flexible slender steel structures or steel members. Therefore, the following guidelines shall be adopted to examine the problem of the induced oscillations in such type of structures.

Buildings and closed structures with a height to minimum lateral dimension ratio of more than about 5.0 and buildings closed structures whose natural frequency in the first mode is less than 1.0Hz.

Buildings or Structures which satisfy either of the above two criteria should be examined for dynamics effects of wind.

Increase in Allowable Bearing Pressure when Wind forces are included, the allowable Bearing pressure in soil shall be increased as per Indian Standard.

2.4 Design for loads during construction

The structures shall not be specifically designed for loads during construction, such as crane loads and storage of masonry on building floors. It is the responsibility of the contractor to ensure that the structure shall not be overloaded during construction, for example by using temporary supports.

2.5 Design for Crane/Monorail Loads

Crane/Monorail load shall be considered for the structures as per the technological requirement. No horizontal surge will be considered for monorails. In load combinations, Monorail load shall be considered as Live load. Actual loads and deflection criteria from crane/ monorail system shall be calculated by the suppliers and submitted in close relation to the design of the main load bearing structure before the detail design of both is undertaken. Fatigue shall be taken into account.

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2.6 Equipment loading

Equipment and other systems, which are supported at floor or at roof, shall be considered as Equivalent Static point load and applied as lumped masses for earthquake conditions. Foundations and fixing arrangements for Equipment which generates vibration, shall be designed to prevent, or at least sufficiently limit, transfer of such vibrations to the adjoining structures.

Structures supporting vibratory/reciprocating equipment's shall be designed so as to obviate occurrence of resonance. The ratio of applied frequency to natural frequency shall be beyond the limits of 0.7 to 1.5.

2.7 Durability

For durability, a design life of 50 years has been considered

Durability of steel structures

The following factors affect the durability of steel structures.

- a) Environment
- b) Degree of exposure
- c) Shape of the member and Structural detail
- d) Protective measures
- e) Ease of maintenance.

The structural durability factors mentioned above shall be dealt with in line with the provisions of Section-15 of IS: 800-2007.

2.8 Design limit states Steel structures

The steel structures are designed by limit state method under the following classification:

- a) Limit state of strength;
- b) Limit state of serviceability;
- c) Limit state of stability.

2.8.1 Limit state of Strength

The Design for strength should be based on characteristic values of material strengths and applied loads. The Design values are obtained by dividing the characteristic values by appropriate partial safety factors.

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The load factors for strength design shall be obtained from the Indian Standard.

2.8.2 Limit state of Serviceability

The Design for serviceability should be based on characteristic values of material strength and applied loads.

The load factors for serviceability design shall be equal to 1.0.

Deflection is the main serviceability design criterion. The Indian Standard gives separate deflection criteria for concrete and steel elements.

2.8.3 Limit state of Stability

Stability of the structures against overturning, sliding and floatation will be carried out for the serviceability load combinations.

For factor of safety for steel structures will be as per Table-4 of IS: 800- 2007.

2.8.4 Control of Deflection for steel buildings

The deflection of various steel structural members shall be limited in line with Table 6 of IS: 800- 2007 so as not to impair the smooth working of the building units.

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Type of Building	Deflection	Design Load	Member	Supporting	Maximum Deflection
(1)	(2)	(3)	(4)	(5)	(6)
Industrial Buildings	Vertical	Live load/ Wind load	Purlins and Girts	Elastic cladding	Span/150
				Brittle cladding	Span/180
		Live load	Simple span	Elastic cladding	Span/240
				Brittle cladding	Span/300
		Live load	Cantilever span	Elastic cladding	Span/120
				Brittle cladding	Span/150
		Live load/ Wind load	Rafter supporting	Profiled Metal Sheetting	Span/180
				Plastered Sheetting	Span/240
	Lateral	Crane load (Manual operation)	Gantry	Crane	Span/500
		Crane load (Electric operation up to 50 t)	Gantry	Crane	Span/750
		Crane load (Electric operation over 50 t)	Gantry	Crane	Span/1 000
		No cranes	Column	Elastic cladding	Height/150
				Masonry/Brittle cladding	Height/240
		Crane + wind	Gantry (lateral)	Crane (absolute)	Span/400
				Relative displacement between rails supporting crane	10 mm
Other Buildings	Vertical	Crane+ wind	Column/frame	Gantry (Elastic cladding; pendent operated)	Height/200
				Gantry (Brittle cladding; cab operated)	Height/400
		Live load	Floor and Roof	Elements not susceptible to cracking	Span/300
				Elements susceptible to cracking	Span/360
	Lateral	Live load	Cantilever	Elements not susceptible to cracking	Span/150
				Elements susceptible to cracking	Span/180
		Wind	Building	Elastic cladding	Height/300
		Wind	Inter storey drift	Brittle cladding	Height/500
				—	Storey height/300

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2.9 Loads and Load Combinations

- **General**

All the values for loads and factors/assembly of load combinations that shall be considered in the structural design are as per requirements of IS: 875 & IS: 1893. These values to be seen as a minimum, more stringent requirements might be applicable and will as a result be specified herein.

- **Dead Loads (DL)**

Dead loads shall include the self-weight of all structural, weight of floor/roof, including all other likely dead loads from equipment of a permanent or semi-permanent nature including tanks, wall panels, partitions, roofing, piping, drains, bus-ducts etc. Self-weight of materials shall be calculated on the basis of unit weights given in IS: 875 (Part-1) -1987.

- **Live Loads (LL)**

The Imposed loads applied in the design shall not be less than the equivalent minimum load specified in Table 1 of IS: 875 (Part 2) -1987. It shall be applied as Static Uniformly Distributed Load over the entire floor area.

- **Uniformly Distributed Load**

Static uniform live loads are unit loads, which are sufficient to provide for movable and transitory loads, such as the weight of people, portable equipment and tools, equipment, or parts, which may be moved over or placed on floors during maintenance operations. These uniform live loads shall not be considered on floor area, which are permanently covered with equipment.

- **Live Loads on Roof**

The Imposed loads on various types of roofs shall be as per Table 2 of IS: 875 (Part 2) -1987. It shall be applied as Static Uniformly Distributed Load over the entire Roof area.

- **Wind Loads**

The Maximum Basic Wind speed shall be 39 m/s. Basic wind speed is based on peak gust velocity averaged over a short time interval of about 3 seconds and corresponds to mean heights above ground level in an open terrain (Category 2), and has been worked out for 50 years return period. Terrain Category 2 shall be used for Design.

Design wind speed & Design wind pressure at any height above mean ground level shall be obtained as per formulae given in Cl. 5.3 & Cl. 5.4 of IS: 875 (Part 3)-2015.

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Calculating load along wind or drag load shall be done as per method given in Cl. 8.0 of IS: 875 (Part 3) -2015.

- **Earthquake Load**

To determine the Seismic forces in the Structure, Seismic Zone-II shall be considered, as the project site falls in Zone-II. The Zone factor (Z), which is considered a reasonable estimate of the effective peak ground acceleration at any specific location, of 0.1 will be adopted.

The Response reduction factor (R), which is a measure for the amount of energy dissipated by the structure during an earthquake and depends on the amount of ductility present in the structure, will be considered as 5.0 for special moment resisting frame (with ductile detailing) and 3.0 for ordinary moment resisting frames (non-ductile detailing). For ductile detailing, references from IS: 13920- 2016 will be followed.

The Importance factor (I), which depends on the functional use of the structure and is characterized by hazardous consequences of its failure, post-earthquake functional needs, historical value or economic importance, shall be considered as 1.0 for administration-, canteen-, gate and gate house-, laboratory- and workshop buildings. For all other buildings, Importance factor value of 1.5 to 2.0 shall be considered.

2.10 Design Horizontal Spectrum

For the purpose of calculating seismic forces, the design value for horizontal seismic coefficient A_h for a structure shall be determined by the following expression as per Cl. 6.4.2 of IS: 1893 (Part-I) – 2016.

$$A_h = [z / 2 * I / R * S_a / g]$$

Where, Z, I, R and S_a/g are given below as per IS: 1893 (Part I) – 2016

Z	Zone factor given in Table 2, (Z=0.1 for zone II)
I	Importance factor, I = 1 to 2, given in Table 6 of IS: 1893 (Part 1) & Table 2 of IS: 1893 (Part 4).
R	Response reduction factor given in Table 7. R=5 for Steel Structure moment resisting frame as per SP6 R=4 for steel frame with concentric bracings.
S_a/g	Spectral acceleration coefficient for different soil types as per Fig.2. Type of the soil is as per the soil data. Damping value = 0.05 for Steel structures

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2.11 Increase in Allowable Bearing Pressure

When earthquake forces are included, the allowable bearing pressure in soil shall be increased as per Table 1 of IS: 1893 (Part 1) - 2016, depending upon type of foundation of the structure and the type of soil.

The design force shall be considered in each of the three principal horizontal directions (2 horizontal + 1 vertical) of the structure

2.12 Design Dead and Live Loads

The earthquake loads shall be calculated for the Full Dead load plus the Reduced percentage of live loads given below as per Table 8 of IS: 1893 (Part I) - 2016.

Live load Classes	Percentage of Live load
UDL of Above 3 kN/m ²	50
UDL of up-to and including 3 kN/m ²	25
UDL on Roof	Not to be considered

2.13 Design Lateral Force

The total lateral force or Design seismic base shear, VB along any principal direction shall be determined below:

$$VB = Ah W$$

Where,

Ah = Design horizontal seismic co-efficient (refer Cl. 4.4.1.2 of this document)

W = Seismic weight of the building calculated according to Cl. 7.4.2 of IS: 1893 (Part 1)

The masses considered in the structure, generating the loads are calculated from:

Self-weight of the structure and super imposed dead loads (Equipment load)

50% of Live load and 0% of roof live load.

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2.14 Design Horizontal Earthquake Load

The structures shall be designed for the effects due to full Designed earthquake load in one Design Vertical EQ Load, unless the IS provides a clause where this requirement can be excluded.

The effects due to vertical earthquake loads shall be calculated by considering two-thirds of the Design Horizontal Acceleration Spectrum.

2.15 Super Imposed Dead Loads (SIDL)

Equipment loads are calculated loads based upon the actual weight and size of the equipment. Loadings (both static and dynamic) of major equipment will be obtained from the manufactures certified drawings of the specified equipment to be furnished. Loadings imposed by equipment shall be specifically determined or estimated before detailed structural design. Estimated loadings shall be noted as such in hand calculations or computer input and verified before detail design.

Each member in the floor which carry these loads shall be designed for the heaviest unit or units of equipment arranged in the most critical position. The impact factor for light weight machinery shall not be less than 20 percent. Loading effect due to Impact and vibration of Equipment shall be as per Cl. 6.0 of IS: 875 (Part 2) -1987.

2.16 Load combinations

Load combinations for Structural steel structures

For structural steel structures the load combination shall be as per the Table 4 of IS: 800-2007. The most unfavourable load combination arising from combined action of dead load, live load, equipment load, wind load, Crane load, Earth quake loads and installation loads will be considered for the design.

2.17 MATERIALS FOR CONSTRUCTION

The materials for steel structures shall generally be as follows:

- a) All rolled steel sections and plates shall conform to IS:2062 – 2011.
- b) Covered electrodes for metal arc welding of structural steel shall conform to IS:814-2004.
- c) Crane Rails shall be as per IS:3443-1980.
- d) Steel chequered plates shall be as per IS 3502- 2009.

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2.18 METHOD OF CONSTRUCTION

- a) Fabrication and erection of steel structures shall be in accordance with IS:800 – 2007 and relevant standards mentioned therein.
- b) Steel structures shall generally be of welded construction. Site connections shall be either by permanent bolts or by erection bolts followed by site welding.

2.19 PRESERVATIONS

All carried out works are to be preserved till its final completion to avoid re-work and time-loss

2.20 INSPECTION

All steel structures shall be subjected to inspection for acceptance by the purchaser.

2.21 ERECTION

Erection of steel structures shall be carried out in accordance with IS:800- 2007 and other relevant IS codes.

2.22 SHEET ROOFING

1. Rock Wool Sandwich Panel Roofing System

Factory-manufactured double skin Rock Wool Sandwich Roofing Panel of Pre-painted galvanized steel sheet (AZ150 & AZ300) of weather resistant coating with rock wool Density of minimum 100 kg/m^3 and 80 to 100mm thickness of roofing panel with thermal conductivity: $\leq 0.42 \text{ W/sqm}$, as 2 hours of fire rating as per class A1 as per EN-13501-1 / equivalent. The profile shall be trapezoidal type; the insulated panels will be as per EN 14509 /IS 12436. The core insulation shall conform to IS 8183. The steel facers shall be 0.6 mm (TCT) for both external and internal facers as base substrate.

Fixing & Installation of panels with complete trims, gutters, flashings and other accessories. Panel side laps are designed to ensure continuous insulation with complete weather tight performance achieved through anti capillary groove & sealants. End laps will be provided wherever applicable of min 150/200 mm. Self-drilling fasteners shall be corrosion resistant plated steel with EPDM bonded metal washer or Aluminium pop rivets. Size of the fasteners /rivets shall be as per design.

The roofing insulated Sandwich Panels systems shall be having provisions for installation of solar modular panels and be engineered to provide required fastener by using appropriate flashings along with Butyl sealant wherever applicable. The roofing system shall include all

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cutting, lapping, making and finishing cutouts, etc. complete. Acoustic Performance shall be suitable for noise reduction from crane operations and testing activities. Ridge cap, eave flashing and valley gutters are to be provided as per requirement of matching profile wherever applicable. All joints to be sealed with Butyl sealant / PU sealant.

2. The Polyurethane Foam(PUF) Sandwich Panels

The polyurethane (PUF) sandwich panels factory fabricated as one unit shall consist of high tensile strength, profile galvalume steel sheet on top and high tensile strength, small rib plain galvalume sheet on bottom. The top profile sheet shall have minimum total coated metal thickness (TCT) of 0.5mm having a yield strength of 550 MPA with minimum coating mass of 150 gm/sqm (considering both sides together) as per AZ 150 of AS 1397-1993. The top profiled sheet shall have silicon modified polymer (SMP) coating on exposed face with 20 microns thick finish and inner face provided with back coat pre-coating of 5-7 microns.

The bottom plain (i.e. Liner) sheet shall have minimum total coated metal thickness (TCT) of 0.45 mm having a yields strength of 550 MPA with minimum coating mass of 150 gm/ sqm (considering both sides together) as per AZ 150 of AS- 1397 1993. The bottom plain sheet shall have silicon modified polymer (SMP) coating provided on exposed face with 20 microns thick finish and inner face provided with back coat pre-coating of 5-7 microns. Both the top profiled and the bottom plain (i.e. liner) galvalume steel sheets shall have a hot dip metallic zinc aluminium alloy coating of zinc (43%), silicon (1.5%) and aluminium (55%). The top profiled sheet shall have a maximum pitch of 205mm C/C and a minimum crest depth of 28 mm. The insulation sandwich in between the top and bottom sheets shall be polyurethane foam (PUF) of density 40 ± 5 Kg/m³ approximate having a thickness of 50 mm as per IS: 12436 -1988 or latest revision.

3. Galvanized Sheeting

Galvanized (Galvalume coating AZ150-150 g/m² Al-Zn alloy coating), Colour Coated (PPGI) profiled sheeting of tensile strength 550 MPA conforming to IS 277 / IS 15961. Minimum 0.6mm TCT (Total Coated Thickness). Trapezoidal / ribbed profile suitable for industrial cladding, minimum crest height: 28 mm, with zinc aluminium alloy of AZ-150(as per AS-1397: 1993). Sheet shall have a hot dip metallic zinc aluminium alloy Coating of zinc (43%), silicon (1.5%) and aluminium (55%) with total mass coating of 150 gms/sqm considering both sides together. Installation using self-drilling, self-tapping fasteners conforming to IS 1367. Fasteners shall be zinc coated with EPDM washers for watertightness. Side laps: Minimum one corrugation overlap. End laps: Minimum 150 mm with sealant bead. Butyl / PU sealant to be provided at all laps to prevent water ingress. Proper alignment to be ensured to maintain uniformity and aesthetic appearance. Ridge flashing, corner flashing, base trim, eave trim and openings

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flashing shall be of same material and finish. Note: 1. The sheet shall have silicon modified polymer (SMP) coating of 20-micron thickness on exposed face and back coat pre-coating of 5–7-micron thickness on unexposed face. 1. The colour of galvalume steel sheet shall be approved colour and shade (BEML's Approval is required before sourcing).

Note:

1. Canteen dining area wherein structural roof is envisaged; roofing shall be of galvalume sheets of above referred specification.
2. PUF insulated panels shall be used for roofing in facilities other than manufacturing and testing blocks, where rock wool insulated panels shall be used for roofing.
3. Wall panelling wherever mentioned or shown in the drawing shall be of galvalume sheet as per referred specification.
4. Panel sizes either in roofing or side cladding to be chosen such that minimum number of joints are created.

2.23 False Ceiling

False ceiling at all height including providing and fixing of frame work made of special sections, power pressed from M.S. sheets and galvanized with zinc coating of 120 gms/sqm (both side inclusive) as per IS : 277 and consisting of angle cleats of size 25 mm wide x 1.6 mm thick with flanges of 27 mm and 37mm, at 1200 mm centre to centre, one flange fixed to the ceiling with dash fastener 12.5 mm dia x 50mm long with 6mm dia bolts, other flange of cleat fixed to the angle hangers of 25x10x0.50 mm of required length with nuts & bolts of required size and other end of angle hanger fixed with intermediate G.I. channels 45x15x0.9 mm running at the spacing of 1200 mm centre to centre, to which the ceiling section 0.5 mm thick bottom wedge of 80 mm with tapered flanges of 26 mm each having lips of 10.5 mm, at 450 mm centre to centre, shall be fixed in a direction perpendicular to G.I. intermediate channel with connecting clips made out of 2.64 mm Dia x 230 mm long G.I. wire at every junction, including fixing perimeter channels 0.5 mm thick 27 mm high having flanges of 20 mm and 30 mm long, the perimeter of ceiling fixed to wall/partition with the help of raw plugs at 450 mm centre, with 25mm long dry wall screws @ 230 mm interval, including fixing of gypsum board to ceiling section and perimeter channel with the help of dry wall screws of size 3.5 x 25 mm at 230 mm c/c, including jointing and finishing to a flush finish of tapered and square edges of the board with recommended jointing compound , jointing tapes , finishing with jointing compound in 3 layers covering up to 150 mm on both sides of joint and two coats of primer suitable for board, all as per manufacturer's specification and also including the cost of making openings for light fittings, grills, diffusers, cut-outs made with frame of perimeter channels suitably fixed, all complete as per drawings, specification and direction of the Engineer in Charge but excluding

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the cost of painting with : 12.5mm thick tapered edge gypsum plain board conforming to IS: 2095- part I.

Grid Ceiling: -Providing & fixing of metal works lay-in system of white/ silver grey 9006. The grid to be superfine xl 15mm (micro look 8) (Superfine exposed Tee grid system. The tiles are to be of aluminium (standard weight for 600 x 600 is 2.08 Kg/ sqm) with 1.8 mm Dia holes (20% open area diagonal pitch) with black acoustic fleece with minimum 0.7 NRC. All as per approved typical shop drawings with a 10-year limited warranty.

Tile Size: 600 X 600mm

Gypsum Board Cove including paint: P/f Cove light pelmet/ trough: 150mm high, 200mm wide in ceiling made of Laggy board with GI framing complete as per design. (Note: - Cove to be complete from inner side as well) & also including the cost of plastic emulsion paint with required finish of 2 or 3 coats as per satisfaction of engineer.

2.24 ROOF EXTENSION

Sidewalk roof extension should be 900 mm cantilevered roof members located at eave and sloped at same pitch as main structure roof slope. End wall roof extension should be 900 mm cantilevered C and Z sections which are continuous span extensions of main building end bay purlins and eave struts. Roof extension structural members (except rafters) should be concealed completely when soffit panel is specified.

2.25 INSTALLATION OF SOLAR PANELS

Installation of solar panels are planned on the roof top of manufacturing block to generate renewable energy. Though supply of panels is not in the scope of EPC contractor, suitable provision to be ensured while doing roofing for ease of mounting of solar panels on a later date. The contractor has to discuss this aspect with BEML and finalise the provision before proceeding with roofing work design/construction. During design and construction stage.

2.26 LIFELINE SYSTEM

The EPC contractor shall make a provision in manufacturing block for easy, safe and convenient access / approach to roof top with weather resistant safety railings around the facility. Permanent lifeline system shall be provided along the designated movement paths on the roof to ensure safe working at height during solar panel installation and during maintenance.

The system shall allow attachment of safety harnesses for multiple users simultaneously. The lifeline system shall consist of:

- The lifeline should have a safe working load of 15KN, with adequate factor of safety.
- End anchors and intermediate supports, Stainless steel wire rope (minimum 8 mm Dia), Energy absorbers / shock absorbers, Turnbuckles and tensioning devices, Anchor fasteners and base plates, Compatible full-body harness connection points.

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- All components shall be corrosion-resistant and suitable for outdoor industrial use.
- System shall comply with relevant IS / EN / OSHA standards for fall protection.
- Fixing to roof structure shall not compromise the structural integrity or watertightness of the shed.
- All penetrations through roof sheets shall be minimized, wherever fixing is required, EPDM washers, sealants and flashing shall be provided to prevent leakage.

Structural supports shall be fixed to primary or secondary structural members only, not directly on thin roof sheeting. While designing and constructing the manufacturing block, the contractor shall ensure that adequate and safe access / approach is provided to the roof top for maintenance purpose. Safety railing (corrosion) around the edges of the roof shall be designed and installed. Any damaged roof sheets during execution shall be repaired or replaced at contractor's cost. All steel components shall be hot-dip galvanized (minimum 80 microns coating). Fasteners shall be stainless steel or galvanized high-tensile bolts. Touch-up painting shall be done at all cut edges and welded joints.

NOTE:

The life line system is to be provided in all structural industrial sheds whose height exceeds 7m

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CHAPTER-3

Landscaping & Railway Siding

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3.0 COMMON DRIVEWAYS/ LANDSCAPING AROUND THE FACILITIES

Adequate drains shall be planned around the building and is to be connected to main drain.

Edge Kerb shall be of pre cast / cast in situ of approved design and shall be minimum 100 mm above the drive way.

The level of landscaping shall be 100 mm above driveway level with edge kerb all around.

Landscaping with Shrubs / trees / lawns / ground covers shall be planned as per Scope of work

3.1 RAILWAY SIDING:

Railway siding is to be developed for running test of rakes, stabling & dispatch of coaches in line with Master Plan Layout. The total length of track (broad-gauge) is envisaged with OHE as of now. The top level of track in different stretches is to be maintained as specified. The development of siding shall include formation work to the required level, supply of all materials viz. ballast, Rail (60 Kg/m), PSC sleeper, switches, fishplates and all other accessories required for laying of rail track including providing & laying of OHE complete which shall be meeting at a level of approx. 452 from the level of testing line facility.

All Specifications, materials and workmanship shall conform to relevant BIS and IRs standard.

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CHAPTER-4

Masonry Wall, Flooring, Painting, Doors & Windows and Other Civil Works

TECHNICAL SPECIFICATION

4.0 MASONRY IN WALL

1. AAC Block Masonry Work

AAC block masonry work shall comprise providing and constructing Autoclaved Aerated Concrete (AAC) block walls of approved thickness, density, and compressive strength conforming to IS 2185 (Part 3), complete in all respects as per approved drawings, specifications, and directions of the Engineer-in-Charge.

The work shall include supply, handling, storage, cutting, laying, jointing, scaffolding, curing, testing, and protection of AAC blocks for industrial infrastructure projects. AAC block shall possess uniform dimensions, smooth surfaces, and minimum compressive strength 7.0 N/mm². Dimensional tolerances of AAC blocks shall not exceed ± 3 mm. All blocks shall be uniform in shape, free from cracks, breakages, warping, and other manufacturing defects, and shall be laid in proper line, level, plumb, and alignment as per manufacturer recommendations and relevant IS standards.

Cement mortar shall be used for Full height follows with 1:5 (1 cement: 5 Fine aggregates)

And for half height wall shall be followed with 1:4 cement mortar (1 cement: 4 Fine aggregates)

RCC surfaces coming in contact with masonry shall be hacked and cleaned before execution. Necessary GI mesh/chicken mesh reinforcement shall be provided at RCC and masonry junctions, around openings, and at locations specified in drawings. Electrical conduits, sleeves, inserts, and openings shall be properly coordinated during execution. The masonry shall conform to IS 1905, IS 2212, IS 2250, NBC provisions, and approved QA/QC procedures.

4.1 FLOORING & FLOOR FINISHES

1. VDF – Flooring

The work shall consist of providing and laying Vacuum Dewatered Flooring (VDF) of 200 mm thick RCC M-25 grade design mix concrete over a properly prepared and compacted sub-base, complete with a polythene separation membrane of minimum 125 microns thickness (overlap 300 mm), placement, vibration, vacuum dewatering, mechanical finishing, joint cutting and curing, in accordance with the drawings and directions of the Engineer-in-Charge. The concrete shall be designed as per IS 10262 and executed in accordance with IS 456, using aggregates conforming to IS 383 (maximum aggregate size 20 mm, water–cement ratio ≤ 0.50 and slump 100–120 mm before vacuum).

Concrete shall be laid in panels, compacted using mechanical vibrators and vacuum-dewatered using vacuum mats and suction equipment to remove excess water and improve

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density and strength. The surface shall then be finished with mechanical power floats and power trowels to obtain a smooth, dense, dust-free and abrasion-resistant surface with level tolerance ± 3 mm under a 3 m straight edge, suitable for industrial flooring and forklift traffic. Control joints shall be saw-cut at 4–6 m spacing with a depth of approximately 50–65 mm within 12–24 hours after casting to control shrinkage cracks. The flooring shall be cured by continuous water curing or approved curing compound for a minimum period of 14 days, and the finished floor shall be uniform, dense, level, and free from cracks, segregation, honeycombing or surface defects, capable of sustaining industrial loads, pallet movement and forklift operations. The controlled joints are to be treated with suitable Expandable sealant.

2. Epoxy Flooring

The work Shall consists of design, supply, surface preparation, application, testing, and commissioning of a heavy-duty industrial epoxy flooring on the VDF flooring with minimum M-25 concrete grade of manufacturing block. The flooring areas which may be subjected to heavy steel wheel loads, Forklift and crane traffic, Welding and fabrication operations, Oil, grease, hydraulic fluids, and coolants, Impact and abrasion, Wash-down operations etc. The contractor shall provide a complete system including primers, screeds, seal coats, joint treatments, markings, and protection.

The flooring system for the production areas shall consist of a heavy-duty epoxy screed system with a total thickness of 3 mm, and a minimum thickness of 3 mm in bogie assembly zones. The system shall comprise a low-viscosity epoxy primer applied at a coverage rate of 0.3–0.5 kg per square metre, followed by an epoxy mortar screed made of epoxy binder mixed with graded quartz aggregates, applied by trowel to a thickness of 3 mm. A high-build epoxy seal coat or top coat of 300–500 microns thickness shall be applied as the final layer, with anti-slip aggregates broadcast in wet areas.

The concrete substrate shall be of minimum M25 grade of VDF floor, cured for at least 28 days, with moisture content not exceeding 3% and a minimum surface tensile strength of 1.5 MPa. Surface preparation shall include shot blasting to achieve a CSP 3–5 profile, removal of laitance and contaminants, repair of cracks using epoxy injection, and surface levelling prior to application. No flooring work shall commence without the Engineer's approval. Application shall be carried out at an ambient temperature between 10°C and 35°C, with the substrate temperature maintained at least 3°C above the dew point and relative humidity not exceeding 85 percent. Adequate ventilation shall be ensured during installation.

Construction joints shall be filled with semi-rigid epoxy filler, and expansion joints shall be sealed with polyurethane elastomeric sealant. All joints shall be properly reinstated after completion of the flooring work with the prior approval for the applications. The floor shall be

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colour coded in production areas, for walkways, for hazard zones. Line markings shall be executed using epoxy paint, and all markings shall be worn resistant with the prior approval for colour and shade. The flooring shall be capable of withstanding forklift loads, localized axle loads, steel wheel traffic, and impact from dropped components. Quality control shall include moisture testing, pull-off adhesion tests at random locations, thickness verification, visual inspection for pinholes, and slip resistance testing where applicable. All test results shall be properly recorded and submitted.

The completed flooring shall be protected from damage during curing. It shall allow foot traffic after 24 hours, light traffic after 48 hours, heavy traffic after 5 to 7 days, and shall achieve full chemical resistance after 7 days.

APPLICABLE STANDARD CODES:

The system shall comply with latest editions of:

- ASTM C881 – Epoxy Resin Systems
- ASTM D4060 – Abrasion Resistance
- ASTM D4541 – Pull-Off Adhesion
- ASTM D695 – Compressive Strength
- ASTM D638 – Tensile Strength
- ACI 302 – Concrete Floors
- ISO 8501 – Surface Preparation

3. False flooring

Providing and fixing removable raised/false access flooring with system and its components of approved make for different plenum height with possible height adjustment up to 50 mm, comprising of modular load bearing floor panels supported on G.I. rectangular stinger frame work and G.I. Pedestal etc. all complete, as per the architectural drawings, as specified and as directed by Engineer-in-charge, Providing at required spacing to form modular framework, pedestals made out of GI tube of thickness minimum 2 mm and 25 mm outer diameter, fully welded on to the G.I. Base plate of size 100mm x 100mm x 3mm at the bottom of the pedestal tube, G.I. pedestal head of size 75mmx75mmx3.5 mm welded with GI fully threaded stud 16mm outer diameter with two GI Check nuts screwed on the stud for level adjustment up to 50mm, locking and stabilizing the pedestal head in position at the required level. The pedestals shall be fixed to the subfloor (base) through base plate using epoxy-based adhesive of approved make or the machine screw with raw plug.

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Vinyl Flooring: P/I of flexible homogeneous, calendared compacted vinyl flooring, suitable for heavy traffic area, of thickness 2mm and with PUR surface treatment and group P wear rating having fungi static & bacteriostatic properties of approved shade and colour.

4.2 FLOOR FINISHES:

- The Technological Buildings shall have the following Finishes:

S. No	Description of work	Finishing Material
1.	Flooring and Skirting except for Toilets / balcony, Drinking water Point and pantry	Vitrified tiles Glossy Finish (Tile size shall be 600 x 1200 mm) of approved Shade
2.	Staircase	18 mm thick Granite stone slab flooring of approved Texture and shade
3.	Flooring for Toilets / Drinking water point, etc.	1200 x 600 mm anti-skid vitrified tile of approved shade and make
4.	Dado for Toilets and DW area	1200 x 600 mm vitrified tile dado up to 2400 mm from FFL. Exposed Corners shall be provided with PVC inner corner tile beading of approved make
5.	Dado for Pantry	600 mm high Glazed Ceramic tiles of approved shade along wall of granite counter
6.	Sill of Windows, Fixed Glazing's, Ventilators and Parapet along internal corridors and all balconies	18 mm thick Granite slab (15 mm projected from edge of wall)

- Other utility & service Buildings shall have the following Finishes:

S. No	Description of work	Finishing Material
1.	Flooring of Battery rooms	20 mm thick Acid resistance tiles of approved Make

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2.	Flooring and Skirting of all locations as per Sr.no -1	Vitrified tiles Glossy Finish (Tile size shall be 1200 x 600 mm) of approved make
3.	Staircase flooring and skirting	25 mm thick Kota stone slab
4.	Flooring of Cable cellar room, Panel Room, Ventilation room / HVAC Room, MCC Room etc.	52 mm thick cement concrete flooring with concrete hardener
5.	Store rooms / Record Rooms	600 x 600 mm 20 mm thick pre polished Kota stone
6.	Flooring in toilets, Pantry, Drinking Water Area	300 x 300 mm Non-Skid Ceramic tile of approved make
7.	Dado for Toilets	300 x 600 mm Glazed ceramic tile of approved shade up to lintel bottom on all sides of wall. Exposed Corners to be provided with PVC inner corner tile beading of approved make.
8.	Dado for Pantry	600 mm high Glazed Ceramic tiles of approved make along wall of granite counter
9.	Dado in Battery Room	1800 mm high dado with 20 mm thick Acid-resistant tiles
10.	Parapet along internal corridors and all balconies other than terrace area	25 mm thick Kota slab (15 mm projected from edge of wall)
11.	Sill of Windows, Fixed Glazing's, Ventilators	18 mm thick Granite slab (15 mm projected from edge of wall)
12.	Server Room or other areas wherever mentioned	False flooring shall be followed

4.3 DOORS AND WINDOWS:

The Flush doors proposed in buildings shall be WPC Door with WPC frame as per specification mentioned hereunder.

All doors shall be provided with Stainless steel hardware's of SS 304 grade from approved make. All the doors except for WC area in toilet shall be provided with door closure.

The Utility Rooms, record rooms shall be provided with multipurpose metal doors of approved make.

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The Metal fire doors shall be of 2 hours fire rated with heavy duty type. The hardware's to be used shall be of SS 304 grade. The metal fire doors shall be provided with RCC Pilaster on all sides of metal door frame

All the windows to be planned shall be heavy duty aluminium windows of approved shade and shall be provided with 4/5 mm thick glass as per approval.

1. WPC Door With Frame

Providing and fixing factory-made solid WPC (Wood Polymer Composite) decorative flush door shutter 30–35 mm thick, including WPC frame, complete with PVC laminated or painted finish of approved shade, stainless steel hinges, mortice lock, handles, tower bolts, door closers and all necessary hardware and accessories, suitable for internal areas including washrooms, installed true to line and plumb, in accordance with approved drawings, frame shall also be of WPC to be painted with suitable paint of matching colour & shade with directions of the Engineer-in-Charge. All doors shall be provided with Stainless steel hardware's of SS 304 grade from approved make. All the doors except for WC area in toilet shall be provided with adjustable automatic Door closure with heavy duty safety spring and built-in lock.

2. Metal Fire Doors

Providing and fixing heavy duty metal fire doors of 2 (two) hours fire resistance rating complete with factory fabricated double skin galvanised steel shutters with fire resistant core, galvanised steel frames with intumescent seals, stainless steel (SS 304) hardware (hinges, lock, handle, door closer, flush bolts, etc.), and RCC pilasters on all sides of the door frame, finishing and fixing as per direction of Engineer-in-Charge. The hardware's to be used shall be of SS 304 grade.

3. Aluminium Sliding Windows

All block masonry wall panels shall be provided with aluminium sliding windows of suitable size each comprising of 3 sliding panels out of which 2-shall be of clear float glass panel and one panel will be of mosquito mesh supported with necessary structural frame work & protective MS grills each window shall be provided with sunshade. Aluminium sliding windows shall be fabricated using extruded aluminium sections of minimum thickness 2mm conforming to relevant aluminium standards, and installed complete with glazing, rollers, locks, and accessories as per approved drawings and directions of the Engineer in-Charge.

The aluminium extruded sections shall generally conform to IS 733 and IS 1285, surface finish shall be polyester powder coating of minimum thickness 50 microns complying with IS 13871. All the windows to be planned & positioned with heavy duty aluminium window frames for 3 track sliding windows is generally made from aluminium extruded sections of approximately 95mm × 38mm rectangular pipe, with bottom track and side/top track sections designed to

TECHNICAL SPECIFICATION

support sliding shutters. The shutters are fabricated using aluminium sections of about 40mm×18 mm size with interlocking sections, fitted with nylon-encased stainless-steel rollers, self-locking catch, handles, and required fasteners, complete with 4/5 mm thick plain glass panels and all necessary fittings.

4.4 Rolling Shutters:

Providing, supplying, fabricating, fixing, testing, and commissioning industrial rolling shutters of suitable size, type (motorized) and thickness, complete in all respects.

- o Curtain / Laths: Interlocking GI laths manufactured from cold-rolled steel sheets conforming to IS 277, with minimum zinc coating Z275. Thickness shall be 0.90 mm to 1.20 mm depending on opening size.
- o Guides: Heavy-duty MS angle / channel guides (minimum 65 × 65 × 6 mm) conforming to IS 2062, securely fixed using anchor fasteners as per IS 1367.

- Spring & Shaft Assembly: High-tensile steel shaft with oil-tempered, heat-treated springs, properly balanced and designed for shutter size and weight, conforming to IS 1367.
- Brackets & Hood: MS brackets (minimum 6 mm thick) and GI hood cover (minimum 0.90 mm thick), fabricated from steel conforming to IS 2062 and IS 277.
- Operation: Electrically operated with motor, limit switches, and manual override, as specified.
- Finish: Factory galvanized or powder-coated / painted finish (zinc primer + two coats of enamel / epoxy) of approved shade, conforming to IS 4759. 8.0

4.5 SLIDING GATE:

Double leaf heavy-duty electrically operated sliding steel gate of required size with a man entry gate of size 1mx2m (WxH) integrated in one of the leaves of the sliding gate complete with all structural members, rollers, tracks, guide rails, EPDM gasket, hardware, surface treatment and accessories, in accordance with approved drawings and specifications. The gate should be strong, sturdy and easy to operate. EPC contractor has to demonstrate smooth operation of the same.

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4.6 MAN-ENTRY GATE (Pedestrian Access Gate) Adjacent to rolling shutters, a man entry/exit gate of suitable size for each bay shall be provided at either side of the manufacturing bay for the entry/exit of man power. A Single-leaf, self-closing, manual-operated gate considering high-frequency usage in industrial environment with clear width and height of 1m X 1.2m from floor level to top rail to comply with standard railing requirements for easy personnel passage and to allow for PPE, tool bags, or stretcher access.

- Material: Galvanized Mild Steel (hot-dip galvanized) or Stainless Steel (AISI 304/316) for high-corrosion areas.
- Swing: Single-direction swing (away from dangerous, towards safe) with self-closing spring hinge/gravity mechanism.
- Frame: Rigid frame, minimum 40x40mm hollow section or 50x25x2.5mm galvanized steel profile.

❖ Safety and Functional Features

- Self-Closing Mechanism: The gate must automatically return to the closed position using spring-loaded hinges or gravity-based mechanisms, tested for 50,000+ cycles.
- Access Control: Biometric/Smart Card reader (RFID) for attendance tracking and restricted access.
- Visibility: Safety yellow powder coating (RAL 1003 or 1004) for high visibility.
- Locking: Provision for a padlock to allow lockout/tagout (LOTO) procedures.

❖ Material and Fabrication

- Steel Sections: Conform to IS 8500 or equivalent EN standard.
- Welding: Continuous MIG welding, free from slag, burrs, and sharp edges.
- Coating/Painting: Hot-dip galvanized to ASTM A123/153, followed by epoxy powder coating to withstand factory environment and resist corrosion.
- Fixing: Heavy-duty, adjustable heavy-duty hinges designed for heavy industrial use.

❖ Installation Requirements

- Foundation: Gate posts shall be mounted on reinforced concrete (M20 grade or higher) with adequate reinforcement, typically extending at least 500-600mm below finished ground level.
- Clearances: Minimum clearance to ensure no fouling with overhead cranes or adjacent machinery (min 65mm from rail top in track areas).

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4.7 Plastering & Finishes for AAC block masonry

Plastering work shall be executed using specified mortar mix, number of coats, and surface finish as indicated in drawings and specifications. Plastering shall commence only after completion of embedded services, door/window frames, fittings, and approval of surfaces by the Engineer-in-Charge. All junctions, corners, arises, and edges shall be finished true to line, level, plumb, and profile using proper templates wherever required. The plaster surface shall be free from waviness and shall not show deviation exceeding 4 mm when checked with a 2 m straight edge. Rendering, floating, and finishing coats shall be applied uniformly over properly prepared and dampened surfaces to achieve adequate bond and smooth finish. Construction joints at the end of day's work shall be finished neatly and old plaster edges shall be properly prepared before continuation of work. Each coat of plaster shall be cured continuously for a minimum period of 7 days preventing excessive drying, shrinkage cracking, damage due to hot or windy weather conditions and suitable to receive paint.

Ceilings & Concrete Soffits: plastering shall be carried out on surfaces using cement mortar in the proportion of 1:4 (1 cement:4 fine sand). and thickness shall be as per relevant IS code

Internal wall plastering & External wall plastering – shall be carried out on all masonry surfaces using cement mortar in the proportion specified by EIC (cement: fine sand) and thickness shall be as per relevant IS code

4.6 Paint: -

After completion and proper curing of plaster, approved primer shall be applied followed by following operation.

- External surfaces: Two coats of weather-resistant exterior Premium external acrylic grade with under coat of external wall putty and primer of approved Make, colour and shade.
- Internal Surfaces: 2 Coats of Premium Acrylic Emulsion paint over white cement-based putty of average thickness 1mm and primer of approved Make, colour and shade.
- Internal surfaces of factory buildings: 2 Coats of Acrylic oil bound washable distemper of approved shade over white cement-based putty of average thickness 1mm of approved make, colour and shade.
- Paint on steel surfaces: With ready mixed red oxide zinc chromate primer of approved brand and manufacture on steel galvanised iron/ steel works, Finishing with Acrylic emulsion/ Deluxe multi surface/Epoxy paint (two or more coats) at all locations prepared and applied as per manufacturer's specifications including appropriate priming coat, preparation of surface, etc. complete.

All paints shall be free from VOC and Lead.

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A. The Non-Technological Infra Buildings shall have the following Finishes:

S. No	Description of work	Finishing Material
1	Internal Wall – All Locations	2 Coats of Premium Acrylic Emulsion paint over white cement-based putty of average thickness 1mm of approved make
2	External Wall – All Locations	Weather coat Acrylic External Emulsion paint of approved shade

B. The Technological Infra Buildings shall have the following Finishes:

S. No	Description of work	Finishing Material
1	Internal Walls and ceilings – All office spaces such as cabins, corridors of office area, workstation area, conference halls, lobby, waiting area, Control rooms, console rooms, VFD Room, Scada room, Record room	2 Coats of Premium Acrylic Emulsion paint over white cement-based putty of average thickness 1mm of approved make
2	Internal Walls and ceiling – All Locations other than mentioned in Sr.no 1	2 Coats of Acrylic oil bound washable distemper of approved shade over white cement-based putty of average thickness 1mm of approved make
3	External Wall – All Locations	Weather coat Acrylic External Emulsion paint of approved shade

4.7 Structural Steel Paint

The paint systems for general service requirement of internal and external steel structures covering surface preparation, application of primer coats, intermediate coats and final coats to develop the required minimum dry film thickness on steel surface is as below.

Surface preparation: Sa2½ according to Swedish Standard SIS055900.

For specific small items like walkway gratings and stair steps galvanization shall be recommended. Painting system shall be as per the Technical Specification.

All Paints shall be free from VOC / lead paints.

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4.8 PARAPET WALL:

The parapet wall must be at least 1050 mm high unless mentioned otherwise in the drawing, constructed over terraces and balconies, complying with building regulations. Masonry walls should be 230 mm thick, while RCC walls must be 150 mm thick, using standards-compliant materials. The roof slab must be prepped before constructing the wall, with brick masonry laid in CM 1:5 mortar and cured for at least 7 days. A 75 mm thick RCC coping with M20 concrete is required at the top for stability, supplemented with plastering and waterproofing. Expansion joints are needed for continuous lengths exceeding 30 m, as per the Engineer's specifications.

4.9 STAIRCASE:

The width of staircase shall be as per Part - 4 of NBC 2016 (minimum 1500 mm Wide as per type of building) The riser shall be maximum of 150 mm and tread shall be minimum of 300mm. The design of staircase shall be as per NBC guidelines Railing shall be of 1100 mm high medium duty mild steel finished with two or more coats of Synthetic Enamel paint of approved shade.

4.10 RAMPS:

In order to facilitate access of Differently Abled people inside building and to make the building barrier free, differently abled ramps to be provided as per NBC guidelines

4.11 PLINTH PROTECTION:

The buildings shall have plinth protection all-around the building of width 900 mm. The finish shall be concrete finish. Kota stone finish shall be provided for Annex Office buildings. The level of plinth protection shall be 100 mm above finished ground level or landscape level.

4.12 CHAJJA & CANOPY:

All Windows and external doors shall be provided with chajjas and Canopies.

The minimum depth of Chajja in windows shall be 600 mm and for External doors canopy depth shall be 1200 mm unless specified.

For rolling shutters provisioned in manufacturing block/Inspection & testing block the canopy depth shall be minimum 2000 mm.

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4.13 PLUMBING FITTINGS AND FIXTURES:

The following shall be provided

- Each offices / Buildings should be provided with suitable capacity HDPE overhead fresh water tank as per the occupancy level of the building.
- Each Water closet area shall be provided with a Health faucet, angle cock as required. All fixtures shall be chrome plated.
- Pantry shall be provided with sink cock / mixture for sink and one water purifier point.
- All fixtures such as sink cock / mixtures, bib cocks, pillar cocks, Angle cocks, Health Faucets etc. shall be of approved make.
- Water Closet shall be a single unit floor mounted type of approved make and colour in areas where the facility is meant for multiple users, in case of single user's wall hung water closet shall be provided, all water closet to be provided with concealed flush tanks. Vanity ledge top to be finished with granite of approved colour, shade & texture.
- Under Counter wash basins shall be provided with 20 mm thick granite counter of approved shade and texture.
- Urinals in gent's toilet shall be of flat back type. 20 mm thick Granite stone divider of size 500 mm x 900 mm shall be provided in between two urinals. The granite divider shall be polished on both sides and shall be fixed with top at +1500 level.
- Women's toilet must be designed for adequate capacity, hygiene, user privacy, and durability. Which includes proper ventilation, lighting, sanitary fittings, and menstrual hygiene management.
- Pantry shall be provided with stainless steel 304 grade sink with drain board of approved make
- The design must adhere to the National Building Code of India, the Factories Act, and safety standards, ensuring accessibility, ease of maintenance, and efficient circulation
- Each Toilet shall have the following Toilet accessories
 1. Mirror of full width of Granite counter with height of 900 mm with beveled edges.
 2. Chrome finish Soap dispenser
 3. 600 mm long SS Towel ring near wash basin
 4. SS Coat hook in all Water closet room

All toilet accessories shall be of SS 304 Grade only.

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CHAPTER-5

Lighting & Ventilation

TECHNICAL SPECIFICATION

5.0 LIGHTING AND VENTILATION:

The lighting and ventilation inside the building should be properly planned. This shall be as per NBC 2016-chapter Lighting and Ventilation and Part - III.

1. DAY LIGHT PANEL

UV-protected polycarbonate daylight panels must be designed and installed with all necessary components to ensure a watertight installation for industrial projects. These panels should adhere to IS 14443:1997, made from high-quality virgin polycarbonate resin with a minimum thickness of 2.0 mm, offering high impact resistance and excellent translucency. They must feature a co-extruded UV protective layer to prevent degradation from solar exposure, ensuring a light transmission of 70% to 80% and temperature resistance. Installation must align with the existing roof/wall profiles and follow approved GFC drawings, employing corrosion-resistant fasteners and sealing joints with compatible silicone. The contractor is responsible for submitting test certificates, obtaining sample approvals, and addressing any defects during the liability period at no cost.

2. LOUVER

Air intake Louvres are envisaged as first stage separators of air borne sand, dust & objects at each ventilation chambers. The Air intake louvers can be of FRP / 3.0 mm thk MS / high quality GI or extruded Aluminium alloy mounted on suitable frame work. The Louvre frame work shall squarely fit into the wall openings having 50 x 50 x 6 edge angle inserts.

3. Wind Turbine / turbo Ventilator

The Wind Turbine Ventilators shall be specially designed and manufactured as per industrial specification and standards and rigorously tested to ensure durability and performance in extreme temperatures and high wind conditions. The Ventilators shall be able to discharge / exhaust required volume at a wind velocity of 10.0 MPH. The vanes shall be of double curved for maximum weather durability, maximum wind driven efficiency and rain spill deflection. MOC of vanes shall be bright hi grade (A1100 / 19000 gr.). The vane assembly shall rotate effortlessly on SS 304 Ball & pin with self-lubricating guiding bush mechanism.

The Turbine ventilator shall be designed to withstand the load of maximum wind velocity at the site of installation.

The turbine ventilator vanes shall be provided with Electro zinc plated center shaft, SS mounting (bottom / neck) rings, top cover, metal / FRP base duct (transition piece), sleeves, support and accessories – nut & bolts, rivets, weather proofing etc.

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5.1 Air Conditioning system:

- a) Air conditioning and Ventilation systems (ACVS) are provided for proper working conditions necessary to maintain environment compatible with human hygienic requirements and to maintain conditions necessary for proper storage of materials and working of plant and equipment in the premises such as Electrical rooms, Control rooms, Offices, etc.
- b) Air conditioning & Ventilation systems are designed based on the climatic conditions prevailing in the region. Suitable VRF/VRV and Split AC has been planned for the facilities proposed in Project BRAHMA. ACVS will be provided with adequate measures for safety.

Design Basis

Air conditioning systems

- a) Air-conditioning facilities are envisaged for Control rooms, PLC Rooms, VFD Rooms, Office areas etc. to remove heat generated from panels & / or to maintain efficient environment for the working personnel.
- b) The following inside design conditions are considered for estimating the Air-conditioning System capacities: -

Table-1

S. No.	Room name	Room Inside conditions	
		Temperature	RH
1	Control Rooms, PLC rooms, UPS Rooms, VFD Rooms cum IMCC panel rooms & any other room where electronic panel / equipment is located	23 ± 2 °C	55 ± 5 %
2	Annex Office rooms, OHC, Canteen, etc.	24 ± 2 °C	<70 %

- c) Outside design Condition, as per the Meteorological data of site
- d) The capacity of Air conditioning system shall be arrived based on room sizes, Temperature, RH, Occupancy, solar loads, internal equipment heat loads, lighting loads etc. as per ISHRAE / ASHRAE standards. 20% factor of safety (for de-rating of equipment / air leakages in ducts etc.) shall be considered on the capacity of the equipment.

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- e) A minimum of 50% standby capacity is provided for the VFD/VRF systems proposed and a minimum of one no. unit / equipment shall be provided as standby for the premises provided with Split Type Air conditioner units.
- f) Premises to be Air conditioned & System Description

Table-2

Sl. No.	Room / Area / Premises	Equipment / System Proposed	Equipment Capacity
1	OHC (Occupational Health Centre)	Split AC	1.5 ton 5-star rating
2	Canteen	Air Cooled VRF Type System	40 TR (60 HP) outdoor unit & suitable capacity Indoor units to various rooms
3	Main security Complex	Split AC	1.5 ton 5-star rating
4	Annexe Building	Split AC	1.5 ton 5-star rating

Ventilation systems

- a) Ventilation facilities shall be envisaged for the premises as per the relevant standards for creating efficient environment for the working personnel & equipment.
- b) The capacity of Ventilation system will be arrived based on Area, solar loads, internal equipment heat loads, lighting loads etc. OR based on minimum air-changes as per NBC / ASHRAE / ISHRAE, whichever is higher with 20% factor of safety considering de-rating (wear & tear) of equipment / air leakages in ducts etc.
- c) For the premises where only Natural ventilation is considered, roof mounted turbo-ventilators are considered & provision shall be kept for installation of Ceiling fans / industrial air circulators.
- d) HT Panel room shall be provided with pressurized plenum ventilation systems. This shall include centrifugal fan, dry panel filters, air washing units, ducting, adjustable louver grilles for air supply, volume control dampers, supports, electrics, instrumentation and controls,

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etc. The premises shall be pressurized to 2-3 mm WC to prevent dust ingress. Ventilation equipment for plenum ventilation shall be located in separate rooms adjacent to the served premises

e) General Exhaust Ventilation shall be considered for Cable cellar, Pump houses, Battery rooms, Stores, Toilets, etc. The supply of fresh air will be through Louvers / open able windows & exhaust will be through wall mounted propeller / axial flow fans with cowl and Bird screen. The Battery room will be provided with wall mounted flameproof exhaust fans with minimum of 6 air changes per hour.

f) Salient Design Features

- Standard, proven and commercially available systems equipment will be used.
- Standby provisions will be made for supply and exhaust ventilation systems components to ensure the continuous operation of the ventilation system.

g) Fan Static Pressure

- The Fan static pressure will be estimated considering maximum allowable pressure drop in the louvers / filters / Air washing unit / dampers / plenums / Fan unit and frictional pressure drop in ducts.

List of Codes & Standards

All equipment, systems and works for air conditioning & Ventilation facilities shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment shall be installed and the following publications, norms/guidelines, standards, acts and rules shall be followed.

- Publications of Bureau of Indian Standards (BIS).
- American / Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE / ISHRAE)
- VDI stipulation for vibration level.
- Sheet Metal & Air-conditioning Contractors National Association (SMACNA)
- National Building Code – India (NBC)
- ACGIH - Industrial Ventilation

The system is designed primarily based on the guidelines of codes/ standards, as listed below:

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Table-4

Standard	Particulars
IS 655 & IS 277	Metal air ducts
IS 7613	Method of testing panel type air filters
IS 2062	Steel for general Structural purposes
IS 3069	Glossary of terms, symbols and units relating to thermal insulation materials
IS 3144	Fire resistance Testing of acoustic insulation
ISO1940 & VDI 2060	Dynamic balancing
IS:4029	Guide for testing 3 Phase Induction Motors
ISO 1940-1	Mechanical vibration – Balance quality requirements of rigid rotors. Part 1 – Determination of permissible residual unbalance
ISO 10816-1	Mechanical vibration–Evaluation of machine vibration by measurements on non-rotating parts. Part 1– General guidelines.
IS 4691	Motors
IS 4894	Specification for Centrifugal fans
IS 3588	Specification for Tube Axial fans
IS:1391	Specification for Split Air-conditioners
IS: 8148	Specification for Package Air-conditioners
IS: 1239 (Part-I)	Piping
AMCA-201	Design of centrifugal fans and classification
AMCA 210-07	Laboratory Methods of Testing Fans for Rating
AMCA 204-05	Balance Quality & Vibration Levels for Fans
AMCA 300-08	Reverberant Room Method for Sound Testing of Fans.
AMCA 99-2404-03	Drive Arrangements for Centrifugal Fans

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Standard	Particulars
AMCA 99-2406-03	Designation for Rotation & Discharge of Centrifugal Fans
AMCA 99-2407-03	Motor Positions for Belt or Chain Drive Centrifugal Fans
AMCA 99-2408-69	Operating Limits for Centrifugal Fans
AMCA 99-2412-03	Impeller Diameters & Outlet Areas for Centrifugal Fans
SMACNA-2005	HVAC Duct Construction Standards - Metal and Flexible
ASHRAE- 52.1 / 52.2	Gravimetric & Dust Spot Procedures for Testing Air Cleaning Devices Used in General Ventilation For Removing particulate matter / MERV Reporting Values testing

5.2 Air-cooled Package Unit

- a) The Air-cooled packaged units shall conform to IS 8148: 2003. These shall have standard features such as air-cooled condensers, refrigerant compressors, interconnecting refrigerant piping, condensate drain connections, thermostats, controls etc. to make the system complete & give trouble free and satisfactory operation.
- b) The units shall be suitable for working under industrial environment and suitable for continuous duty. The unit shall have one evaporator unit and one condensing unit. The evaporator unit shall be detachable type. The condensing unit shall be installed on the space outside the conditioned area.
- c) The refrigerant compressor shall be hermetically sealed scroll type operating on Low GHG / Very low / zero ODP refrigerant (R407C, R410A) The Compressor shall have an Energy Efficiency Ratio (EER) of not less than 10.0 under design operating conditions. It shall be capable of operating continuously in an industrial atmosphere.
- d) The condenser shall be air-cooled copper coil of minimum 3 rows, 12-14 fins/inch Aluminium fins with ample condensing surface. Tubes shall be arranged in a staggering manner for better efficiency.
- e) The evaporator coil shall be of direct expansion type with copper tubes of minimum 4 rows and mechanically bonded aluminum fins of min 15-16 fins per inch. It shall be sufficiently deep and well-proportioned to match the airflow and ensure perfect cooling. Tubes shall be arranged in staggered design for best air contact giving low by-pass.
- f) Centrifugal (evaporator) fans shall be provided to handle the conditioned air. The fan shall be dynamically balanced and its operation shall be smooth and quiet. Fan shall be complete with direct drive motor. The bearings shall be self-lubricating type. A selector switch with "RESET" position shall be provided for running the fan alone without cooling as and when required.

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- g) Propeller type fan shall be provided to cool the condenser coil. The fan shall be dynamically balanced and its operation shall be smooth and quiet. It shall be complete with direct drive motor. The bearings shall be self-lubricating type.
- h) Air filter shall be provided for the fresh air as well as total air. The air filter shall be dry panel type. It shall have large surface area & good dust holding capacity. The filter shall be capable of handling air with dust concentration 10 mg/m^3 of air. The cleaning efficiency of the filter shall be more than 90% down to 10 microns. The filter shall be easily replaceable type. Velocity of air across the filter shall be in the range of 2.0 - 2.5 m / sec. Filter panel shall be cleanable and washable type for reuse. U-Tube manometer shall be provided for measuring pressure drop across the filter. All leakage areas shall be sealed with suitable sealing compound.
- i) Electronic Thermostat shall be provided for control of temperature as per the designed inside conditions.
- j) Inline humidifiers & strip heaters of appropriate capacity forming either as an integral part of Package unit or externally mounted shall be envisaged for the areas requiring RH control ($55 \pm 5\%$). Humidifiers can be of Pan / Bottle or Steam generating type. The operation of Humidifier & Strip heaters shall be based on inputs signals from Humidistat & Return air parameters. The system shall be fully automatic with fool proof interlocks to prevent operation of the system in case of any accidental malfunctioning of Heaters or Humidifiers. Also, suitable (selector) on / off switches / knobs shall be provided to disengage the Humidistat / strip heaters circuit and permit operation of PAC unit as required.
- k) The refrigerant circuit between outdoor unit and indoor unit shall be carried out as per site conditions. The circuit shall include thermostatic expansion valve, filter drier and liquid line shut off valve. It will be protected by Hi-Lo pressure start.
- l) The cabinets of the evaporator and condensing unit shall be constructed of heavy gauge steel, finished with electro deposition paint and synthetic resin baked enamel, weather proof with an attractive appearance. Removable panels shall be provided for convenient service access to interior of the cabinet. The evaporator unit shall have elegant cabinet with all controls discretely concealed to make appearance impressive.
- m) Insulation of suction and liquid line shall be carried out with pipe section - flexible, closed cell elastomeric, nitrile rubber insulation covered with aluminium foil. The complete refrigerant piping shall be insulated and provided with weather protection. The drain pipe shall also be insulated with nitrile rubber to avoid condensation.
- n) Control & Instrumentation
- The Package AC system shall be provided with controls/ contactors / thermostats suitable for sequential starting / stopping i.e. the compressor shall start in the last and shall shut off first.

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- All necessary operational controls, regulating controls, automation, measuring & monitoring required to cope with the equipment duty are to be so designed & arranged such that operation of the plant can be fully automatic or if required, fully manual.
- All necessary interlocking & alarm circuits shall be arranged so as to eliminate any possible damage to the plant due to malfunctioning of instruments or any probable operational mistakes.

5.3 Air cooled Split type Air Conditioners

The Split AC units shall conform to latest standard of IS 1391, Part – II. The model offered shall have BEE Star Rating of not less than 4 Star. These shall have standard features such as air-cooled condensers, refrigerant compressors, interconnecting refrigerant piping, condensate & drain connections, thermostat etc., to make the system complete & give trouble free satisfactory operation.

The units shall be suitable for working under industrial environment and suitable for continuous duty. Each split-type air conditioner shall have one outdoor unit and one indoor unit. The indoor unit shall be of High wall / Floor mounted type. The outdoor units shall be installed on the roof / terrace. The detailed specifications of individual component / parts shall be as described in the following paragraphs: -

- a. The refrigerant compressor shall be hermetically sealed scroll type operating on Low ODP refrigerant preferably R32 / R410A / R407c. It shall be capable of operating continuously in an industrial atmosphere.
- b. The condenser shall be air- cooled copper coil of minimum 10 mm OD with Aluminium fins having ample condensing surface. Tubes shall be arranged in a staggering manner for better efficiency.
- c. The evaporator coil shall be of direct expansion type with copper tubes of minimum 10 mm OD and mechanically bonded aluminium fins. It shall be sufficiently deep and well-proportioned to match the airflow and ensure perfect cooling. Tubes shall be arranged in staggered design for best air contact giving low by-pass.
- d. Single Centrifugal evaporator fan shall be provided to handle the conditioned air. The fans shall be dynamically balanced and its operation shall be smooth and quiet. Fans shall be complete with direct drive motor. The bearings shall be self-lubricating type. A selector switch with “RESET” position shall be provided for running the fans alone without cooling as and when required.

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- e. Propeller fan shall be provided to cool the condenser coil. The fan shall be dynamically balanced and its operation shall be smooth and quiet. It shall be complete with direct drive motor. The bearings shall be self-lubricating type.
- f. The air filter in the indoor unit shall be of dry type. It shall have large surface area and good dust holding capacity. The cleaning efficiency of the filter shall be more than 90 % down to 20 microns. The filter shall be of easily replaceable and washable type.
- g. Electronic Thermostat shall be provided for control of temperature as per the designed inside conditions.
- h. The refrigerant circuit between outdoor unit and indoor unit shall be carried out as per site conditions. The circuit shall include thermostatic expansion valve, filter drier and liquid line shut off valve. It will be protected by Hi-Lo pressure start.
- i. Indoor unit shall have elegant cabinet with all controls discretely concealed to make appearance impressive. Outdoor unit cabinet shall be powder coated so that it is able to withstand corrosive atmosphere.
- j. Insulation of suction and liquid line shall be carried out with pipe section flexible, closed cell elastomeric, nitrile rubber insulation. The complete refrigerant piping shall be insulated and provided with weather protection. The drain pipe shall also be insulated to avoid condensation.

5.4 Multi-Split (VRF / VRV) AC Units

a. Overview

- i. The AC units shall conform to IS: 1391 – 1992, Part – II. These shall have standard features such as Air-cooled Condensers, Refrigerant Compressors, interconnecting refrigerant Piping, Condensate drain connections, thermostat etc., to make the system complete & give trouble free and satisfactory operation. The units shall be suitable for working under industrial environment and suitable for continuous duty.
- ii. The Outdoor Units shall be of modular construction connected with VRF / VRV (wall mounted type / duct able / ceiling suspended / Floor mounted type) multiple Indoor units.
- iii. Each of the modular outdoor units can be equipped with inverter compressors for higher reliability, improved life, better backup and duty cycling purpose. The system shall be capable of changing the rotating speed of inverter compressor by inverter controller to follow variations in cooling and heating load.
- iv. Outdoor Units shall be suitable for mix match connection of all type of indoor units.

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- v. The refrigerant piping between indoor units and outdoor unit shall be possible to extend up to 100.0 m with maximum 20.0 m level difference without any oil traps.
- vi. Both indoor units and outdoor units shall be factory assembled, tested and filled with first charge of refrigerant before delivering at site. The major components of the Multi –Split Air conditioning system shall comprise the following: -
 - Compressors
 - Air-cooled Condenser
 - Condenser fan
 - Evaporator
 - Evaporator fan
 - Filter
 - Controls
 - Refrigerant Circuit
 - Electrics
 - Touch panel controller with minimum 64 units.

b. Equipment Description -Outdoor Units (ODUs)

- i. The outdoor unit shall be factory assembled, with weather proof casing constructed from heavy gauge mild steel panels and coated with baked enamel finish. The unit should be completely factory wired tested with all necessary controls. It should also be provided with duty cycling for multiple compressors switching starting sequence for better stability and prolonged equipment life.
- ii. The outdoor unit shall be modular in design and should be allowed for side-by-side installation.
- iii. The unit shall be provided with its own microprocessor control panel.
- iv. The outdoor units shall be coated with anti-corrosion paint & shall be mounted on Gal barium steel base plate.
- v. 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.
- vi. The outdoor unit should be fitted with low noise, aero spiral design fan with aero fitting grille for spiral discharge airflow to reduce pressure loss and should be fitted with an inverter type DC fan motor for better efficiency.
- vii. The condensing unit shall be designed to operate safely when connected to multiple indoor units.

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viii. The Unit should allow for backup operation to facilitate uninterrupted cooling. Auto backup required during compressor failure, sensor failure, ODU fan / motor failure.

ix. Compressor

- The compressor shall be highly efficient Rotary / Scroll type and capable of inverter control. The inverter compressor shall change the speed in accordance to the variation in cooling or heating load requirement.
- The Compressor shall be capable of operating continuously.
- All parts of compressor shall be sufficiently lubricated. Oil heater shall be provided in the compressor casing.

x. Heat Exchanger

- The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminium fins to form a cross-fin coil. Tubes shall be arranged in staggered design for best air contact giving low by-pass.
- The aluminium fins shall be covered by anti-corrosion resin film.
- The unit should be with e-pass heat exchanger to optimize the path of heat exchanger and for better efficiency of condenser.
- The unit shall be provided with necessary number of direct driven low noise level propeller type fans arranged for vertical discharge. Each fan shall have a safety guard.

xi. Refrigerant Circuit

- The refrigerant circuit shall include liquid & gas shut-off valves and a solenoid valve at condenser end. The equipment must have in built refrigerant stabilization control for proper refrigerant distribution. All necessary safety devices shall be provided to ensure the safely operation of the system.
- Refrigerant should be R410A Only.

xii. Safety Devices

TECHNICAL SPECIFICATION

All necessary safety devices shall be provided to ensure safe operation of the system.

Following safety devices shall be part of outdoor unit: -

- High pressure switch,
- Fuse
- Fan drive overload protector
- Fusible plug
- Over load relay
- Overload protection for inverter compressor

xiii. Oil recovery system

Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigeration piping lengths. The system must be provided with oil balancing circuit to avoid poor lubrication.

c. Indoor Units (IDUs)

- Each indoor unit shall have electronic expansion valve which senses the temperature based on variation of the room load and conveys the same for the outdoor modules to respond accordingly.
- The Indoor units shall be ceiling mounted cassette type/ wall mounted type.
- The address of the indoor unit shall be set automatically for individual and group control. For centralized control, it shall be set by a remote controller (with an LCD display panel).
- 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 supported from housing.
- The cooling coil shall be made out of seamless copper tubes and have continuous aluminum fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically / mechanically expanded for minimum thermal contact resistance with fins. Each coil shall be factory tested at 21 kg/m² air pressure under water.
- Unit shall have cleanable type filter fixed to an integrally moulded Plastic / Aluminium frame. The filter shall be easily serviceable.

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- vii. Each indoor unit shall have computerized PID control for maintaining design room temperature. Each unit shall be provided with microprocessor thermostat for cooling or cooling and heating.
- viii. Each unit shall be with wireless LCD type remote controller. The remote controller shall memorize the latest malfunction code for easy maintenance. The controller shall have self-diagnostic features for easy and quick maintenance and service. The controller shall be able to change fan speed and angle of swing flap individually as per requirement.
- ix. The units shall comprise of following features: -
 - Four (4) way directional flow decorative grille.
 - Each unit complete with Low noise (below 50db inside conditioned area), multi-blade centrifugal fan.
 - Each unit shall have two (2) rows of deep chilled water-cooling coil.
 - Each unit shall have Cleanable filters.
 - Insulated condensate drains pans with drain pump assembly
 - Drain pump failure alarm
 - Decorative panel as per architectural layout.
 - Infra-red remote control one for each unit.
 - LCD display on the unit
 - Four (4) speed motor or as per OEM.
 - Auto swing louver.
 - Condensation drains connections.
 - All units shall be suitable for 220 +/- 10% Volts, 50 Hertz, single phase power supply etc. complete.
 - The Remote temperature control / thermostat shall have memory back up for set point re-store in case of power failure and re-start.
 - Four hanger rods with required anchoring fasteners, hooks, washers etc. for ceiling suspension and a pair of power supply cable of about five metres length shall also be supplied along with the cassette units.

5.5 Air-washer Unit (AWU)

- a. The Air-washer Unit shall be of Double skin type made out of 16-gauge GI casing and shall be of injection filled with PUF / PHENOTHERM / Rockwool slab / rolls (48 kg/m³ density) of 50 mm thick Insulation between the two galvanized metal sheets.
- b. The Air-washer unit shall enclose mono-block self-priming pump assembly for water distribution on the Celdek media.
- c. The Air-washer unit shall comprise of following sections: -

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i) Filter panel section

- Air filter bank shall comprise of panel type pre-filters with mounting frame
- Pre-filter shall be of 3 ply HDPE panel type with efficiency of 90% down to 10 microns.
- Velocity of air across the filters shall be in the range of 2 to 2.5 m / sec.
- Filter panel shall be cleanable and washable type for reuse.
- U – tube manometer shall be provided for measuring pressure drop across the filter.
- Cleaning efficiency of the pre-filter element shall be 90% down to 10-micron size of dust particles.
- Filter material shall be enclosed in a sheet metal framework. Filter frame shall be fabricated from 16 G M.S sheet in welded construction. All leakage areas shall be sealed with suitable sealing compound.

ii) Evaporative section

- The evaporative section shall be complete with CELdek media, water distributing section, water collection trough, droplet separator, pump, interconnecting water piping, valves, strainers, make up, drain, overflow, quick fill, float, mounting frames etc.
- The evaporative section shall be constructed out of Aluminium alloy / folded galvanized sheet.
- The cooling media shall consist of min. 300 mm thick CELdek cooling pads designed for min. 90 % saturation at < 2.5 m/s. Suitable regulating valve shall be envisaged on the piping network for manual control of humidity.
- Mist eliminator shall be provided after CELdek media to separate the water droplets from the air stream.
- The section shall be of bolted construction with min. 100 mm wide FRP lining on the joints in the water tank.

iii) Centrifugal Fan for Air-washer

- The fan is to work at an ambient temperature of maximum + 50 °C and minimum +2 °C.
- Centrifugal fans shall conform to IS: 4894.

TECHNICAL SPECIFICATION

- Centrifugal fan shall be forward / backward curved multi-blade DIDW / SISW inlet type depending upon construction of Air-washer.
- Fan and motor assembly shall be mounted on a common vibration proof base frame & the assembly shall be mounted on anti-vibration spring isolators.
- The fan shall be of rugged steel construction with proper painting and suitable for heavy-duty operations.
- Impeller and shaft assembly of Fan shall be statically and dynamically balanced on precision electronic dynamic balancing machines.
- The specifications for fan have been indicated for standard air.
- Fan shall be fitted with drilled inlet and outlet flanges for fastening ducts with bolts and nuts.
- The air handled by fan shall be clean.
- The fan shall be of limit load design only.
- Speed of the fan shall be preferably within 1000 rpm and outlet velocity shall be within 12 m / sec.
- The fan shall be provided with outlet damper for control of capacity.
- Critical speed of fan shall be minimum 125% of the operating speed.
- Fan shall be provided with airflow switch indicator.
- Fan shall be either connected to motor directly with flexible coupling or shall be connected to motor by V-belt drive with slide rails, pulley blocks, belts & tensioning device, etc.
- The Fan inlet shall be covered with coarse wire mesh guard for safety.

d. Suitable air tight doors, marine lamps, etc are to be provided at Fan section / filter sections for maintenance.

e. The Air-washer unit shall be placed on vibration isolation pads to minimize vibrations.

5.6 Centrifugal Fan

- a. The fan is to work at an ambient temperature of maximum +50 °C and minimum +10 °C.
- b. All Centrifugal fans shall conform to IS: 4894 - 1987 (Reaffirmed – 1994).

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- c. Centrifugal fan shall be forward / backward curved multi-blade single / double width single / double inlet type.
- d. Fan and motor assembly shall be mounted on a common vibration proof base frame & the assembly shall be mounted on anti-vibration spring isolators.
- e. The fan shall be of rugged steel construction with proper painting and suitable for heavy-duty operations.
- f. Impeller and shaft assembly of Fan shall be statically and dynamically balanced on precision electronic dynamic balancing machines.
- g. The specifications for fan have been indicated for standard air.
- h. Fan shall be fitted with drilled inlet and outlet flanges for fastening ducts with bolts and nuts.
- i. The air handled by fan shall be clean.
- j. The fan shall be of limit load design only.
- k. Speed of the fan shall be preferably within the 1000 rpm and outlet velocity shall be within 12 m / sec.
- l. The fan shall be provided with outlet damper for control of capacity.
- m. Critical speed of fan shall be minimum 125% of the operating speed.
- n. Fan shall be provided with airflow switch indicator.
- o. Fan shall be either connected to motor directly with flexible coupling or shall be connected to motor by V-belt drive with slide rails, pulley blocks, belts & tensioning device, etc.
- p. The Fan inlet shall be covered with coarse wire mesh guard for safety.
- q. The capacity of fan motor shall not be less than 125% of the BKW.
- r. The fan shall have followed minimum thickness of materials for different parts:
 - Capacity below 20,000 m³/hr:
 - Casing: 2.5 mm
 - Back plate: 3.15 mm
 - Impeller: 3.15 mm
 - Capacity above 20,000 m³/hr and below 50,000 m³/hr
 - Casing: 3.15 mm

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- Back plate: 4 mm
- Impeller: 4 mm
- Capacity above 50,000 m³/hr
 - Casing: 6 mm
 - Back plate: 8 mm
 - Impeller: 6 mm

Pre-Filters

- a. Pre-filters shall be provided at the inlet of Centrifugal Fan.
- b. Size of pre-filters shall be of standard size 610x610x150 mm thick.
- c. Velocity of air across the filter shall be in the range of 2 m/sec.
- d. Filter panel shall be cleanable and washable type for reuse.
- e. Magnahelic gauge shall be provided for measuring pressure drop across the filter.
- f. Cleaning efficiency of the pre-filter element shall be 90% down to 10-microns size of dust particles.
- g. Filter material shall be enclosed in a sheet metal framework. Filter frame shall be fabricated from 16G M.S sheet in welded construction. All leakage areas shall be sealed with suitable sealing compound.
- h. Proper sealing shall be ensured to prevent leakage of air between mounting frame and filter panels.

5.7 Sheet Metal Ducting

i. Ducting (Site fabricated)

- a. The scope of this section comprises supply fabrication, installation and testing of all sheet metal ducts. It may be noted, the specification for Site fabricated ducting & Factory fabricated ducting are though separate, they shall be considered complimentary to each other w.r.t. Quality / good engineering practices.

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- b. Ducts shall be of Galvanised Iron 20/22/24 gauge and min.18 gauge for plenum box as per IS: 655 and Galvanised Iron coating thickness shall be as per latest editions of IS: 277.
- c. All ducting work shall be strictly reinforced to prevent sagging buckling & vibration, as per IS: 655 or better.
- d. All joints shall be flanged.
- e. For proper air distribution in the premises, supply air grilles & diffusers shall be provided with volume control dampers.
- f. Backflow dampers shall also be provided wherever necessary on the discharge side to prevent back-flow.
- g. All the ducting shall be properly supported to the building structures.
- h. Thickness of the GI sheets for supply air diffusers and dampers shall be min. 20/22 G.
- i. Straight ducts shall be fabricated in segments of maximum 3 m length. The ducts shall have flanged ends & shall have drilled holes for connecting up by bolts.
- j. Bolt holes shall be drilled at a linear distance of 100 to 150 mm centre to centre.
- k. Rubber gaskets of minimum 3 mm thickness shall be used to join the duct segments.
- l. All joints shall be airtight.
- m. Bends & elbows shall have a bend turning radius not less than 1 to 1.5 times depth of rectangular duct.
- n. Angle bends of 30, 45 & 60 degree shall be used as far as possible.
- o. Ducts shall be suitably supported from wall / ceiling by brackets / hanger rods, using grip bolts or from structural beams / members. Maximum unsupported length of duct shall not be more than 3.0 meters.
- p. The velocities in the duct shall be as follows:

Description	Air velocity for Ventilation systems	Air velocity for Air Conditioning systems
Main Duct	8 – 10 m/sec	6 – 8 m/sc
Branch Ducts	6 – 8 m/sec	4 – 5 m /sec

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Description	Air velocity for Ventilation systems	Air velocity for Air Conditioning systems
Diffusers / grilles	4 - 6 m/sec	3 - 4 m/sec

- q. Measuring hatch shall be provided after the fan in the ducting network at convenient locations for measurement of air quantity.
- r. The design of the ducting for supplying, conditioned air to different premises shall be a balanced one. Balancing shall be achieved by providing suitable volume control dampers in the Main & branch supply air / return air ducts.

ii. **Ducting (Factory fabricated)**

a. Governing Standards

The construction, erection, testing and performance of the ducting system shall conform to the SMACNA-1995 standards ("HVAC Duct Construction Standards – Metal and Flexible – Second Edition – 1995"-SMACNA).

b. Ducting – Raw material

- (i) All ducting shall be fabricated of LFQ (Lock Forming Quality) grade prime G.I. raw material furnished with accompanying Mill Test Certificates.
- (ii) Galvanising shall be as per IS:277. The samples of raw material shall be selected at random & subject to approval and tested for thickness and zinc coating.
- (iii) The G.I. raw material should be used in coil-form (instead of sheets) so as to limit the longitudinal joints at the edges only irrespective of cross-section dimensions.

c. Duct Connectors and Accessories

All transverse duct connectors (flanges/cleats) and accessories/related hardware are such as support systems, shall be zinc-coated (galvanized).

d. Fabrication Standards

All ductwork including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and other transformation pieces must be factory-fabricated or equivalent Technology. Equivalency will require fabrication by utilizing the following machines and processes to provide the requisite quality of ducts and speed of supply:

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- (i) Coil lines to ensure location of longitudinal seams at corners/folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any face side of the duct.
- (ii) All ducts, transformation pieces and fittings to be made on CNC profile cutters for required accuracy of dimensions, location and dimensions of notches at the folding lines.
- (iii) All edges to be machine treated using lock formers, flangers and roller for turning up edges.
- (iv) Sealant dispensing equipment for applying built-in sealant in Pittsburgh lock where sealing of longitudinal joints are specified / required.

e. Selection of GI gauge and Transverse Connectors

- (i) Duct Construction shall be in compliance with 1" (250 Pa) w.g. static norms as per SMACNA
- (ii) All transverse connectors shall be the branded 4-bolt slip-on flange system (supplied by OEM) with built-in sealant.
- (iii) The specific class of transverse connector and duct gauge for a given duct dimensions shall be as per SMACNA - Sheet Metal and Air conditioning Contractors' National Association Inc-"HVAC Duct Construction Standards- Metal and Flexible"-1995, U.S.A.
- (iv) Non-toxic, AC-applications grade P.E. or PVC Gasketing is required between all mating branded flanged joints. Gasket sizes should conform to flange manufacturer's specification.

f. Duct Construction

- (i) The fabricated duct dimensions should be as per approved drawings and all connecting sections are dimensionally matched to avoid any gaps.
- (ii) Dimensional Tolerances: All fabricated dimensions will be within $\pm 1.0\text{mm}$ of specified dimension. To obtain required perpendicularity, permissible diagonal tolerances shall be $\pm 1.0\text{ mm}$ per metre.
- (iii) Each and every duct pieces should be identified by color-coded sticker, which shows specific part numbers, job name, drawing number, duct sizes and gauge.
- (iv) Ducts shall be straight and smooth on the inside. Longitudinal seams shall be airtight and at corners only, which shall be either Pittsburgh or Snap Button Punch as per SMACNA practice, to ensure air tightness

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- (v) Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Turning vanes or air splitters shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.
- (vi) Plenums shall be shop/factory fabricated panel type and assembled at site.
- (vii) The deflection of transverse joints should be within specified limit for rectangular duct deflection as given in SMACNA.
- (viii) Reinforcement of ducts shall be achieved by either cross breaking or straight beading depending on length of ducts as per SMACNA.

iii. Support system

- A completely galvanized system consisting of fully threaded rods, slotted angles or double-L bottom brackets (made out of 3.0 mm M.S. sheet) nuts, washers and anchor bolts generally conforming to SMACNA standards should be used.
- Support for Horizontal - Rectangular duct

S. No.	Max. Duct Size (mm)	Hanger Rod Diameter	Interval (mm)
1	Up to - 700	6 mm	2400
2	701 - 1200	8 mm	2400
3	1201 - 2000	10 mm	2400
4	Above 2000	12 mm	2400

- As an alternative, slotted galvanized brackets attached to the top two bolts of may also be used as appropriate for the site condition.
- To provide the required thermal brake effect, Neoprene or equivalent material of suitable thickness shall be used between duct supports and duct profiles in all supply air ducts not enclosed by return air plenums.

iv. Installation -Tools and tackles for site work

The duct installation shall conform to SMACNA norms. For duct assembly and installation, the use of suitable tools and tackles should be used to give the required duct quality and speed of installation including (but not restricted to)

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- Electric Pittsburgh Seamer – used for closing Pittsburgh joints
- Electric Slitting shear – to make cut-outs
- Drilling machine with drill bits – for drilling holes in sheet metal work
- Hammer drill machine with drill bits – for drilling holes in building structures for anchors
- Hoisting system – for lifting the duct assembly upto mounting heights

v. **Testing**

After duct installation, a part of duct section (approximately 5 % of total ductwork) may be selected at random and tested for leakage. The procedure for leak testing should be followed as per SMACNA - “HVAC Air Duct Leakage Test Manual” (First Edition)

5.8 Supply Grilles / Diffusers (with VCD)

- a. Supply air grilles along with volume control dampers (VCD) shall be used for distribution of air into the premises and shall be mounted on duct collars.
- b. GI sheet not less than duct thickness shall be used for the manufacture of grills. All grills shall be true to shape and shall be checked with level gauge before being secured in position. No distortion or wrapping is permitted.
- c. Supply air grills shall be fitted with built-in louvers as per manufacturer’s standard design. The grill shall be operated with an easily accessible lever to direct and control the air (to fully closed position also). The volume and direction control dampers shall be designed for smooth operation.
- d. Air distribution grills / diffusers shall be preferably of square - Anodised aluminium, powder coated of size 300 / 400 / 500 mm.
- e. All duct mounted grills shall be complete with rubber gaskets and flanged holding frames of suitable design for the intended installation. They shall be mounted on collar extending from the duct. No part of grills shall project into the main duct. Wall / vertical mounted supply grills shall have one set of adjustable louvers. The front of louvers shall be of horizontal type to adjust vertical deflection.
- f. Air distribution diffusers / grilles shall offer a pleasing appearance and be of Anodised aluminium, Powder coated to match the F/C & internals. The diffusers shall also be

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provided with adjustable dampers. Return air can be collected above the false ceiling through - return air linear grills at the perimeter of premises.

Volume Control Dampers

- a. Volume control damper shall be provided to regulate the airflow in duct branches.
- b. The volume control damper for rectangular duct shall be multi-leaf, opposed acting, aerofoil blade type with external operating link and operating mechanism.
- c. Size of the volume control damper shall be as per duct sizes.
- d. Volume control damper shall have flanges at both ends to connect – up with the ducts.

Fresh Air Filter at Package AC

- a. Fresh Air filter shall comprise of Pre-filters with damper, cowl, bird screen & mounting frame.
- b. Size of filter panel shall be preferably of standard size - 610 x 610 x 50 / 150 mm thick for Pre filter.
- c. Pre-filter shall be of 3 ply HDPE panel type with efficiency of 90% down to 10 microns.
- d. Velocity of air across the filter shall be in the range of 2.0 - 2.5 m / sec.
- e. Filter panel shall be cleanable and washable type for reuse.
- f. Cleaning efficiency of the Pre filter element shall be 90% down to 10-micron size of dust particles.
- g. Filter material shall be enclosed in a sheet metal framework. Filter frame shall be fabricated from 16 G M.S sheet in welded construction. All leakage areas shall be sealed with suitable sealing compound.
- h. Proper sealing shall be ensured to prevent leakage of air between mounting frame and filter panels.

Solenoid / Motor Operated Fire Damper

These dampers shall be provided on the supply air duct & on return air path / duct to isolate the served premises in case of fire. Operation of these Dampers as well as the Fan Motors is to be interlinked with the Plant's Fire / smoke detection system - to switch off in case of Fire.

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5.9 Thermal Insulation of Duct

Thermal insulation of supply & return air ducts shall be provided with fire retardant quality Closed cell Nitrile Rubber (class 'O') or closed cell Polyolefin foam of thickness not less than 19 mm & 32.0 mm for return and supply air ducting respectively. The insulation material density shall not be less than 25 kg/m³ and the same shall be factory fabricated pre-laminated with Al. foil on one side and seal the joints by means of aluminium foil self-adhesive tape. Calculation for arriving at the thickness of insulation shall be provided for reference.

5.10 Acoustic Insulation of Duct

The acoustic insulation for plenums & 5.0 m from initial portion for ducts shall be carried out with open cell nitrile rubber / open cell polyolefin foam thickness not less than 25 mm and density not less than 25 kg/m³ and should be fixed inside the ducts as per manufacture instruction.

5.11 Under-Deck Insulation of Exposed Roof

Under deck insulation shall be provided for the exposed roof of Air-conditioning premises. The Under-deck insulation shall be carried out as per the following description: -

- a. Fix MS cleat made out of 50 x 50 x 3mm MS flat to the underside of the slab at 600 mm center to center using MS dash fasteners of size M6 x 40 mm long.
- b. Fix cross linked polyethylene foam (XLPE) of density 35 kg/m³ TF quality PUF / 48 kg/m³, 50 mm thick with aluminium foil 0.03 mm laminated on one side on to the open bed made out of 22 SWG GI wire with aluminium foil lamination facing the floor.
- c. Fix GI wire netting of size ½" x 22 SWG on to the MS cleats ensuring proper contact of insulation with ceiling.

5.12 Acoustic Insulation of AC / PAC room walls

Acoustic insulation shall be carried out for PAC / Fan / AHU Rooms which are located near to Office / conference Rooms. Such units will be specifically indicated for providing acoustic insulation as per the following method: -

- Fiber glass CR-300 ½" thick / RB glass wool with perforated Al. foil face to be used.
- The wall shall be cleaned & 50 x 50 mm GSS channels runner at 600 mm center to center shall be fixed to 50 x 50 mm gutties duly grouted to the wall. The hard ware shall be brass no. 8/100 mm long wooden screws.
- Reinforced fiberglass cut to size shall be placed between the GSS channels with foil face on inside.

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- The entire surface shall be covered with 80 mm x 0.63 galvanized wire netting reinforced with 1.0 mm galvanized steel wire

5.13 BLDC-Man coolers

Heavy duty BLDC man cooler (air circulators) 24-inch (600mm) sweep, wall mounted suitable for single phase supply 220vac, 50hz rated power 140–200-watt, speed 1400 rpm $\pm 5\%$, air delivery 550 CMM minimum with reverse polarity protection, short circuit protection and blocked blade protection.

5.14 Tube Axial (TA) Fan / Propeller Fan

- a. The TA / Propeller fans shall be suitable for wall mounting.
- b. The fans are to work at an ambient temperature of + 50 ° C during summer & + 10 ° C during winter & shall conform to IS: 3588 (TA Fan) / IS: 2312 (Propeller fan).
- c. Fans shall be fitted with drilled flanges for fastening with inserts embedded plates at the wall opening.
- d. The specifications for fan have been indicated for standard air.
- e. All fans shall be of rugged steel construction with proper painting, suitable for wall mounting & continuous operation.
- f. The fans shall handle ambient air for providing fresh air supply / exhaust.
- g. The impeller shall be directly mounted on the motor shaft & motor shall be in the air stream.
- h. Fans shall have suitable cowl & bird screen with provision for mounting on the wall opening.
- i. Fans are to be provided with two coats of anti-corrosive finishing paint over two coats of red oxide primer.

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CHAPTER-6

Electrical Works

TECHNICAL SPECIFICATION

6.0 Introduction:

Major electrical loads of facilities can be broadly classified into the following:

- Process & Testing Equipment.
- Utility system (Lifts, STP/firefighting pumps, Water supply facilities etc.,)
- Instrumentation & control loads (LAN, PA, FDA, EPBAX, IT facilities etc.,)
- Light residential loads
- UPS & Critical Lighting
- Illumination for roads, open areas etc.

UPS are planned for Critical Lighting (for entry, fire exit, staircase etc.,) of Office Typology building during Critical situations and Emergency Evacuation.

6.1 DESIGN CONSIDERATIONS:

The design of Power Distribution System and Selection of Equipment shall be based on the main consideration of simplicity, safety and reliability, ease of operation & maintenance.

The Equipment shall conform to relevant IS/IEC specifications and codes of practice to meet the operational requirements and to ensure reliable and safe operation. Generally, all electrical equipment shall be of Type Tested design in line with IS / IEC standards.

6.2 STATUTORY COMPLIANCE:

Indian Electricity Rules as enforced by State Electricity Authority shall be complied with and adhered to. Safety Standards as per relevant codes/norms/practices shall be applicable.

6.3 INCOMING POWER SUPPLY:

33kV incoming Power Supply shall be made available inside the Plant boundary at the Metering cubicle by State electricity Board. Incoming Power transmission lines and metering cubicle shall be made available by Client through SEB.

6.4 SCOPE OF WORK AND BATTERY LIMITS

Battery limits /scope of work shall start from the 33kV metering cubicle and downstream Main Receiving Substation (MRSS). 33kV incoming power supply shall be stepped down to 11kV

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through 33/11kV, ONAN Power transformers and further downstream to 415V through 11/0.433 kV ONAN Distribution transformers.

Adequate qty. of Compact secondary substations (CSS) is considered for catering to LT loads of various facilities from MRSS building.

6.5 DESIGN PARAMETERS:

STANDARD VOLTAGE LEVEL

S.N.	Description	Data
1.	HT AC	33 kV, 3 phase, 50 Hz, effectively earthed. 11 kV, 3 phase, 50 Hz, effectively earthed.
2.	Control voltage for HT switchgear	110 V DC
3	LT AC	415V, 3Phase, 50 Hz, effectively earthed.

SYMMETRICAL SHORT CIRCUIT RATING:

S.N.	Description	Short Circuit Rating
1.	33kV and 6.6 kV switchgear	26 kA for 3 sec.
2	415V switchgear	50kA for 1 Sec.

PERMISSIBLE VARIATIONS IN POWER SUPPLY:

The system/unit/plant/equipment shall be designed so as to be suitable for the following variations in incoming voltage and frequency unless specifically indicated otherwise in the technical specification:

S.N.	Description	Voltage	Frequency
1.	For HT & LT system	+/-10%	+/- 3%
2.	For Control voltage DC	+/-10%	NA

In case of sensitive equipment which require more stringent quality of power supply with lesser variations to achieve the desired performance, the supplier shall provide the necessary regulator/stabilizer required before such equipment.

Equipment selection and de-rating will generally be based on ambient temperature of +50°C

TECHNICAL SPECIFICATION

6.6 EQUIPMENT SPECIFICATION:

A. POWER TRANSFORMER:

The Power transformer is envisaged to step down the 33kV incoming supply voltage to 11kV voltage @MRSS. The transformers will be suitable for outdoor installation and will be oil immersed and designed for ONAN cooling

S. No	Description	
1	3 Phase power supply system in which transformer is to be used	
a)	HV side Max. Voltage	33 KV
b)	LV side Max. Voltage	11.5 KV
2	Transformer application	Power Transformer
3	Rated no load voltage	
	- HV Winding	33 kV
	- LV Winding	11 kV
4	Method of cooling	ONAN
5	Rated MVA at no load voltage & principle tap (ONAN rating)	
	ONAN	As per SLD.
6	Percentage impedance voltage at rated current, frequency, principle tap and 75°C	12.5%
7	Winding data	
	a) No. Of windings	Two
	c) Winding connection (HV / LV winding)	Delta/Star
	d) Vector groups HV-LV	DNyn

TECHNICAL SPECIFICATION

8	Bushing current transformers (LV Neutral side)		Shall be accessible without removing tank cover and active parts
	a) Location		LV neutral
	- Application		Core 1-REF Core 2-SEF
	- No. of cores on the CT (Quantity)		2
	- Type		Ring
	- Ratio	Core 1	As Required
		Core 2	As Required
9	CT for winding Temperature compensation		
	-Type		As Required
	-Ratio		As Required
	-Class		Metering
	-Burden		As Required
10	Transformer mounted on:		
	i)	Rollers/flanged wheels	Flanged wheels
	ii)	Flanged wheels (removable)	Removable
	iii)	Rail gauge (in both axis)	1676mm Rail gauge

B. 11/0.433 kV DISTRIBUTION TRANSFORMER:

HT power supply is stepped down to 415V at each CSS using 11/0.433kV, three phase ONAN, oil filled, outdoor type copper wound distribution transformers.

1	3 Phase power supply system in which transformer is to be used	
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TECHNICAL SPECIFICATION

a)	Primary side (HV) max. Voltage	11 kV
b)	System earthing Primary side (HV) Secondary side (LV)	Solidly grounded
2	Direction of power flow	Uni directional
3	Transformer application Applicable standards	Distribution transformer IS 1180
4	Transformer type Indoor/ outdoor Dry type/ liquid filled Core type/ shell type	As per requirement Mineral oil filled Core type
5	Auto wound / two winding/ three winding	Two winding
7	Number of phases	Three
8	Rated frequency	50 Hz., $\pm 5\%$
9	Rated no load voltage HV winding LV winding	11 0.433 kV
10	Cooling Method of cooling Cooling liquid	ONAN Mineral oil
11	Rated MVA at no load voltage & principle tap (ONAN rating) ONAN	As per IS/IEC.
12	Overloading as per IS 6600	Required
13	Max. Temp. rise at rated MVA & principal tap	

TECHNICAL SPECIFICATION

	Top oil by thermometer method over design ambient temp. Any winding (HV&LV) by resistance method over design ambient temp. of 45°C Hot spot temp. based on the design ambient of 45°C	40°C over 45°C 40°C over 45°C 105°C	
14	Percentage impedance voltage at rated current, frequency, principle tap and 75°C Between HV-LV	As per IS	
15	Tappings Off-circuit/ ON load Manual /automatic No. of steps Percentage variation /step Winding in which tappings are required	Off Circuit Manual 4 2.5 (Equal), -5% to +5% HV	
16	External terminal Short circuit withstand capability of transformer on any tapping for 3 phase and line to ground faults across LV winding	Not less than 2 sec.	
17	Insulation		
	PF withstand kV (RMS)	Impulse withstand kVP	Switching Impulse withstand
	HV winding 20KV LV Winding 2.5KV	60kV -	NA
18	Winding insulation category		

TECHNICAL SPECIFICATION

	a) HV-uniform /non-uniform b) LV-uniform/ non-uniform	Full Insulation Full Insulation
19	Winding data No. of windings Winding material Winding connection (HV \ LV winding) Vector groups HV-LV1	Two Copper Delta / star Dyn11
20	Core laminations Type Material	CRGO SILICON STEEL
21	Noise level in DB scale when measured 4 ft. from the transformer edge at a height of 5 ft. above the floor at rated voltage and load	As per IS
22	Bushing current transformers:	

TECHNICAL SPECIFICATION

	Location		1 HV neutral	2 LV neutral	
	No. of cores on the CT		NA	Inside Neutral terminal box	
	Type		Not applicable	2 cores	
	Ratio		Not applicable	Indoor	
	Protection class		Not applicable	As required	
	Knee point voltage		-	Class PS, 5P15, 15VA	
	CT sec. Resistance at 75°C		-	500 Volts	
	Short time rating for 2 sec		:	Less than 5 ohms	
	Magnetising current at $V_k/2$:	As per trafo	
	Accessibility		:	Not more than 20mA	
			:	Shall be accessible without removing tank cover/active parts	
			:		
			:		
			:		
			:		
23	Bushings	Line bushings		Neutral bushings	
		HV	LV	HV	LV
	Type	Porcelain	Porcelain	Not applicable	Porcelain 2 nos.
	Voltage class	12 kV	1.1 kV		1.1 kV
	Current rating in Amps. Minimum	As per Requirements & Trafo rating			
	Creepage distance	Not less than 31 MM per kV of rated voltage of the bushing			

TECHNICAL SPECIFICATION

	Short time rating & insulation level	As per trafo
24	Terminal arrangement	
	High voltage	Bottom entry, Cable box with Air insulated Disconnect chamber
	Secondary	Bottom entry, Cable box with Air insulated Disconnect chamber
25	Radiators	Detachable
26	Transformer mounted on:	
i)	Rollers/ flanged wheels	Bi-directional rollers

C. LIGHTING TRANSFORMER:

To cater to illumination, need of the plant, required no. of 11/0.433kV and 415/433V Lighting transformers of suitable capacity has been considered as applicable.

The transformer design shall ensure that the efficiency of transformers is compliant with CBIP Guidelines for energy efficient transformers.

Sl. No.	Particulars	
1.	Specification	IS 2026, IS 11171 – 1985
2.	Type	Three phase, core type, cast resin dry type
3.	Duty	Indoor, installed in room
4.	Degree of Protection of Enclosure	IP32 for indoor and IP42 for outdoor.
5.	Voltage HV/LV	11/0.433 kV 415/ 433V

TECHNICAL SPECIFICATION

Sl. No.	Particulars	
6.	Frequency	50 Hz
7.	No. of phase	3
8.	Continuous rating	As per requirement
9.	Conductor	Copper
10.	Insulation class	Class F
11.	Cooling	AN
12.	Winding connection	Delta / Star
13.	Vector group	Dyn 11
14.	Neutral grounding	Effectively earthed
15.	System earthing	HV -Resistance earthed LV-Effectively earthed
16.	Percentage impedance	As per IS
17.	Termination	Cable end box suitable for termination of XLPE aluminium cables, with air insulated disconnecting chamber Suitable for Cable termination
18.	Temperature rise over 50°C ambient temp	In winding (measured by Resistance method) – 70°C Core and other adjacent parts of winding - 70°C
19.	Bushing mounted CT's	
	CT in LV Neutral bushing for standby E/F protection	Ratio: as required Class: as required

TECHNICAL SPECIFICATION

Sl. No.	Particulars	
20.	Off circuit tap changer Range Total tap positions Taps above nominal voltage Taps below nominal voltage Voltage per step variation Tap change controls	Bolted Link type $\pm 5\%$ 5 2 2 2.5 % Manual
21.	Impulse test withstand voltage	As per IS 2026, Part III – 1981
22.	One minute dry and wet power frequency withstand voltage	- do -
23.	Short circuit level on Primary side	50kA
24.	Time duration to withstand 3 phase short circuit at secondary terminals, without any injury.	1 Sec.
25.	Auxiliary supply voltage	240 V AC
26.	Parallel operation	Suitable for parallel operation with transformers of similar ratings
27.	Overload capacity	As per IS 6600

D. HT SWITCHGEAR:

The HT switchgear envisaged shall be indoor type sheet metal clad, draw out type with VCB circuit breakers and shall be provided with necessary protection, control gear, metering and audio-visual alarm annunciation system. The circuit breaker mechanism shall be mechanically and electrically trip free. The circuit breakers shall be electrically operated, stored energy type and shall be operated on 110V DC / 220V DC control power supply.

TECHNICAL SPECIFICATION

The switchgear shall be equipped with microprocessor based numeric relays, energy monitoring devices like multifunction meters etc.

A separate dummy / cable chamber panel shall be provided for the feeders where more than two nos. cables are terminated.

Sl. No.	Particulars	11 kV
1.	Type	VCB
2.	Service	Indoor
3.	Enclosure	IP4X
4.	Nominal System Voltage	11 kV
5.	Highest System Voltage	12kV
6.	No. of phases and frequency	3ph. 50 Hz
7.	Busbar material	Copper/ Aluminium
8.	Bus Color code	RYB
9.	System Earthing	Solidly Earthed
10	Continuous Current Rating at 50°C(I/C)	As per SLD
11.	Short Circuit Rating	26.2 kA
12.	Short Circuit duration	3 Sec
13.	Rated making Current	100 kA
14.	Busbar Rating	As per SLD
15.	Power Frequency Withstand voltage (RMS)	28kV for 1 minute
16.	Impulse withstands Voltage (1.2/50 micro sec) peak	75 kV
17.	Control Voltage	110 V DC / 220V DC

TECHNICAL SPECIFICATION

Sl. No.	Particulars	11 kV
18.	Spring charge motor voltage	240 V AC
19.	CT Ratio	As per SLD
20.	Bus PT and Line PT	As per SLD
21.	Aux. Contacts	6 NO + 6 NC
22.	Termination	
22.1	Incomers	Armoured XLPE, FRLS Al Cable
22.2	Outgoings	Armoured XLPE, FRLS Al Cable
23.	Clearance in air Phase to phase (mm) Phase to earth (mm)	As per IEC

The switchgear shall be equipped with Microprocessor based Numeric Relays, Energy Monitoring devices like multifunction meters etc.

A separate dummy / cable chamber panel shall be provided for the feeders where more than two nos. cables are terminated.

All major relays and multifunction meter shall be microprocessor based numerical and communicable type.

The multifunction meter shall have the following minimum features.

- Ammeter
- Voltmeter
- Frequency meter
- Power Factor meter

TECHNICAL SPECIFICATION

- kW meter
- kWH meter
- kVA meter
- kVAR meter with lead & lag facility
- Maximum Demand meter & controller (as per requirement)

E. CONTROL SUPPLY:

- Control supply buses shall run throughout the switchgear.
- Two DC feeders shall be taken in each board controlled by MCCB's.
- In each panel for controlling of its DC supply MCCB (DC duty) shall be used. DC Auto Changeover and Manual Changeover facility shall be provided. Failure of each DC supply shall be monitored in the switchboard as well as at remote.
- 110V / 220V DC supply shall be taken from a station aux. board.
- Each section shall have separate feed with automatic changeover scheme.
- Each panel shall have one MCB for controlling its AC supply.
- Sub circuits shall be protected with HRC fuses in each panel for indication lamps, closing and tripping circuits.
- Control circuit should be protected, preferably with MCBs, alternatively HRC link type fuses conforming to IS 9224-1979.

F. LT POWER FACTOR COMPENSATION EQUIPMENT

The Capacitor Bank shall be provided to improve Power factor from 0.8 to minimum 0.95 lag at CSS. The HT capacitor bank unit of MRSS shall comprise incoming side Isolators, Lightning Arrestors, Series Reactor, Discharge PT's, Capacitor banks, Neutral unbalance protection CTs, bus work, supporting structures, etc. as required to make the installation complete in all respects.

The selection of Power Factor Compensation (Capacitors with Reactors) and associated Equipment shall be finalized as per system requirements.

Sl. No.	Description	415V
1	Type of connection	Delta Connection

TECHNICAL SPECIFICATION

2	Bank rating in kVAR	refer SLD
3	Bank rating in capacitance	As required
4	Method of mounting	In CSS
5	Type of steel	Galvanised steel with minimum galvanization of 900 gm/ sq.m
6	Bank formation	By copper bus bars taped to full insulation level
7	Insulation level	As per IS (impulse and power frequency)
8	Bus bar insulators	As per IS (Clearance)
9	Installation	Indoor

G. COMPACT SECONDARY SUBSTATIONS (CSS):

Designed in accordance with IEC 61330 standards, the CSS shall be prefabricated secondary substation with type-tested equipment and consists of VCB along with CT & PT, distribution transformer, and associated equipment in a compact unit. The CSS shall be designed to achieve high levels of personnel safety and aesthetics.

The Compact Substations, Non- Walkable type shall be factory assembled unit consisting the following major equipment.

- 11kV RMU with earth switch
- 11 kV Vacuum Circuit Breaker.
- Up to 2500 kVA 11/0.433 kV, ONAN/ AN Transformer
- 415 V LT bus bar
- LT Distribution Board
- HV Surge arrestor
- 11kV Current & Potential Transformers

All components are housed in an enclosure, which protects the equipment against environmental hazards and unauthorised access. The enclosure is typically divided into two sections or compartments as follows:

- Vacuum Circuit Breaker (VCB)
- Distribution Transformer

TECHNICAL SPECIFICATION

H. LT POWER /MOTOR CONTROL CENTRE (PMCC/MCC):

The 415V switchboards shall comprise of Air Circuit Breakers/MCCB, in Draw Out design and multi-tier formation. The switchboard shall have two bus sections and a bus coupler breaker with provision for auto changeover in the event of loss of power on any one bus section.

The circuit breakers shall be electrically operated and equipped with Microprocessor /Static type direct acting releases for over load and short circuit as well as earth fault protection.

All Motor Control Centres (MCCs), large drives starter panel (rating 55 kW to 160kW) and Power Distribution Boards (PDBs) shall be supplied power from the LT PMCC (415V switchboard). The 415V switchgear shall confirm to IS-8623 and IS 13947.

Description	Particulars
Nominal system voltage	415 V
System Earthing	Neutral solidly earthed
Short time rating	50 KA for 1 Sec.
Making capacity	105 kA
Control supply	240V AC
Configuration	As per IS
Colour code	RYB
Busbar rating	As Per Incomer Rating
Enclosure	IP-4X or better
Circuit Breakers	
Symmetrical breaking current	50 kA
Making capacity	105 kA
Short time rating (for 1 second)	50 kA

TECHNICAL SPECIFICATION

Rating for incomers	As per SLD
Rating for outgoing	As per Single Line Diagram Or requirement during engineering stage.
Closing mechanism	
i) Incomer & bus sectionalizer	Motor operated spring charged stored energy type
ii) Outgoing	Independent manual
Spare	20 % of feeder or minimum 2
Tripping mechanism	Shunt trip
Control supply	240 AC
No. of auxiliary contacts	6 NO + 6 NC for future use
Termination	
a) Incomer	Bus duct (top entry)
b) Outgoing	Armoured aluminium cable

I. AC DISTRIBUTION BOARD (PDB/ACDB)

415V, 3 phase, 4 wire, 25 KA short time rating for 1 second (for ACDB) indoor type. Board shall be single front, metal clad, front matched, dust and vermin proof, fully compartmentalized and extensible on both sides, IP5X type enclosure. DB Shall have base channel of size ISMC75.

DB Shall have isolated busbar chamber for main busbar at the top, running throughout the length of the board. Chamber shall have removable cover.

Cable alley shall have sufficient space for Aluminium power cables and bottom cable chamber shall be left free completely isolated from the vertical busbars.

Busbars shall have same cross section throughout the length. Rating of the neutral bus bar shall be 50% of the main bus bar. Earth bus bar shall run in bottom chamber throughout the length of the panel.

DB shall have Moulded Case Circuit Breaker (MCCB) triple pole, air brake type with independent manual quick make and break type. MCCB shall be capable of breaking rated current at 0.3 PF at the rated voltage.

MCCB shall withstand the fault current envisaged for 415V system.

All feeders shall have ON/OFF lamps and 96 sq mm size ammeter.

TECHNICAL SPECIFICATION

Incomer & Bus-coupler shall have manual operated ACBs with Microprocessor based O/c, short circuit, earth fault & shunt trip releases and outgoing shall be MCCBs.

J. Battery, Battery charger and DC distribution board (PLANT)

Adequate capacity of 110V DC or 220V DC Plante type Battery along with Battery charger & DCDB shall be provided for catering 110V DC / 220V DC control supply to 11KV HT switchboards.

The system shall include:

Two Battery system (1 W+ 1 S) each comprising with

- DC Battery set
- Two identical automatic float-cum-boost chargers
- DC distribution board

K. HT / LT CABLES:

Power inside the plant shall be distributed through cables to various premises.

HT & LT Cables shall be laid through Underground Cable Service corridors. HDPE Pipes shall be used at road crossings and paved area.

Inside the substations and covered premises, the cables shall be laid in cable cellar, Cable basement or in concrete channels (over cable supporting structures) or on columns and other available structures. Power cables shall be laid on ladder type GI cable trays, whereas control cable shall be laid on perforated cable trays.

11kV cables shall be heavy duty, FRLS, XLPE insulated, PVC sheathed multi core, aluminium/copper conductor steel wire double armoured, FRLS type.

Cables for 415 V system shall be heavy duty, 1.1kV grade, PVC /XLPE insulated PVC sheathed aluminium conductor, double armoured type FRLS type.

The control cables shall be multi strand copper conductor, PVC insulated and PVC sheathed with minimum cross section of 2.5 sqmm for control voltage circuit and 4.0 sqmm for power circuit.

Copper Cable shall be provided for rating up to 3.7kW.

The HT cables shall conform to IS-7098 –1988, whereas LT power and control cable shall confirm to IS-1554-1988.

All HT and LT power and control cables shall be double armoured type.

TECHNICAL SPECIFICATION

Cable cellar shall be envisaged in LT substation. Also, cable cellar shall be considered in Main receiving substation. All cable trays shall be galvanized and ladder type for power cables.

Cable shall be laid separately for HT and LT feeders. All cable entry points shall be sealed with Fire retardant paints and material and all cable shall be painted with fire retardant paint.

Ventilation system shall be considered dry ventilation system. Split AC shall be considered for control room, office room, conference room, VVVF room etc.

L. 415V POWER DISTRIBUTION BOARDS:

Power distribution boards (PDB) will be feeding power to cranes, hoist and utility sockets. All incoming and outgoing MCCBs/ACBs shall have electronic/microprocessor-based releases with adjustable LSIG protection.

LT Switchboard	
Nominal system voltage	415 V
System earthing	Neutral solidly earthed
Short time rating	50kA for 1 Sec.
Making capacity	105kA
Control supply	240V AC
Busbar rating	AS per SLD
Enclosure	IP-4X or better
Circuit Breakers	
Symmetrical breaking current	50 kA
Making capacity	105 kA
Short time rating (for 1 second)	50 kA
Rating for incomers and buscouplers	AS per SLD
Rating for outgoing (ACBs)	AS per SLD
Incomers & bus couplers	Motor operated spring charged stored energy type.
Outgoing feeders	Motor operated spring charged stored energy type.

TECHNICAL SPECIFICATION

Tripping mechanism	Shunt trip
Control supply	240V AC as applicable
Incomer	Bus duct (top entry)
Outgoing	Armoured aluminium cable
Feeder Arrangement	
Incomer (Mounted in single tier arrangement)	Air circuit breakers
Outgoings (Mounted in Double tier arrangement)	Air circuit breakers

M.LT MOTOR CONTROL CENTRE (LT MCC)

Motor Control Centres (MCCs) shall be Draw-out type, Single front in IP-54 enclosure with single incomer for control of drives of rating equal to or less than 90kW. MCCs will be draw out, single front, modular construction.

General		
1.0	Type	Metal clad Drawout
2.0	Construction	Modular construction. Fully compartmentalized with metal / insulating material partition.
3.0	Enclosure class	IP54.
4.0	Type of execution	Single front.
5.0	Mounting	Floor mounting. Free standing with ISMC 75.
6.0	Installation	Indoor.
Busbars		
(i) Main horizontal & vertical busbars		
1.0	Arrangement	Three phase & neutral. Bus Bar chamber on the top.

TECHNICAL SPECIFICATION

2.0	Material	High conductivity electrolytic aluminium alloy confirming to grade E91E as per IS-5082 -1981.
D. Insulation level		
1.0	Rated insulation voltage	1100 V
2.0	Impulse withstand voltage	4 kV as per IS-13947 (Part I) 1993
3.0	One minute power frequency withstand voltage	2.5 kV for power circuit & 500 V for control circuit
E. Pollution Degree		
1.0	Pollution Degree	Pollution Degree 3 As per IS-13947 (Part-1) : 1993 ; unless otherwise stated

N. MOTOR CONTROL PANELS (MCP)/SOFT STARTER:

For LT motors of rating greater than 55kW and up to 160kW shall be provided with independent Motor Control Panel (MCPs) which shall be directly fed from LTSS/PCC. MCPs shall be conventional type, Single front, non-draw out type with IP-54 enclosure class of protection. Power devices like MCCB, Contactor, Electronic type Over Current relay (EOCR) with combine protection & display, Control transformer etc. shall be located in MCPs.

Soft Starter shall be provided for drive rating in range of 90kW to 180kW where full torque load starting is not required (like fans, pumps etc.). Separate panel to be provided for the same.

O. Main Lighting Distribution Boards (MLDB):

Main Lighting Distribution Boards (MLDB) with two incomers and bus coupler for Power supply to various Lighting Distribution Boards (LDB). MLDB shall have 415/415V isolation transformers in Incomers. capacity.

Main Lighting Distribution Board (EMLDB) will be provided for power supply of all light fittings One incomer will be from MLDB and second incomer will be fed from Emergency source.

TECHNICAL SPECIFICATION

P. VARIABLE FREQUENCY DRIVES (VFD)

VVVF converters will be provided for drives having requirement of speed control or any other equipment where process requirement calls for variable speed application. De-rating on account of ambient temperature of 50°C shall be done while calculating the continuous current rating of VFDs.

Rating Selection of Variable Frequency AC Drives:

For constant torque load, continuous current of AC drives will be 150% of motor full load rated current (as indicated in motor data sheet/name plate).

- a. For motion control drives, belt weigh feeders, Vibrating feeders and intermittent duty drives – 125% of motor full load current (as indicated in motor data sheet/name plate).
- b. For continuous duty drives like pumps, fans etc. – 115% of motor full load rated current (as indicated in motor data sheet/name plate).
- c. Current rating of AC drive will be calculated after de-rating to specified ambient temperature.
- d. Line reactor will be provided in incoming side of VFD. Suitable output chokes/ terminator will be provided in output side of the VFD considering limitations of cable distance as per manufacturer's recommendation.
- e. Continuous current rating of VFDs will be selected for heavy duty rating.

Q. UN-INTERRUPTED POWER SUPPLY (UPS)

Dual parallel redundant system with provision of bypass line with static bypass switch and stabilizer. Each UPS set shall be rated for full capacity and in normal condition both the UPS shall be sharing the total load and in case of failure of any one UPS, other healthy UPS shall take the full load.

Each UPS set shall consist of common battery bank for 30 minutes back up (for lighting) and 1 hour backup (for workstation) in case of power failure.

UPS system with UPS Power distribution board, sub-distribution boards for distribution of power to Automation system equipment, Instrumentation system equipment, Weighing system, CCTV system, FDA system, Telecommunication system, LAN & any other equipment as per requirements.

TECHNICAL SPECIFICATION

R. HT/LT MOTORS

Low Voltage Squirrel Cage Induction Motor

Sl. No.	Parameters		Description
1	Motor body		Grey iron casting.
2	Motor Feet		Integrally cast with the stator.
3	Protection for Motor & Bearing		IP – 55
4	Shaft ends & Extension		Cylindrical.
5	Bearings	-	<ul style="list-style-type: none"> - Motor of rating upto 7.5kW, ball bearings will be used for both DE & NDE end. - Motor ratings above 7.5 kW, DE will be provided with roller bearing and NDE will be provided with ball bearing.
6		Terminal box	
i	Location		RHS viewed from DE/on Top.
7	Cooling	-	- TEFC (IC-411)
8		Electrical design	
I	Power Supply		415V
II	Starting Torque		>= 160 % Rated Torque.
III	Breakdown or pullout torque		Minimum 200 % of the rated torque.
IV	Starting current		As per latest edition of IS 12615.
V	Max speed permissible		120% over speed for 2 minutes.

TECHNICAL SPECIFICATION

vi	Overload capacity		Capable of withstanding 160% Overload for 15 sec.
vii	Efficiency		All continuous duty motors shall be complied to IE4 efficiency class and shall confirm to IS 12615.
viii	Insulation		Class 'F'.
ix	Permissible temperature rise		Limited to class 'B' (120 deg. absolute).
x	Space Heater		Outdoor motors above 45 kW. Indoor Motors above 110 kW.

High Voltage Squirrel Cage Induction Motor

Sl. No.	Parameters	Description
1	Stator Frame	Fabricated Steel/ High grade cast Iron.
2	Stator Core	Laminated sheets of high-grade low loss silicon steel.
3	Motor body	Grey iron casting.
4	Casing Feet	Integral with the motor frame.
5	Protection for Motor & Bearing	IP – 55
6	Bearings (below 5000kW)	Anti-friction bearing with re-greasing facility and with grease quantity controllers.
7	Vibration monitor	Will be provided at the DE of motor bearing for rating 1000kW and above.
8	Bearings insulation	Against circulating shaft currents.
9	RTD & BTD (PT100 type)	- All motors will be provided with PT100 type (duplex) 6 nos. or (simplex 12 numbers) stator winding temperature detectors & 2 nos. Bearing (DE & NDE)

TECHNICAL SPECIFICATION

		<p>temperature detectors (duplex) for monitoring alarm and trip conditions.</p> <ul style="list-style-type: none"> - For HT motor temperature alarm, tripping & monitoring, RTDs (for winding/bearing) will be wired to motor protection relay in HT MCC as well as to PLC RIO as automation system inputs. Limit value contacts for alarm and tripping will be generated in the automation system along with the display of winding and bearing temperature. - Local Dial Gauge to be provided for DE & NDE Bearing temperature indication for Motors rated 1000kW and above.
10	Vibration monitoring	Vibration monitoring (online) will be provided at the DE of motor bearing for motors of ratings 1000 kW and above (or as specified in CTS) and it should be connected to plant automation system inputs for online monitoring.
11	Terminal box	
(i)	Protection	IP – 55
(ii)	Type	Main TB - Phase segregated Neutral TB- Non-Phase Segregated.
(iii)	No. of terminal boxes	Separate TBs for Space heaters, RTDs/BTDs, Vibration monitor etc.
12	Cooling	TEFC/ CACA/ CACW
(i)	Efficiency	High efficiency design of 95% or higher at full load.
(ii)	Direction of Rotation	Direction of Rotation – Bidirectional.
(iii)	Starting current	<= 600% Rated current
(iv)	Max speed permissible	120 % rated for 2 minutes.

TECHNICAL SPECIFICATION

(v)	Differential protection	Required for 1000 kW & above.
(vi)	Insulation	Class 'F' & confirming to IEC 34 - 15/1990.
(vii)	Insulation Material	Cast resin rich/Poor.
(viii))	Permissible temperature rise	Limited to class 'B' (120 deg. absolute).
(ix)	Space Heater	Required & automatically off during RUN.

LT Inverter Duty Motor

Sl. No.	Parameters	Description
1	Motor body	Cast iron.
2	Motor Feet	Integrally cast with the stator.
3	Protection- Motor & Bearing	IP - 55
4	Shaft ends & Extension	<ul style="list-style-type: none"> - Cylindrical. - Shaft will be extended for encoder/tach mounting.
5	Bearing	<ul style="list-style-type: none"> - Insulated bearing will be provided at NDE for motors rating 75kW and above. - For loads exerting high cantilever forces at drive ends, roller bearings to be provided for motors of frame size 225 and above in DE.
6	Terminal box	
(i)	Location	RHS viewed from DE/ on Top.
7	Cooling	<ul style="list-style-type: none"> - TEFC, Effective bi-directional - Motor with 20:1 speed range or higher shall have external fan.

TECHNICAL SPECIFICATION

		<ul style="list-style-type: none"> - External fan motor will be 3 phase, 415 V AC.
8	Service factor	<ul style="list-style-type: none"> - 1.0 for VFD power. - 1.15 for sine wave power.
9	Peak transient voltage	3.16 times rated voltage for Motors
10	Minimum rise time	0.1 microsecond
11	Locked Rotor Torque	<ul style="list-style-type: none"> - 70 to 250% of motor rated torque for applications which requires to start at low starting torque e.g. fans, blowers, centrifugal pumps etc. - 200 to 250% of motor rated torque for applications which requires to start on load e.g. conveyors, crushers, stirring machines, agitators, reciprocating pumps and compressors etc. - 275% of motor rated torque for applications which requires to start at high torque e.g., elevators, cranes, winches, hoists etc.
12	Overload capability	150% of the rated current for 2 minutes at rated voltage and rated frequency.
13	Max speed permissible	120% rated for 2 minutes.
14	Insulation	<ul style="list-style-type: none"> - Class 'H' temperature rise limited to 'F'.
15	Space Heater	<ul style="list-style-type: none"> - Outdoor motors above 45 kW - Indoor Motors above 110 kW
16	Thermistors	<ul style="list-style-type: none"> - Will be provided in the windings. - For motors 45 KW and above, thermistor will be with 6 PTC @ 2 nos. per phase winding.

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AC squirrel cage induction motors (SCIM) of ratings up to 160kW will be fed at 415V, 3 phase 4 wire 50 Hz.

AC squirrel cage induction motors (SQIM) of ratings above 160kW will be connected to the HT power supply system.

AC squirrel cage induction motors require speed control will be from VFD and motor rating of ratings up to 200 kW will be fed by 415V VFD panel.

For motors rated & above 200 kW up to 1000 kW shall be fed by VFD rated 690V.

For motors above 1000 kW, the Motors shall be fed from MV VFD of 11 kV through dedicated converter duty transformer.

S. LOCAL CONTROL STATIONS

Each drive motor shall be provided with one Local Control Station (LCS) for testing and maintenance purpose.

The LCS shall be provided with Local-Remote selector switch, Start/stop or open/close push buttons and one emergency stop push button (mushroom headed push button press to lock turn to release type).

6.7 ILLUMINATION:

The lighting system inside and outside plant units will be designed based on the desired minimum illumination levels specified below and practices followed in industries, architectural arrangement, building dimensions including mounting height, environmental considerations, Ease of maintenance and reliability of the lighting distribution network.

Lighting Power Density (LPD i.e., Watts per Sq.m) is limited as per ECBC norms and Effective lux level is achieved as per lighting Design calculations. As per IS 3646, Type of LED fixture envisaged and Minimum Average Illuminance (lux) level to be achieved for enclosed spaces are listed below:

Area/ Application	Avg. Lux Level (Minimum) required	Type of Luminaire considered
Office Area	300	Recessed (2x2) LED Tile type fixture suitable for 600x600 mm ceiling
Store Rooms/ Food Stores/ bulk storage/ record room	150	Surface mounted (2x2) LED Square type fixture suitable 600x600 mm ceiling

TECHNICAL SPECIFICATION

Lunch Hall / Laundries	200	Surface mounted (1x4) LED type fixture
Dining Area / cafeteria (AC)/ canteen	200	Recessed (2x2) LED Tile type suitable for 600x600 mm ceiling.
Entrance / Waiting Area/Lobby	150	Round recessed LED flat panel fixture
Corridor	100	
Toilets/ Rest Room	100	
Food Preparation/ Cooking Area	200	Surface mounted (1x4) LED type fixture
Gas Manifold, Battery rooms	100	(1x2) LED flame proof luminaire fixture
Electrical Rooms	200	Surface mounted (1x4) LED type fixture
Dormitory / change room/ Locker room/ Pantry	200	Surface mounted (1x4) LED type fixture or Surface mounted (2x2) LED Square type fixture suitable for 300x300mm / 600x600 mm ceiling as applicable.
Reading Room / Library/ Discussion room / Laboratory	300	Recessed (2x2) LED Tile type fixture
Dockyard Workshop / Loading -unloading bay	300	LED High Bay Fixture
Hospital- Reception/ Waiting Lobby	150	Recessed (2x2) LED Tile type fixture
Hospital Wards-General	100	
Hospital Wards- Beds	150	
Hospital -Operation Theatre	300	
Hospital- Lab	300	

TECHNICAL SPECIFICATION

Hospital -Radiology Department	100	
Hospital-Casualty/ OPD	150	
Hospital Dispensaries	300	

A. LIGHTING POWER DISTRIBUTION

The distribution of lighting power supply for the individual areas will be done at 415V, 3 phase, 4 wire bus system through Main Lighting Distribution Boards (MLDB) for the area. Each incomer of MLDB will be fed through separate lighting transformers.

The outgoing feeders of the MLDB shall feed the required numbers of Sub Lighting Distribution Boards (SLDB) for lighting. Each SLDB shall receive power at 415V AC, 3 phase, 4 wire and distribute it into 240V, 1 phase circuits for connection to the lighting fixtures and 240V receptacles. The SLDBs will be located in the rooms, bays, shop units etc. preferably near entry/exit.

6.8 VENTILATION & AIR CONDITIONING REQUIREMENTS:

Electrical rooms of the plant will be provided with ventilation and air conditioning facilities as indicated below:

HT/LT substation room, switch gear room and MCC room, PDB/MLDB room etc. which do not house any electronic equipment but contain only electrical equipment, will be provided ventilation system. Toilet will be provided with exhaust ventilation.

Electrical room housing electronic equipment like VFDs, PLC, Remote I/O, computers, Servers, UPS, Office rooms, Conference room etc. will be provided with air-conditioned environment.

6.9 CABLE CARRIER SYSTEM:

Laying of all power cables, control cables, communication cable, FDA system cable, Telephone cable etc. from MRSS to various LT CSS, MCC room, HT Motors, Inter-facility cable route hall be through Underground Cable trench / service corridors.

Power cables will be laid on ladder type cable trays & control/ signal cables will be laid on perforated trays. Tray shall be GI Prefabricated.

Ladder type cable trays will be selected from sizes 300mm, 450mm and 600mm. Tray sizes of 200mm, 100mm, 50mm will be perforated type.

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6.10 GI OCTAGONAL STREET LIGHT POLES

The Octagonal Poles will be designed to withstand the maximum wind speed as per IS 875. The top area i.e. area of pole itself and weight of brackets & fixtures will have to be considered to calculate maximum deflection of the poles and will meet the requirement of BS 5649 Part VI 1982.

The Pole shaft will have octagonal cross section and will be continuously tapered with single longitudinal welding; there will not be any circumferential welding. The welding of Poles shaft will be done by submerged Arc Welding process.

All Octagonal pole shafts will be provided with rigid flange plate of suitable thickness with provision for fixing minimum 4 foundation bolts. This base plate will be fillet welded to the pole shaft. Foundation bolts will also be supplied.

The Octagonal Poles will have door of approximate 500mm length at elevation of 500mm from base plate. The door will be dust & weather proof & water tight. The door will be flush with exterior surface and will have suitable locking arrangement. There will also be suitable arrangement for the purpose of earthing. The pole will be adequately strengthened at the location of door to compensate the loss in section. Inside door, suitable Power Terminal Box for looping incoming 415V power cables 4CX16Sq. MM & DP MCB (C-Curve) with 3x2.5sq.mm wires will be provided for power supply to light fittings. Street light pole with two arms will have two MCBs inside the JB.

6.11 HIGH MAST LIGHTING TOWER

The mast will be high and designed in such a manner that it is capable of withstanding external forces exerted by wind pressure as per IS: 875 (Part 3)-1992 along with load of the lantern carriage assembly.

Mast Construction

The mast will be fabricated from special steel plates conforming to BS 4360/BS- EN10025 S-355 cut and folded to form number of polygonal sections, giving a continuous tapered profile for stability and aesthetics, Silicon content in steel should not exceed 03% for good quality galvanization. Bottom section will be provided with plate welded to it for anchoring the mast to a reinforced concrete foundation block. To increase the strength, gussets will be provided.

The bottom section will be accommodating winch, electric drive etc. and for the safety of the same a vandal resistant and weather proof door will be provided with locking arrangement.

The fabricated and welded mast sections as detailed above will be hot dip galvanized with a minimum thickness of coating 90 microns conforming to IS 4759-1996, IS: 2629-1990 & IS: 2633-1992, both internally and externally.

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After the delivery of the mast at site, these will be joined by slip stressed fit method with necessary stressing equipment. No site welding or bolted joints will be accepted. Earthing terminal will be provided on the mast base and feeder pillar-box as per relevant ISS. The mast will be provided with suitable LED aviation obstruction lamp.

6.12 LIGHT FITTINGS

LED Light fittings shall be considered for Internal and external lighting.

All the luminaires will be designed, manufactured and tested in accordance with the Indian Standards as far as they are applicable.

All the luminaires will be industrial type. All the lighting fixtures will be complete with all parts along with lamps/tubes, control gears and accessories for installation and efficient performance whether specifically mentioned in the schedule of items or not.

Individual LED light fittings will be provided with suitable gland arrangements for 3x2.5 sq.mm Armoured copper cable entry unless otherwise specified. Terminals of all fittings will be suitable for taking 3x2.5 sq.mm, copper conductor PVC insulated and PVC sheathed cable.

All fittings will be supplied with all interconnections made and fully wired up to the terminal block.

All live parts will be provided with suitable sleeves to prevent accidental contacts. The earthing terminal in the fitting will effectively earth the body of the entire luminaire.

Dust and vapour tight fittings will have the enclosures suitably designed to withstand the heating effect.

The fixing arrangement of various components and lamps will be in such a way that the maintenance and replacement jobs can be easily carried out.

6.13 STREET LIGHT FITTING

LED LUMINAIRE FOR ROAD LIGHTING

Street light fitting will be LED based, minimum 150-Watt, energy efficient type with minimum burning time of 50,000 hours at minimum 70% light efficiency with no toxic content and Street light fittings, suitable for outdoor duty in weatherproof enclosure class with IP65 protection, integral starting/control gear complete with controls/starter pre-wired to a terminal block. Power factor will be more than 0.9 and efficiency more than 86%. LED fixture housing will be made up of high-grade pressure die cast aluminium with powder coating to provide excellent resistant to corrosion. The fittings will be provided with heat resistant & toughened glass cover. Junction Temperature will be kept as low as possible so as to increase performance and life time of LED and ensure that the luminaires are as heat efficient as possible. Hinging

TECHNICAL SPECIFICATION

arrangement for glass cover to be provided for maintenance. The fittings will be suitable for direct mounting on poles having extended arm. LED Light fittings will be suitable for operation at an ambient temperature of 50°C and suitable for outdoor installation. Heat sink temperature rise above ambient will be limited as per relevant IS/IEC as available.

Colour Rendering Index will be greater than 70. LED Luminaire will have built in surge protection. Luminaire will have efficacy higher than 85 lumens/watt.

LED will be provided with secondary lens optics to achieve effective light intensity distribution. Make & Model Number of Luminaries will be embossed/ engraved on the luminaire The Test Reports as per IS-16105, IS-16106 & IS-10322 will be from NABL/ IESNA/GOI certified labs or lab of the manufacturer with NABL accreditation.

Design of LED fittings should be for minimum glare.

6.14 FLOOD LIGHT FITTING:

Weather proof Flood light non-integral luminaire suitable for 240V, LED lamp, high pressure die-cast aluminium housing powder coated in black, Electro chemically brightened pre anodized asymmetrical aluminium reflector with heat resistant toughened glass cover, IP 65 Lamps and lighting fixture will be of the same make.

6.15 EARTHING PROTECTION:

Entire system shall be earthed in accordance with the provisions of the relevant IEEE/ IEC recommendations/ IS code of practice IS 3043-2001 and Indian Electricity Rules, so that the values of the step and contact potentials in case of faults are kept within safe permissible limits.

Parts of all electrical equipment and machinery not intended to be alive shall have two separate and distinct earth connections each to conform to the stipulation of the Indian Electricity Rules and apparatus rated 240V and below may have single earth connections.

All shops and buildings as well as the electrical sub-stations and electrical rooms shall be provided with a ring main earthing system each. Individual ring main earthing systems shall again be interconnected as a network.

The ring earthing system around each building shall be laid at a distance of approximately 1.5 M from the building and at a depth of approximately 0.8m. The earth ring shall further be connected at intervals to deep earthing electrodes to achieve a combined earth resistance of less than one ohm.

Electronic earthing shall be provided as per requirement.

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6.16 LIGHTNING PROTECTION

All buildings and factory structures vulnerable to lightning strokes owing to their height or exposed situation shall be protected against atmospheric flash-over and lightning strokes in such a manner as to eliminate any danger to the personnel employed therein. Stipulations of IEC: 62305 shall be followed. All electrical equipment shall have double earthing.

A 'Faraday Cage' made of hot galvanized strip steel connected to all buried pipes and steel structures crossing this cage ring shall be laid around each main building or factory unit as earthing device.

This shall be separate from the electrical equipment earthing ring main. All lightning arrestor earth leads of the buildings and factory units shall be connected to this cage ring. Air termination network should cover all salient points of the structure. Down conductors shall follow the most direct path possible between air termination and earth termination avoiding sharp bends. Down conductor shall have a testing point adjacent to the earth electrode. Each conductor shall have an independent earth termination. All earth terminations shall be interconnected.

Earthing connection to equipment subject to movement, vibration and shocks, shall be through flexible stranded conductors.

6.17 EXTERNAL INFRASTRUCTURE/ MANAGEMENT SYSTEM:

This shall cover the complete electrical system to feed the internal building electrification Viz. Overall Cable Network, Overall Earth Network, and services / road.

Cable network:

Cable Network under external electrification may be defined mainly in two parts.

- HT Cable Network
- LT Power Cable Network

LT Power Cable network:

LT Power cable Network for LT Power cable distribution to individual building shall be provided. LT Power Cable Network for shall be formed along with the road network.

LT Power Cable network May further be divided in two three parts

- Main LT Power cable network along the road network
- Road crossing through Hume pipe/Conduits.

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- Sub Cable Network to connect to main network to individual building. For this connectivity Cable ducts / conduits shall be considered.

Buried Cable trench:

Construction of buried cable trench shall include excavation, preparation of sieved sand bedding riddled soil cover, supply and installation of brick or concrete protective covers, back filling, compacting, supply and installation of route markers and joint markers.

LT Power Cable

- a) LV power cables will be 1.1 KV Grade heavy duty, PVC/ XLPE insulated, flat strip Armoured, Aluminium Conductor.
- b) Minimum size of aluminium cable will be 10 mm². For any requirement of below 10 mm², copper cables will be used.
- c) No. of Cores and cross section area of the cables shall be as per requirements.
- d) Inner sheath shall be of PVC type ST2 and shall be applied by extrusion.
 - LT Power cable shall confirm to following IS:8130, IS:5831 IS:3975 IS:3961 IS:7098

LT Control Cable

- a) LV control cable will be unarmoured, PVC insulated, copper conductor.
- b) Control cables spare core philosophy shall be as per TS.
- c) Specification of control cable shall be as per TS.

6.18 Earthing network:

Entire system shall be earthed in accordance with the provisions of the relevant IEC recommendations / IS code of practice IS: 3043 - 1987 and Indian Electricity Rules.

Earthing system shall be designed to achieve earth resistance of value not exceeding 1-Ohm. The LV side neutrals of the distribution transformers shall each be connected to two separate earthing electrodes. They shall also be connected with the neutral bus of the corresponding switchgear and the switchgear neutral bus shall be connected to the earthing ring at two different and distinct points.

50x6 MM GI earth strip shall run along the cable network and necessary additional route as required to make a complete ring.

For Building Earthing, Buildings Energy Meter Cum Distribution Board shall be connected to nearest earth grid at minimum two Points.

Earthing of Individual Sub Unit of building shall be done through Cu wire.

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6.19 INTERNAL WIRING:

Wiring within the building is classified in the following parts:

- **Mains Wiring:** Mains wiring shall mean wiring from buildings MLDB/ Energy Meter cum Distribution Board to LDB/ELDB.
- **Sub main Wiring:** Sub Main wiring shall mean the wiring from LDB to Switch Board or Switch Board to another Switch Board / Switch Socket Outlet.
- **Point Wiring:** Point Wiring shall mean wiring from the switch board's Switch to electrical equipment fitting i.e. (lighting / fan / exhaust fan / call bell point etc.)

1. Point Wiring

All Wiring shall be done in concealed conduits. Concealed conduits shall be laid before casting. Looping in on the phase side shall be at the switches and on the neutral side at the ceiling roses. Every light point, fan point and plug point shall have individual control switch unless stated otherwise. Earthing shall be provided for all the points according to the statutory requirement wherever necessary.

The number of points per circuit, generally, shall not exceed 10 or 800 Watts. However, same shall be finalized during engineering.

The point wiring consists of wiring from the switch board in conduit with its ancillary work, such as inspection bends, junction boxes and FRLS wires up to the fixed terminals of ceiling roses, connectors, batten holders, etc. depending upon the type of point. All the conduits entering and leaving Switch Boards shall be bonded together with bare aluminium / copper wire and earth clips.

2. Light Point

Point wiring for light points shall commence at the distribution board terminals and shall terminate at the ceiling rose/connector in ceiling box/lamp holder via the control switch.

3. Ceiling Fan Points

Point wiring for ceiling fan points shall be same as for light points in Para above and shall, in addition, include recessed fan hook, ceiling outlet box.

4. Exhaust Fan Point

Point wiring for exhaust fan points shall be same as for light points in Para above and shall in addition include socket outlet near the exhaust fan and control switch with regular at a convenient location complete as required.

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5. Call Bell Point

Point wiring for call bell points shall be same as for light point in Para above.

Minimum Wire Size shall be as follows:

Sl No.	Description	Phase & Neutral Wire	Earth Wire
1	Point Wiring	1.5 Sq. mm	1.5 Sq. mm
2	Sub Main Wiring 6A / 5A	2.5 Sq. mm	2.5 Sq. mm
3	Sub Main Wiring 16A / 15A	4.0 Sq. mm	4.0 Sq. mm

6. Bunching of wires:

Wires carrying current shall be so bunched in conduits that the outgoing and return wires are drawn into the same conduit. Wires originating from two different phases shall not be run in the same conduit. Lighting & Power Circuits shall be separate. All wires shall have ferules for identification.

7. Rigid PVC Conduits:

These shall be rigid PVC Type, threaded type having perfectly circular tubing. The minimum wall thickness of Rigid PVC Conduits permitted for concealed conduits shall be 1.8 mm. MMS conduits to be used for conducting in slab and walls Conduit & Accessories shall conform to relevant Indian standards. The tubing must perfectly circular, without any burrs or kinks. The conduits shall be of such type, so as to be capable of making tight fitting joints. The minimum size of Rigid PVC Conduits allowed in open / concealed work shall be 20 mm and above.

The number of wires in each conduit shall not exceed as specified in the table of conduit capacity.

All the conduits shall be supported using M.S. Spacers and G.I. Saddles and fixed using GI screws.

Wherever straight runs exceed 3 m, additional pull boxes or junction boxes shall be provided.

8. Energy Meter cum Distribution Board:

Energy Meter cum Distribution Board shall be made of high quality Polycarbonate (shock proof, rust free, corrosion free, acid and chemical resistant, fire retardant, having high impact, made of halogen and silica free recyclable material), UV resistant, having high grade gasket made of Polyurethane, should withstand glow wire test at 9600C in accordance with IEC 60

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695-2-11 UL subject 94, should be flame retardant, the Junction box should have test certificate in accordance with IEC 60 439-1 (IS8623), IEC 60 439-2 and IEC 60 364-7-712

9. Switch Boxes:

Switch Box shall be made of GI/MS with Minimum thickness of 1.2 mm. Switch boxes shall be suitable to house modular type switches of required ratings, unless otherwise stated, and fan regulators as required shall be provided.

These will be so designed that accessories are mounted on a grid plate with tapped holes for brass machine screws leaving ample space at the back and on the sides for accommodating conductors and check nuts at conduit entries. The grid plates and M.S. boxes shall be fitted with a brass earth terminal. Boxes shall be attached to conduits by means of check nuts on either side of their walls.

MS boxes shall be completely embedded leaving edges flush with finished wall surface.

The system shall be extremely easy to assemble and modules can be individually changed without re-wiring of complete assembly by removal of front plate and simply clipping in or out as required.

Moulded front covers made from high impact resistant, flame retardant and ultraviolet stabilized engineering plastics shall be fixed by means of counter sunk chromium plated brass machine screws. No timber shall be used for any supports.

10. Socket Outlets

6/16 amps socket outlets shall be of modular flush mounting type, unless otherwise stated, and shall be switched, and fitted with automatic linear safety shutters to ensure safety from prying fingers. 6A Sockets shall have three Pins, however 16A Sockets shall have 3/5 Pin to make it suitable for 6A and 16A plug both.

Socket outlets shall be made from high impact resistant, flame retarding and ultraviolet stabilized engineering plastic material.

An earth wire shall be provided along the wires feeding socket outlets for electrical appliances. The earth wire shall be connected to the earthing terminal of the socket and shall be connected to the earth terminal provided inside the box.

11. Switches

All 6- and 16-amps switches shall be of the modular flush mounting type, unless otherwise stated, 240 Volt AC of best quality and standard. The switch moving and fixed contacts shall be of silver nickel and silver graphite alloy and contact tips coated with silver. Housing of switches shall be made from high impact.

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12. Flush Plates

Switches, receptacles and telephone system outlets in wall shall be provided with Moulded cover plates, unless otherwise stated, of approved colour, shape and size made from high impact resistant, flame retarding and ultra violet stabilized engineering plastic material, and secured to the box with counter sunk /round head chromium plated brass screws.

13. Fan Hook Boxes

Ceiling boxes for fan hooks shall be made out of sheet steel not less than 14 SWG and hexagonal in shape with one 'U' shaped 15mm dia. rod inside secured tightly with the top reinforcement of the roof. 3 mm thick Perspex / Hylam sheet cover of matching colour shall be provided.

14. Draw Boxes

16 SWG mild steel draw boxes of ample dimensions shall be provided at convenient locations to facilitate drawing of long runs of conductors. These shall be mounted flush with wall / ceiling surface as required and shall have screwed covers of 3 mm thick Perspex / hylam sheet.

15. Inspection Boxes

Inspection boxes of 16 SWG mild steel and steel and having smooth external and internal finish shall be provided to permit inspection and maintenance. These shall be mounted flush with wall / ceiling surface as required and shall have screwed cover of 3mm thick Perspex / Hylam sheet.

16. Ceiling Fan

Electric ceiling fans shall be capacitor type, with double ball bearing complete with capacitor, 300 mm down rod, canopies, three number blades made of aluminium alloy, with suitable speed regulator, suitable for operation on single phase, AC 230 Volt, 50Hz supply and shall conform to class 1 of IS: 374 / 1979 (Reaffirmed 2005).

TECHNICAL SPECIFICATION

CHAPTER-7 INSTRUMENTATION & PROCESS CONTROL

TECHNICAL SPECIFICATION

7.0 FIRE DETECTION AND ALARM SYSTEM

GENERAL

The Fire Detection and Alarm System (FDAS) shall be an addressable, microprocessor-based system designed in accordance with the latest editions of:

- NFPA 72 (2022) – National Fire Alarm and Signalling Code
- NFPA 70 – National Electrical Code
- UL 864 – Control Units and Accessories for Fire Alarm Systems
- Detectors – UL 268 / 521
- Local Fire Authority / NBC India (Part IV), wherever applicable

All components (detectors, control panels, modules, and notification appliances) shall be UL listed and/or FM approved.

SYSTEM COMPONENTS

The FDAS shall comprise of the following major components:

- a) Microprocessor-based Main Fire Alarm Control Panel (FACP) with CPU, loop modules, control modules, and integral power supply. All the major buildings will have a dedicated Microprocessor based FDA panel. All the FDA panels shall be looped together and information from each panel shall be available in the IBMS room.
- b) Human–Machine Interface (HMI) or Graphical Monitoring Station (UL listed software).
- c) Addressable detectors – multi-sensor smoke/heat detectors on ceilings, and where required, under raised floors or above suspended ceilings.
- d) Beam Detectors for Workshop areas
- e) Manual Call Points (MCPs) at exits and along escape routes.
- f) Audible and Visual Notification Appliances (sounder–strobe units) in all occupied areas.
- g) Addressable control/relay modules for interfacing with HVAC, lifts, PA system, access control, and fire pumps.
- h) Class A wiring using FRLS fire alarm cables in raceways, shafts.
- i) Short-circuit isolator modules provided for every 20 devices.

SYSTEM PHILOSOPHY

- a. The Fire Alarm Control Panel shall be located in the IBMS Room at Office Complex 2 / entry area of each building. Repeater panel shall be provided in Fire stations, Main gate complex.

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- b. Each floor or fire area shall constitute an independent detection zone; loop distribution shall ensure no single fault disables more than one floor.
- c. The Graphical Monitoring Station shall display all alarms, troubles, and supervisory conditions, allowing operator control through a secure, password-protected interface.
- d. Upon fire detection, the system shall display the exact device address and location on the FACP and GUI, and initiate corresponding cause-and-effect actions.
- e. Selective evacuation shall be adopted: alarm notification shall activate on the affected floor, one floor above, and one floor below.
- f. System operation shall revert to normal upon acknowledgment and manual reset of the panel after the fire condition clears.

CAUSE & EFFECT MATRIX

- a. In the event of confirmed fire detection:
- b. Sounder–strobe units on affected and adjacent floors shall activate.
- c. The activated device address and location shall appear on the main FACP and graphical workstation.
- d. A pre-recorded voice message shall broadcast through the Public Address System.
- e. All AHUs and ventilation systems in the affected area shall shut down.
- f. Access-controlled doors shall unlock to permit evacuation.
- g. Fire-fighting interface relays shall trip power to non-essential systems as programmed.
- h. All actions shall automatically reset when the fire panel is manually reset after clearance.

7.1 DETECTOR INSTALLATION AND SPACING

Multi sensor detector

- a. Under flat ceilings, the horizontal distance between any point in a protected area and the detector nearest to that point shall not exceed 7.0 m.
- b. The detector shall be envisaged to cover entire room.
- c. In case of a sloping roof or pitched ceiling (where the distance between the top of apex and bottom of the roof exceeds 600 mm), spacing of detectors at or in the vicinity of apex shall be spaced between 7.5 m and 8.5 m or as recommended by manufacturer.
- d. Detectors shall not be mounted within 500 mm of any wall.
- e. Detectors shall be located at least 1 m away from air conditioning units.
- f. An obstacle e.g. beam shall be very well taken care of during designing of FDAS system. For multi sensor detectors, ceiling with beam depth of 200mm shall be considered as smooth ceiling however if it exceeds 200mm the spacing between detectors should be reduced to twice the depth of obstruction. If the beam projects more than 450mm below and are more than 2.5m on centres, each bay formed should be treated as separate area.

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- g. A detector shall be placed on the ceiling 1.5m from any door, window or any opening in the wall partition.
- h. All stairwells, lift shafts etc. shall have a detector at the top.
- i. The detector shall also be provided in the cable tunnels, ducts, false floors, AC and AHU room.
- j. Every enclosure (room or cabin) shall have a detector at ceiling level and also under false ceiling, false flooring, if provided.

Heat Detector

- a. Heat detectors shall be installed to ensure sensing element is not less than 50 mm and not more than 150 mm below the ceiling/roof level, except as necessary by site test during designing.
- b. For heat detector mounted on ceiling with beam projection height of 100mm, the beam construction shall be treated as smooth ceiling but for ceiling projected more than 100mm the spacing of heat detectors at right angle to the direction of the beam travel should not be more than two thirds of smooth ceiling spacing. If the beam projects more than 450mm below and are more than 2.5m on centres, each bay formed should be treated as separate area.
- c. Other guidelines for spacing of heat detectors remain the same as that of multi sensor detectors, which has already been covered above.

TECHNICAL REQUIREMENTS

Addressable Fire Alarm Control Panel (FACP)

- a. UL 864-listed, microprocessor-based, modular panel with LCD/LED color display.
- b. Enclosure: NEMA Type 1 (indoor)
- c. Power Supply: Integral, supervised PSU with automatic battery charging.
- d. Standby Power: Minimum 24 hours standby + 5 minutes alarm (or 15 minutes for voice system).
- e. Loop Capacity: 3 loops + 1 spare loops
- f. Event history stored in non-volatile memory with date/time stamp.
- g. Shall provide dry contacts (NO/NC) for common fire, fault, and supervisory signals.
- h. Communication with Building Management System (IBMS) via standard protocol (e.g., Modbus, BACnet).

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- i. Self-diagnostic features: loop open/short, ground fault, power fail, CPU fault, module failure.
- j. All communications to external agencies shall use listed fire alarm communicators—no direct autodial via public telephone network.

Detectors

- a. Intelligent, addressable, UL-listed type.
- b. Equipped with dual LEDs for communication and alarm.
- c. Sensitivity automatically compensating for drift; programmable day/night sensitivity levels.
- d. Multi-sensor detectors used where false alarms are probable (e.g., kitchens, workshops).
- e. Addressing by soft-address protocol (no manual DIP-switch addressing).

Manual Call Points (MCP)

- a. UL listed, break-glass or resettable type, installed such that the travel distance to the nearest MCP does not exceed 22.5M.
- b. Mounting height: 1.2 m – 1.5 m above finished floor.
- c. Located adjacent to each exit and at each floor level.
- d. Activation shall generate both local alarm and indication at FACP and graphical workstation.

Notification Appliances

- a. Audible and visible appliances shall be synchronized, UL listed, and compatible with the FACP.
- b. Minimum sound level: 15 dB above ambient or 5 dB above maximum noise lasting >60 sec, whichever is greater.
- c. Visual notification shall be provided wherever ambient noise exceeds 105 dBA.
- d. Evacuation tones shall be of uniform pattern throughout the building.

Remote Response Indicators

- a. Provided for detectors installed in concealed areas (false ceilings, false floorings, shafts, etc.) to aid in alarm localization.

TECHNICAL SPECIFICATION

Power Supply

- a. FDAS shall derive power from an exclusive 230 VAC single-phase circuit, protected, labelled “FIRE ALARM – DO NOT SWITCH OFF”.
- b. Battery type: VRLA / sealed lead acid, capacity calculated as per IEEE 485.
- c. Automatic switchover to battery supply upon mains failure; automatic charging on restoration.

Cabling and Wiring

- a. All field wiring shall be supervised, Class A, using FRLS fire alarm cables in conduits or raceways.
- b. Splices only in listed junction boxes with terminal blocks.
- c. Shielded cables shall be used for analog signals.
- d. All circuits shall be labelled at both ends and tagged for identification.

7.2 VERY EARLY SMOKE DETECTION ASPIRATION (VESDA) SYSTEM

SYSTEM DESCRIPTION

The VESDA System (Very Early Smoke Detection Apparatus) is a high-sensitivity aspirating smoke detection system designed to provide early warning of incipient fire conditions by continuously sampling the air through a network of pipes installed throughout the protected area.

The system shall be fully integrated with the addressable Fire Detection and Alarm System (FDAS) and shall comply with the requirements of NFPA 72 (Chapter 17 – Initiating Devices) and UL 268A / UL 2904 listings.

Each VESDA detector shall incorporate:

- a. Air sampling chamber with high-efficiency filter
- b. Laser or LED-based optical detection chamber
- c. High-sensitivity smoke measurement (0.01% obscuration/m)
- d. Programmable alarm thresholds (Alert, Action, Fire 1, Fire 2)
- e. Integral aspirator (fan) with monitored airflow
- f. Supervised inputs and outputs for interface with Fire Alarm Control Panel (FACP)

TECHNICAL SPECIFICATION

SYSTEM APPLICATION

VESDA detectors shall be provided in critical or high-value areas where early detection is essential, such as:

- a. Server Rooms

SYSTEM OPERATION

- a. The aspirating fan shall draw air continuously from the protected area through the sampling holes in the pipe network.
- b. The air is passed through a filter and into the detection chamber where a laser or LED - based optical sensor analyses the smoke content.
- c. On detection of smoke above programmed thresholds, the VESDA unit shall generate graded alarms:
 - Alert Level: Early indication, annunciate only to monitoring staff.
 - Action Level: Maintenance or investigation alert.
 - Fire 1 Level: Initiates visible and audible alarm on the FACP.
 - Fire 2 Level: Triggers full evacuation and interfacing actions (HVAC shutdown, access release).
- d. The VESDA unit shall continuously monitor airflow in each pipe to detect blockages or leaks. Any deviation shall generate a fault signal to the FACP.

TECHNICAL REQUIREMENTS

Feature	Specification / Requirement
Detector Type	Laser or LED-based, aspirating type, UL-listed VESDA or equivalent
Sensitivity Range	0.01% obscuration/m
Alarm Levels	Alert, Action, Fire 1, Fire 2 (programmable)
Interface	Addressable via relay or communication module to FACP
Pipe Material	Flame-retardant ABS or HDPE, red colour

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Sampling Holes	Size and spacing as per design software output and NFPA 72 cl. No.17.7.3
Flow Supervision	Each pipe monitored for blockage and break
Power Supply	24 VDC from FACP or dedicated PSU with 24h standby + 5 min alarm backup
Integration	All alarms and faults transmitted to FDAS for annunciation and event logging & IBMS
Compliance	NFPA 72, UL 268, UL 2904, FM Approved

7.3 VIDEO CONFERENCE SYSTEM

This Design Basis Document defines the **technical requirements, system design philosophy**, and **configuration methodology** for the **Video Conference (VC) Systems** to be deployed across various meeting spaces within the facility.

The scope includes **Discussion rooms, Board rooms, and large conference halls**, each configured to meet the functional, operational, and user-experience requirements of the respective space.

The system design emphasizes **integrated audio-visual collaboration, cross-platform interoperability**, and **ease of use**, supporting **modern hybrid work patterns** and **remote collaboration workflows**. The architecture ensures consistent performance, reliability, and intuitive operation across all room types.

Design Objectives

The Video Conference System shall:

- Enable seamless real-time collaboration between on-site and remote participants.
- Deliver **high-quality audio and video** with low latency and stable connectivity.
- Support **multiple conferencing platforms** (e.g., Microsoft Teams, Zoom, Webex, Google Meet).
- Provide **user-friendly interfaces** for simplified operation and minimal support dependency.
- Ensure **energy efficiency, aesthetic integration**, and **scalable expansion** for future requirements.

TECHNICAL SPECIFICATION

SYSTEM CONFIGURATION

CORE SYSTEM ARCHITECTURE

All room types are designed on a **common architectural foundation**, customized to specific functional and spatial requirements, **core components include:**

- a. **Video Conference Codec / Endpoint:** Provides connectivity to collaboration platforms, encodes and decodes AV streams, and manages meeting functions.
- b. **Display Systems:** 96" / 108" for Conference Halls and Board Rooms, supporting content sharing and remote participant visibility.
- c. **Audio Systems:** Includes microphones, speakers, and DSP processors to ensure echo-free, clear, bidirectional communication.
- d. **Control Interfaces:** Enables intuitive operation via **touch panels, wireless controllers, or voice-enabled interfaces.**
- e. **Network Infrastructure:** Configured with **adequate bandwidth** and **Quality of Service (QoS)** prioritization for stable HD video performance.
- f. **Power Management:** Integrated with room scheduling for **automated start up and shutdown**, ensuring energy efficiency and operational readiness.

1. Discussion Room Configuration

4-seater discussion rooms utilize **compact all-in-one VC units** combining camera, microphones, speakers, and codec in a single enclosure.

Key features:

- a. **Single display system** with wireless presentation capability for both conferencing and local sharing.
- b. **Minimalist control interface** with one-touch meeting join options or small touch panels supporting multiple platforms.
- c. **Simplified cable management** using a single **USB-C or HDMI** connection for both audio and video.
- d. **Power over Ethernet (PoE)** enabled components to reduce cabling clutter and eliminate local adapters.

2. Board Room Configuration

Board rooms employ a **distributed AV architecture** featuring **high-quality, flexible components** for executive-level communication.

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Key components:

- a. **High-definition PTZ or auto-tracking cameras** providing adjustable framing and superior image clarity.
- b. **Ceiling-mounted microphone arrays** for uniform pickup and noise reduction.
- c. **High-fidelity loudspeakers** optimized for natural voice reproduction.
- d. **Rack-mounted DSPs, codecs, and control processors.**
- e. **Multiple display systems** supporting simultaneous remote video and content sharing with dynamic routing options.

3. Conference Hall Configuration

Conference halls are equipped with professional-grade AV systems offering scalability, redundancy, and versatility for various event types.

Key features:

- a. **Large-format LED displays or projection systems** for wide audience visibility.
- b. **Distributed loudspeaker arrays** for uniform sound coverage and **assistive listening systems** for accessibility compliance.
- c. **Wireless microphones** and presenter reinforcement systems for clarity in large spaces.
- d. **Centralized control system** supporting both automated presets and manual operator control modes.

7.4 DATA COMMUNICATION SYSTEM

This Design Basis Document defines the overall design philosophy, system architecture, and implementation framework for the Data Communication System to be deployed across the facility.

The data communication network forms the digital backbone of all IT and low-voltage systems, enabling secure, high-speed, and reliable connectivity between enterprise applications, user endpoints, and integrated IP-based building systems. The design encompasses intranet, internet, Wi-Fi, and Local Area Network (LAN) infrastructure supporting both wired and wireless connectivity requirements.

The system is engineered to facilitate seamless communication across all functional areas, ensuring **redundancy, scalability, and operational continuity**. It also provides a unified

TECHNICAL SPECIFICATION

network foundation for ERP, CCTV, Access Control System (ACS), IP-PBX, VoIP phones, Video Conference (VC) systems, Public Address (PA) system, and Integrated Building Management System (IBMS).

The proposed Data Communication System provides a **secure, scalable, and resilient network infrastructure** that serves as the central nervous system of the facility. Through its **redundant architecture, structured design, and integrated approach**, it ensures reliable connectivity for enterprise users and mission-critical IP systems alike.

The design shall align with industry best practices, supports future technological evolution, and ensures continuous, efficient, and secure operation of all connected systems.

DESIGN OBJECTIVES

The Data Communication System shall:

- a. Establish a **robust and secure IT infrastructure** supporting all enterprise and building automation functions.
- b. Provide seamless connectivity for intranet and internet access for users and devices.
- c. Enable integration of IP-enabled utilities (CCTV, ACS, IP-PBX, VoIP, VC system, PA system, IBMS & ERP) into a converged network backbone.
- d. Ensure **network segmentation and isolation** between critical systems to enhance security and manageability.
- e. Incorporate **redundant paths, equipment, and power sources** to achieve high availability and fault tolerance.
- f. Support **scalable bandwidth growth** and seamless integration of future technologies.
- g. Facilitate **centralized management** with real-time monitoring and performance analytics.
- h. Maintain compliance with **industry standards, information security policies, and local IT governance requirements**.
- i. Comply with applicable national regulatory standards and governance frameworks, including the DoT guidelines for M2M/IoT service provisioning and use of WPAN/WLAN connectivity.

APPLICABLE STANDARDS AND GOVERNMENT GUIDELINES

Beyond international and industry standards for structured cabling, network design and AV/IT convergence, the system shall align with the following recent regulatory guidance:

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- a. The DoT has issued a Direction (D.O. No. 3-28/2021-IoT/TEC-pt, dated 15 July 2025) stating that M2M/IoT services must be availed only through DoT-registered M2M Service Providers (M2MSPs) and WPAN/WLAN connectivity providers, and must comply with prescribed standards.
- b. Under this guideline, any wireless connectivity (including WPAN/WLAN) used for M2M/IoT must be via a provider registered with DoT; and the M2M service provisioning must be through a registered service provider.
- c. These regulations affect the way IoT/M2M devices (for example sensors in IBMS, AV system endpoints, access control sensors) are connected, monitored and managed inside the facility network.
- d. The network design must incorporate the ability to segregate IoT/M2M traffic, interoperate with registered service providers, maintain audit trails, and ensure compliance with the DoT's device-connectivity and service registration regime.

SYSTEM ARCHITECTURE OVERVIEW

The facility's network architecture adopts a **hierarchical structured design** comprising **Core**, **Distribution**, and **Access layers**, ensuring efficient traffic management, flexibility, and ease of maintenance.

a. Core Network:

- Serves as the high-speed backbone interconnecting all major data and communication systems.
- Connects the enterprise LAN, data centre, and gateway routers to external internet and intranet links.
- Designed for **non-blocking throughput** with redundant switches, dual links, and failover routing.

b. Distribution Layer:

- Aggregates traffic from access switches serving different departments, floors, and utilities.
- Provides policy-based routing, VLAN management, and inter-subnet communication.
- Incorporates **firewalls and network access control mechanisms** to enforce security boundaries.

c. Access Layer:

- Provides wired and wireless connectivity to user endpoints and field devices.

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- Includes **Ethernet access switches, wireless access points, and PoE infrastructure** supporting IP-based systems.
- Configured with **port-level security**, VLAN tagging, and Quality of Service (QoS) prioritization for time-sensitive applications such as voice and video.

7.5 NETWORK COMPONENTS AND SUBSYSTEMS

LOCAL AREA NETWORK (LAN)

The LAN interconnects all building areas through **structured cabling** and **intelligent switching infrastructure**, supporting both **data and IP-based building services**. The design incorporates dual backbone fiber routes for redundancy and high throughput.

Key functions include:

- High-speed data transport for corporate applications.
- Integration of all IP-based systems including CCTV, ACS, IP-PBX, VoIP, PA, VC, and IBMS.
- Segregation into **logical VLANs** based on function (e.g., IT, security, voice, building automation) for performance and security.
- Dual uplinks to redundant core switches ensuring **zero single point of failure**. Intranet and Internet Connectivity

The network provides **secure and scalable access** to internal enterprise applications and external internet resources.

- The **intranet** segment connects internal systems such as ERP, mail, storage, and database servers hosted within the facility or private data centre.
- The **internet gateway** connects through redundant ISP links ensuring continuous connectivity.
- Unified Threat Management (UTM) firewalls protect against cyber threats and manage access policies, web filtering, and VPN connections for remote access.
- Network Address Translation (NAT) and routing policies are configured to separate internal and external traffic while maintaining data security.

Redundancy and High Availability

The data communication network is designed for **continuous operation** with **redundant architecture** at all critical layers.

TECHNICAL SPECIFICATION

- a. Dual core switches/routers in active-standby or active-active configuration.
- b. Dual fibre backbone paths between communication rooms, providing path diversity.
- c. Dual power feeds and UPS/backup power for critical network devices.
- d. Dual ISP links for internet/intranet access with automatic failover.
- e. Redundancy for network servers, gateways and service provider links (including for M2M/IoT service path).
- f. Failover mechanisms to maintain operation without manual intervention during hardware or link failure.

7.6 NETWORK FOR IP-BASED SYSTEMS

The communication backbone supports multiple converged IP systems, each operating within logically segmented networks:

System	Network Integration Approach
CCTV System	Dedicated VLAN for video traffic ensuring recording continuity without impacting corporate traffic.
Access Control System (ACS)	Connected through secure LAN segment with central server authentication and monitoring.
IP-PBX and VoIP Phones	QoS-enabled voice VLAN ensuring clear audio quality and low latency.
Video Conference System (VC)	Prioritized traffic routing and bandwidth allocation for HD video and collaboration sessions.
Public Address (PA) System	Network-enabled controllers integrated through PoE switches and IP-based amplifiers.
IBMS (Integrated Building Management System)	Separate VLAN for monitoring HVAC, lighting, energy, and safety systems through BACnet/IP or Modbus TCP.
ERP network	For Clients ERP system

All IP-based systems utilize the same structured cabling and switching infrastructure, maintaining logical separation through VLANs and firewall rules while sharing the physical medium efficiently.

TECHNICAL SPECIFICATION

System Sizing and Design Criteria

- a. Network sized for current and projected device populations, including workstations, wireless clients, IP-systems and IoT/M2M endpoints with a growth allowance of 20–25%.
- b. Minimum two network drops per workstation and dual network connections for critical systems.
- c. Fibre backbone between communication rooms and data centre sized for high-throughput (10 Gb/s or higher) with headroom.
- d. Access switch capacity and PoE budget sized to support all IP-devices with growth.
- e. WiFi AP density planned for both user access and device connectivity; ensure overlapping coverage and seamless roaming.
- f. Bandwidth and QoS provisioning to support voice, video, data and IoT traffic; ensure separate VLANs and priority settings to avoid congestion.
- g. IoT/M2M service traffic routed via dedicated VLANs and service provider links with monitoring and audit trail compliance to DoT guidelines.

System design ensures sufficient switching capacity, structured cabling bandwidth, and backbone throughput to meet peak load conditions with headroom for future scalability.

7.7 VOICE COMMUNICATION SYSTEM

This Design Basis Document defines the design philosophy, functional requirements, and configuration framework for the Voice Communication System for the facility. The system enables reliable, high-quality voice connectivity across all operational, administrative, and utility areas through a combination of IP-based (VoIP) and analog telephone infrastructure.

The design ensures seamless internal and external communication, integration with the facilities data network, and compatibility with unified communication platforms. The voice system shall support inter-departmental connectivity, emergency communication, public-address integration, and remote collaboration, forming an essential part of the facility's ICT backbone.

The voice communication network is designed as an integrated, scalable, and redundant system built around a central IP-PBX platform, interconnected with local and remote extensions via structured cabling and Power-over-Ethernet (PoE) infrastructure.

TECHNICAL SPECIFICATION

DESIGN OBJECTIVES

The primary objectives of the voice communication system are to:

- a. Provide reliable and high-quality voice communication across all areas of the facility.
- b. Integrate IP-PBX systems, VoIP phones, and analog endpoints into a unified communication platform.
- c. Ensure redundancy and resilience in call handling and power supply.
- d. Enable interoperability with external PSTN/ISDN/SIP trunks as applicable.
- e. Support scalability for future expansion in user base and additional communication services.
- f. Provide ease of management through centralized administration and monitoring tools.
- g. Maintain network security and QoS prioritization to ensure uninterrupted voice service.
- h. Comply with local telecommunication regulations and structured cabling standards.

SYSTEM ARCHITECTURE OVERVIEW

The overall voice communication architecture adopts a hybrid IP-based topology integrating digital, analog, and IP endpoints into a unified voice network. The system consists of three primary layers:

- a. Core Layer: IP-PBX server(s), gateways, and centralized management platform.
- b. Distribution Layer: Intermediate Distribution Frames (IDFs), PoE network switches, and VoIP integration points.
- c. Access Layer: IP phones, analog phones, soft clients, and telephone junction boxes distributed across the facility.

All voice components connect via the structured cabling system with Cat 6 (or higher) copper cabling and fiber uplinks, providing a unified network backbone for voice and data convergence.

System Components

1. IP-PBX SYSTEM

The IP-PBX forms the core switching platform for all internal and external voice communication. It manages call routing, signalling, user registration, and integration with voicemail, conferencing, and IVR services. The IP-PBX shall interconnect with external trunks (SIP/PSTN) through gateways and support redundancy to ensure uninterrupted operation.

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2. VOIP PHONES

VoIP phones (Session Initiation Protocol) serve as the primary user interface for voice communication within office and utility spaces. They connect through PoE switches and receive both data and power over the same network cable.

3. ANALOG PHONES

Analog phones are retained in selective areas such as workstations, security rooms, lift lobbies, maintenance zones, and service areas. These connect through analog ports of the IP-PBX or analog gateways located in communication racks.

4. MAIN DISTRIBUTION FRAME (MDF)

The MDF acts as the central termination and cross-connect point for all voice circuits. It houses the IP-PBX, trunk interfaces, network gateways, and primary patch panels connecting to distribution-level IDFs. The MDF provides interconnection between internal extensions and external telecom lines.

5. INTERMEDIATE DISTRIBUTION FRAME (IDF)

Each floor or zone includes an IDF housing PoE network switches and analogue extension termination points. IDFs provide localized connectivity to endpoints, reducing cable lengths and simplifying maintenance. Fiber uplinks from MDF to IDFs ensure high-speed and fault-tolerant connectivity.

6. TELEPHONE JUNCTION BOXES (TJBS)

Telephone Junction Boxes are provided at convenient wall or floor locations. Each TJB terminates the horizontal cabling from IDFs and allows flexible patching for IP or analog telephone sets.

7. POE NETWORK SWITCHES

PoE switches provide data connectivity and power to VoIP endpoints, IP-PBX gateways, and related network devices. The PoE feature eliminates local adapters and improves cable management. Switches are installed within IDF racks with redundancy and managed under the network control system.

7.8 CABLING INFRASTRUCTURE

The voice communication system uses structured cabling aligned with the overall network. Category 6 /CAT6 copper cables are deployed for VoIP endpoints, while multi-pair telephone cables serve analog extensions. Fiber links connect the MDF to IDFs ensuring scalability and future integration.

TECHNICAL SPECIFICATION

DESIGN CRITERIA

The system design is governed by the following key principles:

- a. Unified Network Integration: Voice and data share a common structured cabling and switching infrastructure with logical segmentation (VLANs) for performance and security.
- b. Reliability and Redundancy: Dual network paths, redundant PoE switches, and failover IP-PBX configurations ensure continuous service availability.
- c. Scalability: Capacity provisioned for 20–25% future growth in the number of users, extensions, and IP endpoints.
- d. Quality of Service (QoS): Network configured to prioritize voice packets, minimizing latency and jitter.
- e. Power Continuity: PoE switches backed by UPS ensure uninterrupted operation during power disturbances.
- f. Ease of Maintenance: Centralized management with detailed labeling, patching schedules, and documented routing between MDF–IDF–TJBs.
- g. Compliance: Adherence to structured cabling standards (TIA/EIA-568), data centre guidelines (TIA-942), and local telecom regulations.

SYSTEM SIZING PARAMETERS

The sizing of the voice communication system has been determined based on the following considerations:

- a. User Base: Total number of staff, departments, and functional areas requiring internal/external voice connectivity.
- b. Extension Count: Allocation of extensions per workstation, conference room, and common area.
- c. IP Endpoints: Number of VoIP phones, IP conference units, and gateways.
- d. Analog Extensions: Quantity of analog phones for critical and utility areas.
- e. Network Infrastructure: Number of PoE ports, switch capacity, and uplink redundancy.
- f. Distribution Framework: Number and location of MDF and IDF racks based on building layout and cable length limitations.

TECHNICAL SPECIFICATION

- g. Cable Sizing: Horizontal copper cable runs limited to 90 m per channel; multi-pair voice cables sized for analog distribution; fibre sizing between MDF and IDF for future scalability.

7.9 IP-BASED PUBLIC ADDRESS (PA) SYSTEM

This Design Basis Document defines the system design approach, configuration philosophy, and functional requirements for the **IP-based Public Address (PA) system** to be deployed across the facility.

The system provides **voice announcements, emergency notifications, and background music** capability to enhance communication, safety, and operational efficiency within the premises.

The PA system will be **fully network-based**, utilizing the structured cabling and LAN infrastructure to ensure centralized management, scalability, and reliability. It integrates with other building systems such as **Fire Alarm, IBMS, and Security** systems for automated emergency announcements.

The design ensures compliance with the latest **government communication and safety standards**, following guidelines issued by the **Bureau of Indian Standards (BIS)**, **Ministry of Electronics and Information Technology (MeitY)**, and **National Building Code (NBC Part 4 – Fire and Life Safety)** for emergency audio announcements.

DESIGN OBJECTIVES

The design of the IP-based PA system aims to:

- a. Deliver clear and intelligible voice announcements across all areas of the facility.
- b. Allow **zoned and selective paging** for operational flexibility.
- c. Enable **integration with Fire Alarm and IBMS systems** for automatic emergency messaging.
- d. Support **background music (BGM)** and scheduled announcements during normal operation.
- e. Provide **redundant network paths and servers** to ensure continuous operation during power or link failure.
- f. Facilitate centralized control and remote monitoring through the PA management software.
- g. Include provisions for **future expansion** to accommodate additional zones or new facilities.

TECHNICAL SPECIFICATION

SYSTEM ARCHITECTURE

The IP-based PA system adopts a **distributed, server-controlled architecture** consisting of digital audio nodes connected via the facility's Ethernet network.

Core system components include:

a. Central PA Server / Controller:

Manages audio routing, priority logic, scheduling, and system diagnostics. Integrates with IBMS, Fire Alarm, and security systems for coordinated emergency responses.

b. Paging Call Stations:

Installed at IBMS rooms, reception areas, and key administrative locations to enable live announcements, zone selection, and recorded message playback.

c. Network Amplifiers:

Distributed across equipment rooms to drive local speaker circuits in each zone. Each amplifier connects to the network via PoE or Ethernet link and receives digital audio streams from the central server.

d. Speakers:

Ceiling, wall-mount, and outdoor horn-type speakers provide audio coverage in offices, corridors, stairwells, public areas, and outdoor spaces. Speaker types and mounting positions are selected based on acoustic requirements and area usage.

e. Cabling Infrastructure:

Utilizes **Cat 6 structured cabling** for IP connectivity between network devices and **speaker cabling** (two-core shielded copper) from amplifiers to loudspeakers.

All devices are connected through managed PoE switches integrated within the data communication network.

Design Criteria

The PA system is designed based on the following criteria:

a. Coverage:

100% coverage of all occupied spaces, circulation zones, and emergency areas. Speakers are spaced to maintain uniform sound pressure levels and speech intelligibility (STI > 0.5).

TECHNICAL SPECIFICATION

b. Zoning:

Facility divided into functional zones (e.g., Annex office, corridors, lobbies, parking, utilities) to allow area-specific announcements.

Each zone shall be independently controllable for volume, source selection, and priority.

c. Integration:

- Interface with Fire Alarm System for emergency evacuation messages.
- Interface with Building Management System (BMS) for automated or scheduled announcements.
- Integration with IP telephony or security systems (optional) for all-call paging.

d. Scalability:

System sized to accommodate 20–25% future expansion in number of speakers, amplifiers, and network ports without major hardware modification.

System Sizing

System sizing is determined based on:

- **Total floor area and acoustic zones** within the facility.
- **Number of speakers per zone**, derived from coverage and intelligibility requirements.
- **Amplifier capacity**, calculated from total speaker load with 20% headroom for expansion.
- **Network bandwidth** allocation for audio streaming between PA server and amplifiers.
- **Power provisioning** through PoE switches and dedicated UPS backup for continuous operation.
- **Server capacity** designed to support all active zones, paging consoles, and scheduled announcements concurrently.

Central and local equipment racks (MDF/IDF) will house network switches, amplifiers, and junction boxes. Structured cabling routes are shared with ICT pathways, complying with data and electrical separation norms.

7.10 IP-BASED ACCESS CONTROL SYSTEM (ACS)

This Design Basis Document establishes the design approach, configuration principles, and operational framework for the **IP-based Access Control System (ACS)** to be implemented across the facility. The system **provides secured entry and exits management** for personnel, ensuring only authorized individuals access restricted zones.

TECHNICAL SPECIFICATION

The ACS integrates with other IP-based building systems — such as **CCTV, IBMS, and Fire Alarm** — to enhance overall safety, security, and operational efficiency. It employs **biometric and RFID-based identification** combined with centralized server management for flexible control, monitoring, and reporting.

The design aligns with the latest **Government of India guidelines for security systems**, including MeitY's cybersecurity framework for IP-based equipment, and conforms to the **National Building Code (NBC – Part 4)** and **Information Technology Act, 2000** regarding digital identity management.

DESIGN OBJECTIVES

The Access Control System is designed to:

- a. Restrict unauthorized entry to secured areas and sensitive facilities.
- b. Maintain digital records of personnel movement for audit and reporting.
- c. Enable multi-factor authentication using biometric and RFID credentials.
- d. Support remote monitoring, configuration, and central management via IP network.
- e. Integrate with fire alarm and emergency systems to unlock all doors during evacuation events.
- f. Ensure high availability, redundancy, and scalability for future expansion.

SYSTEM ARCHITECTURE OVERVIEW

The IP-based ACS uses a **distributed controller architecture** with centralized supervision. Each access point (door) is equipped with field devices that communicate with door controllers over the network, while the main server handles authentication, event logging, and user management.

The architecture includes:

- a. **Access Control Server:** Centralized software-based system managing users, credentials, time zones, door permissions, and event logs. It interfaces with CCTV and IBMS platforms for unified monitoring.
- b. **Door Controllers:** Intelligent networked controllers managing one or multiple doors. They operate in standalone mode during network failure, maintaining local authentication data.
- c. **Biometric and RFID Readers (Mifare):** Installed at entry and exit points for user identification through fingerprint or card credentials.

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- d. **Exit Push Buttons and Emergency Release Units:** Facilitate safe egress; emergency units override door locks during fire or emergency conditions.
- e. **Locking Devices:** Electromagnetic locks ensuring secure physical control at each door, powered through the controller.
- f. **Local Security Adapter (LSA):** Provides secure interface between field devices and controllers, ensuring localized connectivity and fail-safe operation.
- g. **Cabling Infrastructure:** Cat 6 structured cabling for IP connectivity between readers, controllers, and servers; shielded power cables for door locks and auxiliary components.
- h. **Integration with Other Systems:** Interface with fire alarm system for automatic unlocking during emergency; linkage to CCTV for video verification of access events.

The network backbone provides **connectivity** between field controllers and central servers, supported by UPS power backup and dedicated VLAN segmentation for enhanced cybersecurity.

DESIGN CRITERIA

The design of the Access Control System follows these guiding principles:

- **Coverage:** All restricted areas, main entry points, and critical rooms (e.g., VSAT room, classified OPS Room, electrical room, UPS & Battery room, and IBMS room) shall be covered by access control.
- **Scalability:** Designed for a 20–25% growth in user base, door points, and credential capacity without major infrastructure modification.
- **Safety Compliance:** All access points connected to the Fire Alarm system to automatically unlock doors during emergency evacuation.
- **Integration:** Seamless interoperability with CCTV, IBMS, for automated credential synchronization and event verification.
- **Power and Network Reliability:** Controllers and readers powered through PoE or redundant power supply, supported by UPS.

SYSTEM SIZING

System sizing is determined based on the total number of access-controlled doors and user population:

- **Access Points:** entry / exit to classified areas shall be configured with entry reader, exit reader or push button, electromagnetic lock, and controller interface.

TECHNICAL SPECIFICATION

- **Controllers:** Sized based on the number of connected doors, with additional capacity for 25% expansion.
- **Server Capacity:** Designed to handle total concurrent access events, data storage for logs, and system backups.
- **Network Bandwidth:** Calculated for real-time event updates and integration with monitoring systems without latency.
- **Power Requirements:** Each controller and reader connected to UPS-backed circuits ensuring continued operation during outages.
- **Cabling:** Cat 6 network cabling for IP data; shielded copper for power/lock control. Route segregation maintained as per electrical safety standards.

Central and floor-level communication racks host door controllers, LSAs, and PoE switches, interconnected to the main ACS server over a LAN backbone.

DESIGN CRITERIA & FUNCTIONAL REQUIREMENTS

- **Access Control Integration:** All turnstiles and boom barriers shall integrate with facility ACS, including RFID, biometric, and visitor management.
- **Central Monitoring:** Systems shall feed real-time status to Security Control Room (SCR) via network or dry contacts.
- **Fail-Safe Operation:**
 - Turnstiles: Free-rotation / open on fire alarm input.
 - Boom Barriers: Auto-raise/manual release during emergency.
- **Environmental Conditions:**
 - Temperature: 0–50°C (indoor/outdoor specific).
 - Humidity: 10–90% RH.
 - Dust/Ingress: Minimum IP54 for outdoor units.
- **Electrical:**
 - Power Supply: 230V AC $\pm 10\%$, 50 Hz or per OEM.
 - UPS-backed for critical units (30–60 min).
 - Surge protection for outdoor installations.

FULL-HEIGHT TURNSTILES

- **Purpose:** Prevent tailgating and unauthorized entry at pedestrian gates.
- **Operation:** Electro-mechanical or motorized drive mechanism, bidirectional control, card/biometric access.
- **Duty Cycle:** 24/7 continuous operation.
- **Construction:** Heavy-gauge SS 304/316; IP54/IP65 for outdoor units.
- **Clear Passage:** ~650–700 mm.
- **Fail-Safe/Fail-Lock:** Configurable based on security policy.

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- Integration: Access Control System (ACS), Fire Alarm (for free-rotation on alarm), and central monitoring.

Boom Barriers

- Purpose: Regulate vehicular entry and exit at gate perimeters.
- Arm Length: 3–6 m depending on lane width.
- Operation Speed: 1–3 seconds adjustable.
- Mechanism: Electromechanical or servo-type with heavy-duty cycle.
- Features: Loop detector integration, traffic light support, manual override.
- Integration: RFID/ANPR system, guard console, gate control panel.

TECHNICAL SPECIFICATION

CHAPTER-8 INTEGRATED BUILDING MANAGEMENT SYSTEM (IBMS)

TECHNICAL SPECIFICATION

8.0 INTEGRATED BUILDING MANAGEMENT SYSTEM (IBMS)

The Integrated Building Management System (IBMS) is envisaged as a unified, intelligent control and monitoring platform to enhance building performance, energy efficiency, operational reliability and occupant comfort. The system integrates and supervises key building services such as Heating, Ventilation & Air Conditioning (HVAC), Lighting, Access Control System (ACS), Closed-Circuit Television (CCTV), Fire Detection & Alarm System (FDA), Power Monitoring & Electrical Distribution, Water/Utility Management and other electromechanical equipment.

The IBMS will provide centralized visibility of the entire building's mechanical and electrical systems through a single command-and-control interface, enabling real-time monitoring, alarm/event handling, trend analysis, automation routines, and maintenance support.

The system is designed for 24×7 operation, high availability, scalability and conformity to relevant national guidelines for safety, energy management and security.

8.1 SYSTEM OBJECTIVES

The IBMS is designed to achieve the following objectives:

- a. Integrated Monitoring & Control: A unified platform to control HVAC, lighting, security systems, fire safety, power management and utility services.
- b. Energy Optimization: Automated scheduling, adaptive control logic, occupancy-based automation and demand-based equipment operation.
- c. Operational Efficiency: Minimize downtime through continuous monitoring, predictive alerts and real-time diagnostics.
- d. Safety & Security: Coordination with FDA, ACS, CCTV and emergency systems for enhanced occupant safety.
- e. Data-Driven Decision Making: Historical trends, analytical dashboards and reports for facility management and optimization.
- f. Scalability & Flexibility: Modular hardware and software supporting future growth, additional services and technology upgrades.
- g. Compliance: Adherence to government safety guidelines, energy norms, and smart building standards.

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8.2 SCOPE OF IBMS

The IBMS covers automation, integration and monitoring of the following building services:

- a. HVAC System – VRV/VRF, pumps, ventilation fans, dampers
- b. Lighting Control System – interior/exterior lighting, occupancy sensors, daylight-based dimming
- c. Access Control System (ACS) – biometric/RFID readers, door controllers, emergency release
- d. CCTV / Video Surveillance System (VSS) – IP cameras, VMS/NVR integration, monitoring
- e. Fire Detection & Alarm System (FDA) – smoke/heat detectors, panels, alarms, notification devices
- f. Power Monitoring System (PMS) – DG sets, UPS, panels, energy meters, load management
- g. Electrical Equipment Control – capacitor banks, transformers, LT panels, motor control
- h. Water & Utility Management – plumbing pumps, STP/ETP, overhead/underground tank levels
- i. Environmental & Safety Monitoring – temperature, humidity, CO₂, gas leak detection
- j. IT & Communication Integration – data network interfaces, alarms to command centre
- k. Central Monitoring Workstations & Server Infrastructure – IBMS server, database, operator consoles
- l. Cabling Infrastructure – control cables, communication cables and structured cabling for IP-based systems.

8.3 DESIGN CRITERIA

General Design Philosophy

- a. Create a centralized, redundant, high-availability automation environment.
- b. Use open communication protocols for interoperability.
- c. Provide separate VLANs or dedicated networks for IBMS traffic to ensure security and performance.

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- d. Ensure that the system supports remote access, centralized reporting, and integration through the IBMS server.
- e. Allow 20–25% spare capacity in processors, I/O modules, switch ports and server resources for expansion.
- f. Ensure compliance with government norms on building safety, energy conservation, fire regulations and security system integration.

1. Lighting Control Criteria

- a. Zonal lighting control based on occupancy and time-of-day schedules.
- b. Manual override capability on site.
- c. Exterior lighting automation based on astronomical clock or sensors.
- d. Integration with emergency lighting status.

2. Security System Integration (CCTV & ACS)

- a. High-level integration for event-driven automation (e.g., door-forced alerts trigger CCTV pop-ups).
- b. Access logs captured and archived on IBMS server.
- c. Central monitoring of credential status, alarms, door status and controller health.

3. Fire Safety Integration

- a. High-level integration with FDA for alarm/event visibility on the IBMS console.
- b. Fire signals override HVAC operation (e.g., AHU shutdown, damper closure).
- c. Real-time alarm display with audio-visual indicators at the IBMS workstation.

4. Power & Utility Management Criteria

- a. Integration with energy meters, UPS, DG sets, LT panels and feeders.
- b. Monitoring of voltage, current, power factor, energy consumption and load profiles.
- c. Alarm generation for abnormal electrical conditions.

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8.4 SYSTEM ARCHITECTURE

Overall Architecture

The IBMS architecture consists of:

a. Field Level Devices:

Sensors, actuators, detectors, controllers, relays, power/energy meters, dampers, VFDs, pumps and lighting control devices.

b. Controller/Automation Level:

Distributed control panels housing DDC controllers, I/O modules, communication modules, and power supplies.

These panels interface with field devices and communicate with the IBMS server.

c. Network Layer:

Redundant IP-based communication backbone using structured cabling and PoE switches where required.

d. Server & Application Layer:

Central IBMS server, database server, historian, redundancy server and application engine.

e. Monitoring & Control Layer:

Operator workstations, large display screens, mobile/tablet interfaces and reporting consoles.

Communication Design

- a. Standardized IP-based communication for all major systems.
- b. Segregated VLANs for HVAC, security systems, fire systems and power monitoring.
- c. Redundant fiber backbone to ensure uninterrupted communication across the facility.
- d. Time-synchronized data exchange for accurate event and alarm tracking.

8.5 COMPONENTS INVOLVED

1. Field Devices & Sensors

- a. Temperature, humidity, pressure, airflow sensors
- b. CO₂ sensors
- c. Lighting sensors, occupancy sensors

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- d. Water level sensors, flow meters
- e. Electrical power meters, breaker status monitoring
- f. Damper actuators, valve actuators
- g. Pushbuttons, relays, interface modules

2. Controllers & Panels

- a. DDC controllers for HVAC equipment
- b. Lighting control modules
- c. IO modules for discrete/analog signals
- d. System integration panels
- e. Emergency override and fire integration modules

3. Server Infrastructure

- a. IBMS application server
- b. Redundant server setup (active/standby)
- c. Storage for real-time and historical data
- d. Workstations and operator consoles
- e. Unified graphical interface for monitoring and control

4. Communication & Cabling

- a. UTP Cat 6/Cat 6A structured cabling for IP devices
- b. RS-485 or similar cables for legacy system integration
- c. Fiber optic backbone between technical rooms
- d. Patch panels, racks, cable management accessories

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CHAPTER-9 MATERIAL HANDLING FACILITIES

TECHNICAL SPECIFICATION

9.1 Electric Overhead Travelling Crane (EOT)

9.1.0 GENERAL

The material handling facilities envisaged for this report covers the conveying of car body transferring from one work station to another work station in Car body fabrication & Assembly building facility and along with all standard supporting facilities, hoisting & handling facilities.

The scope covers design, manufacture, supply, erection, testing and commissioning of electric overhead travelling (EOT) crane along standard accessories and items required to make crane fully functional.

9.1.1 SCOPE

Scope covers supply of EOT crane complete in all respect along with necessary accessories and items detailed hereunder to make EOT fully functional.

- a) Electrical cables for power supply from distribution control panel in shed to DSL up to 10m length as per GAD of shed.
- b) Supply and fixing of gantry rail/ square or rectangular bar on crane girder along the entire length of shed as indicated in GAD of sheds. Bidder should ensure proper fixing and alignment of crane gantry rail/ bar before erection of crane.
- c) Supply and fixing of shrouded type DSL along the entire length of shed as indicated in GAD of sheds.
- d) Pendant push button control for long travel, cross travel and hoist motions with necessary flexible multi-core cable of sufficient length for operation of crane from floor level.
- e) Portable radio remote control along with accessories and items required controlling all motions of crane including synchronous operation of two cranes.
- f) Supply of power supply arrangement (clause #2.14), necessary spares, consumables, tools and tackles (clause #3), inspection and test certificates (clause#4), installation and commissioning (clause #5), documentation (clause #6), training (clause #7) and warranty (clause #8) as per General Terms and Conditions applicable for Bill #13 for each crane.
- g) Supply of maintenance tools for each crane: a tool box containing D/E Spanners of required sizes- 1 set, grease gun-1 No, oil can-1 No, screw driver of required sizes- 1 set, nose pliers- 1 No, Insulated pliers- 1 No, hammer 2 lb.- 1 No, Allen key of required sizes-1 set, hydraulic jack- 1 No.
- h) Supply of operation and maintenance spares including the following for each crane:
 - ✓ Fixed & moving contact tips for contactors- 1 number of each size

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- ✓ Contactors coils- 1 set consisting of 3 numbers of each size
- ✓ Limit switches- 1 set of MH, 1 set of CT, 1 set of LT
- ✓ Current collectors- 1 set
- ✓ Fuse links- 1 set of each size
- ✓ Thrusters- 1 of each size
- ✓ Brake Liners with rivets- 1 pair of each size
- ✓ Main spring for thruster brakes- 1 of each size
- ✓ Brakes shoes complete with lining- 1 pair of each size
- ✓ Oil seals for gear cases- 1 for each size of gearbox and geared coupling.
- ✓ VVVF drive module- 1 no of each type
- ✓ long travel and Cross travel wheel duly machined without axle and bearings- one number of each type.
- ✓ Supply of lifting tackles, wire ropes, chains, hooks etc along with crane as detailed hereunder.

9.1.2 DESIGN FEATURES

- a) Crane should be designed as per codes and specifications (or equivalent international standard like DIN and broad technical parameters, detailed hereinabove. Crane should comply with relevant safety regulations under the Factories Act, Indian Electricity Rules and other statutory regulations as applicable.
- b) Crane should be manufactured and erected to tolerances specified hereunder.
- ✓ Span over LT wheels +6mm
 - ✓ Diagonal on wheels +5 mm
 - ✓ Long travel wheel alignment +1mm
 - ✓ Tilt of wheels or Balance Axle +1mm/1000mm (Horizontal & Vertical)
 - ✓ Trolley wheel gauge +3mm.
 - ✓ Trolley track gauge +3mm
 - ✓ Difference in height between trolley rails(H) for different trolley track gauge(S) shall be within following limits: (S) up to 2500 mm- (H) 4mm, (S) from 2500 to 4500mm- (H) 6mm and (S) above 4500mm – (H) 8mm

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- ✓ Speed at full notch with rated load, voltage and frequency shall be (a) Travelling & Traversing +10% / -5% of specified speed (b) Hoisting +10% / -5% of specified speed (c) Lowering +25% / -5% of specified speed.
- c) Operator's cabin should be located at one end opposite DSL side. Closed accessible cabin should have sliding side windows, toughened glass 6mm thick to have unobstructed view of load and surrounding. Layout of controls should enable crane operation from a seated position. Cabin should have adjustable padded seat, rubber matting, fan, lighting and fire extinguisher for electrical fire etc.
- d) AC variable frequency control (VVVF) for MH, AH, CT & LT should be used by using independent variable voltage variable frequency drives. Common controller for both LT motors may be used.
- e) LED lighting should be provided in operator's cabin, staircase etc. Bulkhead fittings with dust proof covers should be used for above areas. Four numbers underslung LED lamps with shock absorbing and anti-swing suspension arrangement should be provided for uniform shed floor illumination. Minimum one socket outlet for hand lamp 24V should be provided in cabin, long travel side and in areas where control panel, resistors and transformers are installed.
- f) Labels of permanent nature shall be provided on supports of all switches, fuses, contactors, relays etc to facilitate identification of circuits and replacement. Panels, controllers, resistors etc should be properly marked for each motion. Equipment terminals shall also to be marked likewise.
- g) Earthing to crane should be done through fourth conductor of DSL. Electrical equipment mounted on crane should be connected to crane structure by means of earthing links. Inverter should be suitable for crane application for all motion.
- h) Dead man's handle should be provided in cabin-operated crane, which will stop crane movement in case operator neglects proper handling. A foot-operated alarm should be provided to caution workers. A continuous ringing alarm should be provided for long travel motion of crane.
- i) Crane controls should be interlocked to prevent accidental movement of crane. Suitable limit switches, one each for LT and CT, and two each for MH and AH, should be provided to stop and to prevent over- travel. Electrical interlocks should be provided for simultaneous operations of traversing and traveling but during hoisting it is not possible to undertake either traversing or traveling.

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- j) All hoist motions should be provided with limit switches (rotary/ gravity) to prevent crane from over hoisting and over lowering. Two limit switches should be provided for proper back up protection.
- ✓ First limit switch shall act in case of over hoisting and over lowering.
 - ✓ Second, one shall be gravity limit switch and will operate only for hoisting.
- k) Safety switches of sustained contact type shall be provided at each end of crane- bridge so that in any emergency conditions, by operating any switch incoming circuit breaker is tripped to cut power to all motions. A mushroom head type push button shall be provided in operator's cabin so that main incoming circuit breaker could be tripped in emergency condition by pressing operating head. Pilot lamp in control circuit shall glow when any switch is operated.
- l) Suitable guard or enclosure should be provided on crane to prevent inadvertent contact with DSL or any other exposed electrical conductor and cable. Suitable isolation switches and stop buttons should be provided to isolate electric supply for maintenance and in case of an emergency. Safety hand railing of tubular construction should be provided on bridge foot walks, end carriages, staircases, landing in cabin, trolley and other places where access has been provided.
- m) Scope covers pendant push button control for LT, CT, MH and AH motions. Supply voltage to pendant control shall be 110V AC obtained through a suitable transformer. Necessary flexible multi-core cable of sufficient length should be supplied to operate crane from floor level. Pendant should be moving type and movement of pendant will be independent of trolley. Pendant control with double key lock system should have spring loaded push buttons to return to off position to stop crane movement as soon as operator releases thumb pressure on button.
- n) Scope covers supply of portable push button type radio remote control along with two-step push button type transmitter, receiver, antenna & cable, two sets of rechargeable batteries, battery charger and other standard accessories and items for controlling all motions of crane.
- ✓ Radio remote control shall be provided in addition to main control system through pendant/ master controller.
 - ✓ Transmitter of radio remote control should meet features like three stage audible and visual low power warning; audible and visual alarm; removable magnetic key (waterproof); shock resistant to 50G, password protection, narrow band FM, large mushroom E-stop switch, AA rechargeable batteries, internal antenna, programs receiver from ground through RE communication (no need to climb on crane to change frequency or address), two dual axis joysticks, range 100 m, 16 strap for transmitter slinging etc.

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- ✓ Receiver of radio remote control should meet features like power interruption protection, relay's contacted failure detection circuit, shock resistance mounting.

DG EOT Crane

The Double girder EOT crane (IS 3177: 2020, M8 Duty) is envisaged in the Ground floor area for handling the Car bodies from one work station to another work station and also handling the individual components received from warehouse and placing to respective work station. Other major DG EOT crane parameters as below:

Sl. No	Location	Capacity (T) (M/A)	Span (m)	LT travel (m)	TOR in m	Height of Lift (m)	Hoist Speed (m/min)	CT speed (m/min)	LT Speed (m/min)
1.	Ground floor	25 /5	22	400	12	12	4	20	50
2.	First floor	10/2	22	400	32	32	5	20	50

The crane main features of cabin operated as well as independent movable pendent operation. Also cranes having features of tandem operation for lifting the car body using both bay cranes. The lifting the car body, hook arrangement with slings is considered.

Forks / Telescopic Forks / Load Handling Mechanism: The crane is often equipped with forks or specialized load handlers to pick up pallets or bins and deposit them onto racks.

Warehouse area arrangement

The warehouse area is considered for size 400m (L) X 24m (W) in the middle bay for storage of the various components in pallets & bins. The either side of 25m length is considered for transfer area of handling the components loading in to the warehouse / unloading the components and distributed to respective work stations.

Racking Structure: High-rise racks/shelves designed to store loads in many vertical levels.

The pallets are stored in vertical manner both in ground floor & first floor.

The bins are stored in vertical manner in the height of 12 m X span 4.2 m (In the row of 4 Nos. bins) at ground floor. Also, the bins are stored in vertical manner in the height of 12 m X 4.2 m span. (In the row of 4 Nos. bins) at first floor separately.

Forks / Telescopic Forks / Load Handling Mechanism: The MHE is often equipped with forks or specialized load handlers to pick up pallets or bins and deposit them onto racks.

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Other Cranes

The following Single girder under slung cranes are envisaged for maintenance of compressors / water system pumps.

Sl. No.	Location	Capacity (T)	Hight of lift	Span
1	Compressor room	5T SG Under slung crane	7.0 m	10 m
2	Water pump house	2T SG Under slung crane	4.5 m	9 m

9.2 ELEVATORS

1. SCOPE

The scope of work covers Design supply, installation, testing, commissioning and handing over of the elevators meeting the intents of the tender specifications. Elevators may be with a machine room or without it.

The scope of work shall also cover the responsibility to obtain necessary approvals and License to operate from the appropriate local authority.

2. CODES & STANDARDS

Design of elevator components, their installation and operation shall meet with:

- IS 1860 :1968 Code of practice for installation, operation and maintenance of electric passenger and goods lifts.
- IS 4666:1980 Specification for electric passenger and goods lifts.
- Indian Electricity Act 1910 and Indian Electricity Rules 1956.

All codes and standards referred herein mean the latest and any work to alternate codes or practice shall be specifically stipulated by the tenderer citing the variations for acceptance by BEML.

3. HOISTWAY

A clear hoist way with gate openings or holes will be provided. No additional structural supports, members shall be provided in the hoist way for mounting of the traction motor in the case of machine room less elevators. The contractor shall use shear-type fasteners of adequate size to derive supports for all his requirements. During construction, to ensure verticality, straightness and dimensional accuracy of the hoist way, Mivan shuttering to be

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used. The visit of supplier during construction of the hoist way is desired on intermittent basis to ensure hassle free installation of elevator.

In the case of elevators without machine room, the traction motor shall be mounted within the hoist way with necessary mounting frame.

Car and counter weight buffers shall be of spring type for speed up to 1.6mps and hydraulic for higher speeds, with necessary supporting channels and struts. The buffers shall be capable of with-standing twice the fully-loaded car and two times the counter weight at contract speed + 15% and the fully compressed buffer top shall be not less than 1.2 metre. from the bottom.

Car and counter weight guides shall be machine rolled mild steel T-section with smooth, sliding, tongued and grooved joints. The guide rails shall be continuous throughout the travel. The brackets for fixing the guide rails shall be of steel and spaced so that the deflection shall not exceed 5mm under normal operation. Brackets shall be designed to suit the clear hoist way with necessary supporting structures.

Counter weight shall be made up of cast iron enclosed in a steel frame. Counterweight shall be car-weight plus 40% of contract load or any other value providing smooth and economic operation. Counterweights shall be provided with necessary guards at the bottom of the hoist way for at least 1.8 m.

All hoist way materials shall be non-flammable and Traveling cables shall be rendered flame resistant with suitable cladding.

4. ELEVATOR ENTRANCES

Entrances shall be centre opening or two speed with jamb openings. Entrances shall be complete with necessary frames, doors, sills, fascia, toe guards, dust covers, headers, hanger tracks, cover plates and all other hardware.

Doors for elevators shall consist of hollow metal panels pressed out sheet stainless steel adequately reinforced to form a rigid assembly and acoustically treated, so that noise transmission to corridors is not more than 20 dB on all octave bands. Doors shall have safety retracting shoes. Doors shall be of stainless steel.

Each door shall have integral hangers with balanced point of suspension. Main and up-thrust rollers shall have neoprene or any other suitable tyres and be mounted on factory lubricated ball bearings for smooth and noiseless operation. Roller tracks shall preferably be integral with the header assembly. Each door leaf shall be fitted with bottom Teflon/nylon stabilizers.

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Frames, fascia, hanger and dust covers and toe guards shall be of not less than 12 mm sheet steel. Sills shall be of extruded aluminium with necessary non-slip grooves. The entire door assembly shall be fire-resistant for not less than 1.5 hrs.

Frames and other exposed parts shall have a baked enamel finish of approved colour. All sheet steel members shall receive a suitable treatment for rust inhibition before receiving the after-coats of primer, filler and paint. Unexposed structural members shall be provided with necessary shop coats and one field coat of paint. Final colour and finish selection for the car rests with the BEML and no work shall be carried out until written instructions are issued.

5. CAR

Car frame supporting the car platform and enclosure shall be made of structural steel with isolating rubber cushion. Platform deflection shall not exceed 3 mm under maximum loading conditions. Car shall be complete with:

1. Wiring for lighting up to 1000 watts incandescent/fluorescent/LED.
2. Centrifugal Blower fan selected specially for noiseless operation.
3. Stainless steel car operating panel
4. Non-slip extruded aluminium threshold plate.
5. Interphone with an ear set microphone and speaker and the trailing cables shall be included.
 - a) 4 pair 14/0076 music cable.
 - b) 4 pair 0.5 Dia Cat.3 cable (All pairs shall be twisted)
6. Emergency lighting & alarm with necessary battery for 30 minutes complete with battery, charger etc.
7. An overload gauge feature which defeats the operating circuit when the car load reaches 110% of contract load.

All wiring for (5) (6) & (7) shall be provided as part of the traveling cables.

Car size shall be as per the relevant IS standards. The car interior shall be according to the Interior design and the car shall be designed to take a marble or granite flooring.

The car operating panel shall have the following devices:

- i. Hall buttons corresponding to the landings serviced.
- ii. Up and down direction indicators
- iii. Emergency stop switch
- iv. Alarm button connected to an alarm bell situated on the ground floor complete with wiring.
- v. Key-operated selector switch for 'Attendant' and 'Automatic' operation.
- vi. Door 'open' and 'close' buttons

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- vii. Fan switches
- viii. Key operated non-stop emergency switch
- ix. Handrail all around the car cabin
- x. P A System Mic.

All buttons shall be pushing self-illuminating type.

An alpha-numeric car position indicator shall be provided in each car. This should be digital type with announcement of floor. Car doors shall be Centre opening hollow metal doors. Door construction, suspension etc. shall be as specified for entrance doors.

A key operated switch with up-down buttons and a 100W lamp shall be provided for testing on top of the car.

6. DOOR OPERATOR FOR AUTOMATIC DOORS

Door operator shall be electric driven and shall work through a low-speed gear reducer. Operator shall provide smooth, quiet and positive operation of the car and hoist way doors simultaneously driving them to fully opened or fully closed positions. Doors shall be smoothly brought to rest at the end of travel by a rotary type hydraulic cushioning device. An adjustable timing device shall hold the door open for a set time interval after a stop is made except when the ultra-red monitor over-rides. An Infrared monitor shall be incorporated to initiate door closing 2 seconds after last beam interruption. This is over and above the mechanical retracting shoes.

Door operator shall have the following safety interlocks:

- i. Only the door at the landing where the car is stopping can be opened and no other hoist way door.
- ii. Car cannot move when the car or hoist way door is open.
- iii. During emergencies, car and hoist way doors shall be capable of being opened from outside.

For other safety devices refer section on 'Safety Devices.'

7. SIGNALS

Hall buttons shall have car direction lights which will remain illuminated when the call is registered and shall remain so, until the call is answered.

Car position indicator at each landing shall be incorporated for each elevator. These should be alpha-numeric electronic display with up-down arrows and a gong. Also lift location Panel on all floors.

All fixtures shall be of stainless steel and shall be approved by the Project Manager.

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8. ROPES & SHEAVES

The suspension ropes shall be of special acid proof quality steel or high-grade traction steel of suitable size, construction and number specially designed for lift duty, having a factor of safety at least equal to that specified in IS: 2365: 1977 or approved equivalent standard. Approved means of attaching the ropes to the car and counterweight shall be provided for each rope and all ropes anchored to a winding drum shall have not less than one complete turn of the ropes on the winding drum when extreme limits of travel are reached.

Governor ropes shall be of steel.

Tests shall be carried out at the manufacturer's works to ascertain that the ropes comply with the appropriate code or standard and test certificates shall be submitted for approval prior to shipment.

The traction sheave shall be made from close grained cast iron of the proper hardness accurately grooved for the proper number and size of hoisting ropes and shall be designed to give constant traction and long rope life. All deflector sheaves necessary to obtain proper lead of the ropes shall be provided and shall have similar construction to the traction sheaves.

A guard extending below the machine level shall be provided underneath the deflector and secondary sheaves.

9. ELEVATOR MACHINE

Machine shall be gearless traction type with necessary drive A.C motor, brake assembly, shaft sheave, all mounted on a common base. Motor shall be heavy duty; reversible type particularly designed for elevator service. Drive motors shall be selected for high starting torque and low starting current. All drive motors shall be rated for not less than 150 starts per hour.

The drive system shall operate on electronically computed acceleration and deceleration references through a microprocessor for achieving maximum inter floor speeds while providing consistently smooth ride and accurate stopping. The starting current shall be not more than 2.5 times the normal current. The processor shall control the drive motor speed through pre-calculated acceleration and deceleration references for achieving smooth rides. Levelling shall be through distance dependent speed reference to achieve the specified levelling criteria. The controller should achieve maximum inter floor speeds.

A spring applied and electrically released brake assembly with non-asbestos lining shall be provided on the drive shaft. A cranking device for manual operation of elevator car shall also be provided to meet emergencies together with manual break release. The manual break

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release and cranking device upon application shall automatically interrupt power supply. Wherever specified, a battery-operated emergency landing facility shall be provided.

A micro-levelling feature shall be incorporated. Micro levelling shall correct for over- travel, under travel and rope stretch, within its zone independently of the operating device. Car levelling at each landing shall not exceed +/- 4 mm with or without load and down or upward travel.

In the case of elevators without machine rooms, the traction machine shall be fitted within the hoist way and the break-release mechanism shall be operable from the last landing without entering into the hoist way.

10. CONTROLLER

The lift controller shall be vertical, totally enclosed cubicle constructed of sheet steel with hinged doors on the front and screwed panels or hinged doors on the back, giving easy access to all components inside the controller. The cubicle enclosure shall be minimum of IP 22.

The controller shall have a microprocessor with solid state switching devices sequenced and interlocked. All operations shall be software controlled with facility for interfacing with the building Fire Alarm System and Building Management System. Necessary protocols shall be made available for integration into the Building Management System. The controller shall operate within the supply voltage fluctuations specified and shall incorporate necessary input voltage stabilizers. The system shall have proven reliability.

In the case of machine room less elevators, the controller should be located such that it can be easily accessed from the last landing and shall be key locked and vandal proof.

The controller shall provide protection against the following:

- a) No-voltage or sustained under voltage
- b) Over current in any component
- c) Phase reversal of the power supply
- d) Overload
- e) Single phasing

The controller shall be arranged to cut-off the power supply, apply the brake and bring the car to rest at the nearest landing in the event any of the above failures occur.

Remote car position indicating panel shall be provided on each floor.

Latest version of controller and its software shall have to be provided.

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11. SAFETY DEVICES

An automatic stopping device shall stop the car at the terminal landing independent of the regular operating device. In the event, the car travels beyond the zone of the above stopping device, the final limit switches in the hoist way should arrange to stop the car and also prevent normal operation until reset.

A mechanical safety shall be mounted on the car frame and should actuate the fly ball governor gear which shall cause the following:

- Disconnect power to elevator machine
- Apply the main brake
- Apply the guide rail safety jaws The safety gear shall be manually reset.

Retractable safety shoes shall be provided on the car & hoist way doors together with an infra-red scanner. (Curtain full ht.)

An emergency stop switch in the elevator pit shall be provided to stop the car.

A battery-operated emergency landing facility shall be provided. This facility shall bring each elevator to the nearest landing and keep the car and hoist way doors open. In the case of multiple elevators, the batteries shall be adequately powered to bring all the elevators to the nearest landing in an orderly sequence (Auto Rescue device).

SN	PARTICULARS	ELEVATORS		
		Passenger	Passenger	Service
1.	Capacity	20 Passenger	15 Passenger	1.5 Tonnes
2.	Speed	1.5 m/sec	1.5 m/sec	0.5 m/sec
3.	Drive	A.C. VVVF	A.C. VVVF	A.C. VVVF
4.	Location of M/c room	Machine room less	Machine room less	Machine room less
5.	Travel	As per Building Requirements		
6.	Serving	As per Building Requirements		
7.	No. of stops	As per Building Requirements		

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8.	Power supply	415V, 3 Phase 50 Cycles AC	415V, 3 Phase 50 Cycles AC	415V, 3 Phase 50 Cycles AC
9.	Auxiliary	Single Phase 220V 50 Cycles AC	Single Phase 220V 50 Cycles AC	Single Phase 220V 50 Cycles AC
10.	Available car area	As per relevant IS standards	As per relevant IS standards	As per relevant IS standards
11.	Available pit depth	1.8 metres	1.8 metres	1.8 metres
12.	Available overhead	4.8 metres	4.8 metres	4.8 metres
13.	Available Hoist way size	2450 x 2550 mm	3050 x 1850 mm	2450 x 2550 mm
14.	Car Enclosures			
a	Car ceiling	Stainless steel 304	Stainless steel 304	MS painted finish
b	Car panels	Stainless steel 304 (1mm Thickness)	Stainless steel 304 (1mm Thickness)	MS painted finish (1mm Thickness)
c	Car flooring	25 mm Recess in Platform with Italian flooring	25 mm Recess in Platform with Italian flooring	25 mm Recess in Platform with Granite flooring
d	Lighting	LED	LED	LED
15.	No. of entrances	Single entrance	Single entrance	Single entrance
16.	Car entrance	Automatic Centre Opening Power Doors in SS 304	Automatic Centre Opening Power Doors in SS 304	Automatic Centre Opening Power Doors in MS painted finish
17.	Door safety	Full Screen Infra-Red Protection	Full Screen Infra-Red Protection	Full Screen Infra-Red Protection
18.	Landing entrance	Automatic Centre Opening Power Doors in SS 304	Automatic Centre Opening Power Doors in SS 304	Automatic Centre Opening Power Doors in MS painted finish

TECHNICAL SPECIFICATION

19.	Clear opening	1.0 mt (W) x 2.1 mt (H)	1.0 mt (W) x 2.1 mt (H)	1.1 mt (W) x 2.1 mt (H)
20.	Control system	Microprocessor Based Duplex selective collective control operation with or without attendant	Microprocessor Based Duplex selective collective control operation with or without attendant	Microprocessor Based Simplex control operation with or without attendant
21.	Operating & signal fixtures			
a		Motion Hall Button with Led Illumination at All Floors	Motion Hall Button with Led Illumination at All Floors	Motion Hall Button with Led Illumination at All Floors
b		Digital Hall Position at all Floors	Digital Hall Position at all Floors	Digital Hall Position at all Floors
c		Car Operating Panel with Motion Led Illuminated Floor Buttons with Built in Digital Car Position Indicator	Car Operating Panel with Motion Led Illuminated Floor Buttons with Built in Digital Car Position Indicator	Car Operating Panel with Motion Led Illuminated Floor Buttons with Built in Digital Car Position Indicator
d		Intercommunication	Intercommunication	Intercommunication
e		Extra Leeds in Traveling Cables for Music System	Extra Leeds in Traveling Cables for Music System	Extra Leeds in Traveling Cables for Music System
f		Fireman's Switch at The Main Lobby	Fireman's Switch at The Main Lobby	Fireman's Switch at The Main Lobby
22.	Control specifications			
a	Door operator	Automatic with Power Operated Door	Automatic with Power Operated Door	Automatic with Power Operated Door

TECHNICAL SPECIFICATION

b	Operating Device	Single Call Push Button at each level, Floor Buttons, Door Open / Close Buttons, Emergency Stop Control, Integral Interphone, Fire Man's Switch	Single Call Push Button at each level, Floor Buttons, Door Open / Close Buttons, Emergency Stop Control, Integral Interphone, Fire Man's Switch	Single Call Push Button at each level, Floor Buttons, Door Open / Close Buttons, Emergency Stop Control, Integral Interphone, Fire Man's Switch
c	Indicator	Digital Car Position Indicator and Illuminated Direction Arrows in Car and all landings, Pre-Announcing Gong at all Landings.	Digital Car Position Indicator and Illuminated Direction Arrows in Car and all landings, Pre-Announcing Gong at all Landings.	Digital Car Position Indicator and Illuminated Direction Arrows in Car and all landings, Pre-Announcing Gong at all Landings.
d	Alarm Bell	Battery Operated Alarm Bell and Emergency Light	Battery Operated Alarm Bell and Emergency Light	Battery Operated Alarm Bell and Emergency Light
e	Indicator	Overload Warning Indicator	Overload Warning Indicator	Overload Warning Indicator
f	Others	Automatic Rescue Device, Variable Door Time, Auto fan off, Voltage stabilizer for controller, Car Door Lock, Braille Buttons, Manual Rescue Device	Automatic Rescue Device, Variable Door Time, Auto fan off, Voltage stabilizer for controller, Car Door Lock, Braille Buttons, Manual Rescue Device	Automatic Rescue Device, Variable Door Time, Auto fan off, Voltage stabilizer for controller, Car Door Lock, Braille Buttons, Manual Rescue Device

TECHNICAL SPECIFICATION

CHAPTER-10 FIRE FIGHTING SYSTEMS

TECHNICAL SPECIFICATION

10.0 GENERAL

Firefighting shall be installed as per requirement of National Building Code -2016 (NBC). All the buildings shall be classified according to the use or nature of hazard occupancy in following groups.

- Group G Industrial

The specifications for Fire Fighting system elaborated in different chapters are generally based on NBC (latest) / TAC codes (India) / NFPA codes and BIS specification as applicable.

10.1 DESIGN BASIS

Considering the above building occupancy, the hazard classifications (Light, Medium, and High) of buildings / area are derived from the standards mentioned below.

- NBC-2016, part-4.
- BIS: 13039: 2014
- TAC – Fire Protection Manual

As per BIS norms, the various Buildings of Rolling Stock Manufacturing Plant area Comes under “Engineering work shop, godowns and water pump house.” As per this classification, the degree of Hazard of Rolling Stock Manufacturing Plant premises is **“Light Hazard Occupancies”**.

As per TAC, Clause no.7.2, the various Buildings of Rolling Stock Manufacturing Plant area comes under “Electric substation/distribution station, Engineering work shop, godowns and water pump house.” As per classification, the degree of Hazard of Rolling Stock Manufacturing Plant premises is **“Light Hazard Occupancies”**.

As per NBC-2016, Annex-B of Part-IV, the various Buildings of Rolling Stock Manufacturing Plant area comes under “Engineering work shop, godowns and water pump house.” industrial Occupancies. As per classification, the degree of Hazard of Rolling Stock Manufacturing Plant premises is **“Light Hazard Occupancies”**.

From the above, it is concluded that the Rolling Stock Manufacturing Plant premises is categorised under *Light Hazard* for providing the Fire Fighting and Safety system to protect the area/premises.

TECHNICAL SPECIFICATION

10.2 FIRE FIGHTING SYSTEM REQUIREMENT

The starting Point for design and provision of Firefighting protection system is based on the hazard classification of buildings, type of building occupancy, fire risk Involved etc. The requirement of firefighting system has been designed based on the following Codes and standards.

- NBC-2016, part-4.
- National Fire Protection Association (NFPA) standards 13, 14, 72, 2001.
- BIS: 13039
- BIS: 3844
- Tariff Advisory committee (TAC) FP Manual & Rules on Sprinkler

In order to combat any occurrence of fire in various areas/units of the Rolling stock Manufacturing Facilities, an elaborate system of firefighting facilities have been provided as per above standards/norms.

- Fire Water pumping system
- Yard Hydrant system
- Wet Riser system
- Hose reel system
- Fire Brigade Connection
- Automatic Sprinkler system
- Fire Tenders
- Portable Fire Extinguishers
- Fire Detection & Fire Alarm System

10.3 FIRE WATER PUMPS & ACCESSORIES

1. General

The Rolling stock Manufacturing plant, premises shall be provided with Fire Water pumping systems comprising mainly of the following and details as follows:

2. Fire Water Pumps

One number of firefighting pump house is envisaged for catering to fire water needs of the proposed. The following electrical driven firefighting pump, diesel engine driven pump and Jockey pumps are envisaged.

Sl NO	Description	Capacity (cum/Hr)	Head (mWC)
1	Electric Driven pump	171	88
2	Diesel Driven pump	171	88

TECHNICAL SPECIFICATION

3	Jockey pump	18	88
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3. Description Fire Water Pumping System

The fire hydrant system and Spray system have been provided considering fully automatic operation of pumps and control systems. Normally, both systems shall be kept pressurized at a pressure of 7.0 Kg/cm². To take care of minor leakages from the systems two number jockey pumps common for Fire hydrant system have been provided. When there is leakage of water from either system, first jockey pump shall start automatically so that system pressure is maintained at 7.0 Kg/cm².

In case of fire, when any landing valve / yard hydrant is opened, the water pressure in the respective network shall drop resulting in automatic starting of main electric pumps for respective system at the present low pressure in headers. If the main electric pumps for hydrant fail to start or trip, the diesel engine driven pumps shall start automatically. Whenever the Main fire pumps are working, the jockey pumps shall not work. Also when the header pressure drops beyond a present value, the Diesel Engine pumps shall start even with main pumps (motor driven) running.

Complete system shall be provided with Auto as well as local mode of operation. The local mode of operation shall override the Auto mode. Individual selector switches (Local / Auto / off) shall be provided for drives of Pumps. For jockey pumps, the selector switches shall also have a selection for reserve pump.

Static water tank of 513 Cum useful volume with compartment for Fire Water system shall be provided. The pump suction header shall be connected with common header. The common header connected with sump with two inlets.

4. Broad Technical Parameters of Static Water Tanks and FWPH

- The static water sumps shall be provided with RCC Construction and Shape is rectangular.
- To facilitate cleaning dewatering pit shall be provided in both static water tanks.
- The pipe network and valves within the pump house shall be adequately supported so as to avoid undue stress on the equipment.
- Suitable toe drain, connected to garland drain shall be provided in the pump house to drain out any spillage of water from the glands etc.

TECHNICAL SPECIFICATION

10.4 Fire Fighting Pumps

The Horizontal centrifugal pumps shall conform to the following codes, standards regulations

S. No.	Codes	Description
1	IS-12469-1978 (R.A 2011)	Specification for Pumps for Fire Fighting System
2	IS-5120-1977(R.A 2001)	Technical requirement for Roto-dynamic special purpose pumps
3	IS-9137-1978(R.A 2002)	Code of acceptance for centrifugal, mixed flow and axial flow pumps - Class 'C'
4	BS-5316, Part-I-1977	Acceptance tests for Centrifugal (ISO-3555-1977) mixed flow and axial flow pumps - Class 'C' tests
5	BS-5316, Part-II-1977	Acceptance tests for centrifugal (ISO-3555-1977), mixed flow and axial flow pumps – Class 'B' tests
6	Hydraulic Institute standards of U.S.A (Latest Edition)	
7.	PTC 8.2 – 1965	Power Test Code – Centrifugal pumps

wherever applicable:

The horizontal centrifugal pumps along with their auxiliary equipment shall be suitable for the required duty conditions and shall be designed and manufactured for continuous duty at full load.

The motor rating shall be of continuous; rating type and its rating shall be equivalent to the horse power required to drive the pump at 150% of its rated discharge.

Capacity Vs discharge pressure curved for each pump shall be continuously drooping from the shut-off point to the rated operating point and be suitable for parallel operation. The pump shall be designed to avoid cavitation at any of the operating points. The characteristic of the pump shall be non-over loading type.

The required duty range for a pump shall be on stable portion of its head capacity curve close to the best efficiency point. The head developed at the best efficiency point shall be close to the required differential pressure so that throttling is not required at pump discharge.

TECHNICAL SPECIFICATION

Pumps shall be capable of supplying not less than 150% of rated capacity at a head of not less than 65% of rated head. The shut off head shall not exceed 120% of rated head.

The equipment design shall incorporate provisions for reduction in noise level. For Diesel engine driven pumps, Noise level shall not exceed 110dBA at 1 metre from the equipment and for other equipment, it shall not exceed 85 dBA at 1 m distance from equipment.

1. Casing

The casing shall be designed for a pressure not less than the shut-off pressure at the highest operating speed or the maximum pressure that may be encountered at the pump inlet.

Jack screws, lifting lugs, eyebolts or equivalent horizontal positioning screws and guide dowels etc. shall be provided in the casing to facilitate alignment disassembly and reassembly. When jack screws are furnished as means of parting contacting faces, the catching face shall be counter bored to receive the jackscrew.

Running clearance between wearing rings and other moving parts shall be such as to prevent seizure under the operating conditions of temperature, suction conditions, characteristics of the fluid handled and the expansion characteristics of the wearing ring material.

2. Impellers

Impellers shall be statically and dynamically balanced. Dynamic balancing shall be at the operating speed of the pump.

The impeller shall be securely locked and keyed to the shaft in a way such that it is not loosened due to reverse rotation of the pump.

3. Shafts

The shafts of all the pumps and drive motors shall be designed for combined critical speed. The ratio of critical speed to speed of shaft shall be not less than 1.2.

Shafts shall be easily accessible throughout their lengths. All steel shafting 150mm or less in diameter shall be hot rolled and turned, forged and turned, cold rolled or cold drawn. All shafting above 150mm in diameter shall be forged and machined to size.

The deflection in line shaft shall not exceed 0.1 mm per meter length. All shafts above 150mm diameter shall be ultrasonically tested. Shafts shall be checked for endurance and strength. Change of sections in shafts if considered shall be made with due allowance for stress concentration. Shafts shall be machined to close tolerance for mounting on impeller bearings, shaft seal, shaft sleeve, shall not exceed 50 microns.

4. Coupling and coupling guard

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The pumps shall have flexible coupling with motor. Removable coupling guards shall be supplied and mounted. Guards shall be sufficiently heavy and rigid to provide adequate safety to personnel.

5. Shaft sealing

Shaft seals shall be provided to prevent leakage out of, or into, a pump over the range of specified operating conditions including reverse rotation of the pump. The seals shall be suitable for variations in inlet conditions that may prevail during start-up and shut down. They shall be accessible for inspection and replacement without disturbing any part of the installation.

Packed glands with supply of sealing liquid shall generally be used. Packed glands shall be sufficiently deep to accommodate at least five packing rings and shall not require separate lubrication. A lantern ring sandwiched between rows of packing shall be provided for packed glands subject to vacuum split type lantern ring shall be used so that the same can be taken out easily. Throat bush or collar ring is to be provided with the casing to support the packing inside the gland. Provision shall be made for tightening the pump glands during running of the pumps. Sealing connection to the lantern ring shall be taken from the pump discharge while handling clear and non-aggressive liquids.

6. Bearings

Bearings shall be manufacturer's standard design and of water lubricated sleeve type. Suitable thrust bearings shall be provided in the pump to take total thrust of the pump including hydraulic thrust. Thrust bearings shall be oil lubricated type with suitable cooling arrangement. Suitable tapped holes shall be provided for refilling of oil in the bearing housing.

Bearing oil temperature shall not exceed 72° C based on continuous operation for anti-friction bearings and 62°C for white metal bearings under specified operating conditions. Bearings may be water or air cooled to maintain oil temperature within the limitations. Where water cooling is required, either water jackets formed by cored castings or cooling coils may be used. Cooling jackets shall not offer possibilities of leakages of coolant into the bearings.

Bearing housing shall be of such design as to exclude entry of water, dust and other contaminations. When the housing serves as an oil reservoir, an oil level indicator shall be furnished.

Oil lubricated bearings shall be equipped with constant level oilers with the recommended oil level clearly indicated by permanent marks.

The bearing housing used with grease lubricated bearing shall be constructed as to require the grease to pass through the bearing when being forced from the inlet fitting to the vent or drain plug.

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7. Companion Flanges Bolts, Nuts & Gaskets

Plate flanges having raised face shall be provided at delivery side of pumps and they shall be of mild steel and conform to the relevant table of IS: 6392 -1972 (R.A. 1988)

SS bolts and nuts confirming to IS: 1363 shall be provided for the companion flanges and column pipe connections.

The MOC of the parts shall be as follows:

Hardware in contact with water: SS 304.

Hardware not in contact with water: IS 1367 – Class 4.6

Heavy Hex. Nuts Cs: IS1367 / ASTM A 194 GR 2H IS 1364 CL4. Rubber gaskets conforming to IS:638 shall be provided for the companion flanges.

Broad Specifications of Fire Water Pumps

A)	Fire water pumps	:	<ul style="list-style-type: none"> • 171 m³/h, Electrical driven = 3 Nos. • 171 m³/h, Diesel Engine driven = 2Nos.
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TECHNICAL SPECIFICATION

CHAPTER-11

WATER SUPPLY FACILITIES

TECHNICAL SPECIFICATION

11.0 General

The water requirement for the proposed rolling stock commuter Rail and Metro Cars manufacturing plant is predominantly for CAR testing, fire-fighting, drinking purpose, general purposes like bathing & canteen application with a small part of the requirement being for cooling purpose & direct process needs like washing etc. To minimize the fresh water drawn from the source, cooling water, CAR testing water recirculation systems have been envisaged with required makeup.

11.1 Requirement of water

The fresh water requirement of the plant is estimated at 53 m³/h (650 cum/day approx.).

Recirculation systems have been envisaged only in car testing facility & remaining major water consumption in the plant is once through type. The break-up of re-circulation and fresh make-up water required in the plant is indicated in table below.

TABLE SHOWING BREAK - UP OF RECIRCULATION AND FRESH MAKEUP WATER REQUIREMENT

Sl. no.	Description	Water Requirement (cum) per day
1	Water consumption for car body leakage testing.	12
2	RO reject water @ 30% of feed water	5.14
3	Cooling water recirculation @ 7.5KL per Hr losses (evaporation + system loss)	90
4	Water requirement washroom and drinking @45l/pax No. of People around 2512(2284+10%)	113
5	Water requirement canteen @ 70 litre/pax	176
	Total Water Requirement per day	396.14 say 400
(A)	Total water storage required considering a reserve of 2-days	800
(B)	Firefighting water reserve	513
	Total A+B	1313

TECHNICAL SPECIFICATION

11.2 Source of water

The source of water for the proposed plant will be from the municipal fresh water supply pipeline (i.e. drinking water pipeline from Narmada River to Bhopal city) passing near the plant site, from where raw water / fresh water will be supplied to the storage reservoir to be constructed in the plant. The plant storage reservoir of 1313 Cu.m will cater for 2 days storage requirement. It is considered that the water is made available at the storage reservoir in the plant.

11.3 Proposed facilities

To cater to the water requirements of the plant, the following facilities are envisaged which are explained below.

11.4 RO PLANT:

A RO plant of capacity approx. 1 MLD has been proposed for feeding the RO water to the water leak test area for testing of car body shell & the completed car body.

Water from the water pump house shall be fed to the RO plant for the RO water generation. The RO water will be supplied via piped network to Car body fabrication & Assembly line and Car body inspection & testing facility.

11.5 Fire-fighting facilities

Refer separate write-up for Firefighting facilities.

Water distribution

MS / CS / Galv. pipes & fittings are envisaged for water supply based on the requirement. The pipelines will be routed overhead along the building columns / walls. Ball valve / Gate valve / butterfly valves / control valves of suitable diameter & pressure gauges will be provided as per requirement & at tapping points. Water hammer arresters & air release valve are envisaged in the distribution network considering sudden surge during operation. Platforms, access ladders, etc. will be provided for operation and maintenance of valves, instruments & controls and gauges provided in the pipeline network.

Pressure reducing valves (PRV) will be provided as per requirement to regulate the pressure. PRV's to be easily accessible for repair.

Pipe sizing and pressure drop Calculation is carried out using sing Hazen William's formula as given below (Reference: NBC 2016 PART -9 ANNEX c Clause 4.7)

TECHNICAL SPECIFICATION

Hazen-Williams equation for pipe flow

- ✓ Headloss in pipes(water supply network)
- ✓ Empirical
- ✓ Named after Allen Hazen and Gardner Stewart Williams.
- H= head loss(m)
- Q= flow rate(m³/sec)
- L= length of pipe(m)
- d= diameter(m)
- C= Hazen William's coefficient

$$H = 10.65 \frac{Q^{1.85} L}{C^{1.85} d^{4.87}}$$

Piping layout will follow good engineering practices.

Reference codes & standards

Sl. No.	Design standard	Standard	Description
1.	BIS	IS: 1520	Horizontal centrifugal pumps for clear, cold & fresh water
2.	BIS	IS: 5120	Technical requirement for roto-dynamic special purpose pumps
3.	BIS	IS: 9137	Code of acceptance tests for centrifugal, mixed flow and axial pumps
4.	BIS	IS: 1710	Pumps - Vertical Turbine Mixed and Axial Flow, for Clear Cold Water
5.	BIS	IS: 10553	General guidelines chlorination plant, including handling, storage and safety of chlorine cylinders and drums
6.	ANSI	ANSI B 31.3	Process piping code
7.	BIS	IS: 1239 (Part-I)	Steel tubes, tubulars and other wrought steel fittings - Specification
8.	BIS	IS: 1239 (Part-II)	Steel tubes, tubulars and other wrought steel fittings - Specification

TECHNICAL SPECIFICATION

9.	BIS	IS: 3589	Electrically welded steel pipes for water, and sewerage (168.3 to 2540 2000).
10.	BIS	IS: 5504	Spiral welded pipes
11.	ASTM	ASTM A 106 Gr. B	ERW & Seamless CS pipe specification
12.	ASTM	ASTM A 53	MS pipe specification
13.	ANSI	ANSI B 36.1	Welded & seamless wrought steel pipe dimensions
14.	ANSI	ANSI B 36.19	Stainless Steel pipes dimensions
15.	ANSI	ANSI B 16.9	Butt welding pipe fittings dimensional standard.
16.	ANSI	ANSI B 16.11	Forged steel fittings : Socket welded & threaded
17.	BIS	IS: 6392	Steel pipe flanges.
18.	ANSI	ANSI B 16.5	CS pipe flanges & flanged fittings
19.	BIS	IS:13095	Butterfly valves for general purpose.
20.	IPSS	IPSS-1-06-012	Steel industry OPSS specificaiotn of Butterfly valves
21.	BS	BS EN: 593	Industrial valves: metallic butterfly valves for general purposes
22.	ANSI	ANSI/AWWA C504	Rubber seated butterfly valves
23.	BIS	IS: 5312	Swing check type reflux (non-return) valves for water works purposes — specification
24.	BS	BS: 5153	Specification for cast iron check valves for general purposes
25.	BIS	IS: 778	Copper alloy gate, globe and check valves for waterworks purposes
26.	BIS	IS: 3042	Specification for single faced sluice gates (200 to 1200 mm size.)

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27.	BIS	IS: 13349	Cast iron single faced thimble mounted sluice gates - Specification
28.	BIS	IS: 14846	Sluice valve for water works purposes (50 to 1 200 mm size) — specification
29.	BIS	IS: 14845	Resilient seated cast iron air relief valves for water works purposes — specification
30.	ISO	ISO:17192	Metal ball valves for petroleum, petrochemical and allied industries
31.	BIS	IS: 1703	Water fittings — copper alloy float yalves (horizontal plunger type) — specification
32.	BIS	IS: 2906	Indian standard specification for sluice valves for water works purposes (35-1200mm size).
33.	BIS	IS: 4038	Specification for foot valves for water works purposes.
34.	BIS	IS: 5312	Swing check type reflux (non-return) valves for water works purposes — specification
35.	BS	BS: 5155	CI & carbon steel butterfly valve for general purpose
36.	BS	BS: 5158	CI & carbon steel plug valve for general purpose
37.	BIS	IS 14845	Air release valves.
38.	IPSS	IPSS-1-06-001	Foot valves standard.
39.	API	API: 602	Steel gate, globe & check valves for sizes pns 4 (ND100) and smaller for the petroleum and natural gas industries.
40.	BS	BS: 5352	Steel wedge gate, globe and check valves 50 mm and smaller for the petroleum, petrochemical and allied industries.
41.	API	API: 600	Gate valves for petroleum & natural gas.

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42.	BS	BS: 1414	Specification for steel wedge gate valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries
43.	BS	BS: 1873	Specification for steel globe and globe stop and check valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries
44.	BS	BS: 1868	Specification for steel check valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries.
45.	API	API: 599	Metal plug valves - Flanged, threaded, and welding ends
46.	API	API 598	Valve inspection & testing.
47.	BIS	IS: 2002	Steel plate for pressure vessel for intermediate and high temperature service including boilers.
48.	BIS	IS:2062	Hot rolled medium and high tensile structural steel – Specification.
49.	BIS	IS: 5822	Code of Practice for Laying of Electrically Welded Steel Pipes for Water Supply.
50.	BIS	IS: 3114	Code of practice for laying of cast iron pipes.
51.	BIS	IS: 12288	Code of Practice for Use and Laying of Ductile Iron Pipes.
52.	BIS	IS: 1387	General requirements for the supply of metallurgical materials.
53.	BIS	IS: 7307	Fusion welding of steel.
54.	BIS	IS: 7310	Approval Tests for Welders Working to Approved Welding Procedures.
55.	API	API: 1104	Welding of Pipelines and Related Facilities.
56.	ASTM	ASTM Sec. 5	Non-Destructive examination.

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57.	ASME	ASME Sec 9	ASME boiler & pressure vessel code.
58.	BIS	3 IS: 1447	Code of practice for painting of ferrous metals in buildings.
59.	BIS	IS: 5	Colours for Ready Mixed Paints and Enamels.
60.	-	-	Indian Petroleum rules.

TECHNICAL SPECIFICATION

CHAPTER-12 SEWAGE TREATMENT PLANT

TECHNICAL SPECIFICATION

12.0 SEWAGE TREATMENT PLANT

Design, engineering, construction, supply, installation, testing and commissioning of STP based on MBR technology complete with electro-mechanical works necessary equipment, interconnecting piping network etc.

12.1 General

The main source of wastewater to be treated shall be resulting from factory floor washing, cleaning and leakage test of coaches, kitchen waste water and waste water coming out from washrooms/Toilets. The scope of work includes design, engineering, preparation of drawings, getting approvals from statutory bodies, construction, erection, commissioning, trial run and obtaining test results of completely below ground sewage treatment plant with electrical, mechanical, piping and controls along with operation and maintenance for one year. The treated effluent should be fit to reuse for Flushing and Landscaping etc. The work is required to be carried out on a turnkey basis covering a guarantee of satisfactory performance as per the standards laid for a minimum period of One year.

12.2 BASIC DATA ON INFLUENT RAW WASTE WATER (SEWAGE): -

Following shall be the Parameters for design of Sewage Treatment Plant.

TABLE-1	
Parameters	Values
pH	6.0 - 8.5
BOD5	250 - 350 Mg/L
Total Suspended Solids	250 - 450 Mg/L
COD	500 - 700 Mg/L
Oil & Grease	up to 50 Mg/L
Inflow time	8 hrs.
Peak factor	3
Temperature	Ambient

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Standards of the Sewerage Discharge after treatment shall be as follows:

As stipulated by State Pollution Control Board (PCB), the treated effluent quality shall be within the following values for various parameters.

Waste water after treatment below shall be suitable for recycling in flushing and landscaping.

TABLE-2	
Parameters	Values
Turbidity (NTU)	< 2
Total Suspended Solids	Less than 10 mg/L
pH	6.5 – 8.5
Temperature °C	Ambient
Oil & Grease	< 10 mg/L
Total Kjeldahl Nitrogen as N	10 mg/L
NH ₄ -N	5 mg/L
BOD ₅	Less than 6 mg/L
COD	Less than 50 mg/L
Dissolved Phosphorous as TP	1 mg/L
Nitrate Nitrogen as N	10 mg/L
Faecal Coliform in 100 ml	Nil
Colour	Colourless
Odor	Aseptic which means not septic and no foul odour
TDS	2000

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12.3 DESIGN CRITERIA: -

- a) The STP is designed on the basis of wastewater flow and quality parameters as mentioned above in Tables 1 & 2 Where the contractor to submit an offer for STP, these values shall form the design criteria for designs.
- b) The plant shall function in aerobic condition only. Formation of any anaerobic / septic condition in the bio-reactor shall not be allowed.
- c) The “Manual on sewerage and sewage treatment”, “Manual on water supply and treatment” and other relevant BIS / PCB / Ministry of environment publications shall be followed.

12.4 STATUTORY APPROVALS: -

On award of the work, contractor shall submit and obtain approval and permission from State Pollution control Board and any other statutory approval may be required for the installation and operation of the sewage treatment plant for the proposed process and disposal arrangement. The contractor shall make presentation and all submittals required by the authority.

On satisfactory completion of the works and commissioning of the plant and getting desired effluent results the contractor shall obtain the No Objection Certificate (NOC) from the authorities.

12.5 SCOPE OF WORK

The Scope of work includes Design, Engineering, Construction, Supply, Installation, Testing, Commissioning, trial run and handing over of Sewage Treatment Plant (STP), to give treated effluent quality as specified and in accordance with norms of central / State Pollution Control Board. The successful bidder is also to undertake operation & maintenance of the facility for a period of 5-years (1+4) from the date of signing of the handing over document of the facility through OEM after successful trial run and handing over of the plant out of which one year shall be covered under DLP and further four years shall be under AMC (Annual maintenance charge). Nothing shall be payable additionally on this account. The bidder is to take into account this aspect and quote accordingly. The EPC contractor would be required to deploy at least one operator per shift in all three shifts to take care of operation and maintenance of the facility for a period of five years(5-years) as stated above. A separate and fresh performance BG of the amount equivalent to 10% of this line item (as per price break-up) is required to be submitted by the contractor after DLP and before start of AMC with validity of 4.5-years. During the period of DLMP (defect liability & maintenance period), cost incurred on consumables and replacement of defective parts, components etc., shall be the

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responsibility of the bidder for which no-additional payment will be made shall undertake day to day maintenance of the facility, consumables during this period shall be provided by the contractor at no additional cost.

The contractor will be solely responsible for smooth running of the sewage treatment plant and overall functioning of STP. In case it is found in the later stage that some additional fixtures / equipment is required to be added in order to achieve desired quality, the contractor would be liable to provide without any extra charges.

Following items are within the scope of contract. The basic flow diagram is attached herewith. The capacity of different tanks / units is indicative and for reference only. The successful contractor will be required to carry out detail design and submit the detailed Process and shop drawings incorporating various civil and equipment's details. These detailed drawings shall be vetted by BEML and approved drawings shall be released for construction submitted to the Client / Consultant for their comments & approval.

Vendor has to submit all the technical details for equipment's used for operation of plant for approval. All the works shall be carried out as per approved construction drawing only.

Vendor's scope includes Engineering of the System along with the detailed hydraulic calculations, chemical dosage calculations, including preparation of detailed equipment drawings, piping, electrical & instrumentation, and other items of work required for installation and commissioning of the plant.

- Complete civil works.
- Complete interconnecting piping between various units including supply of all materials like pipes, fittings, all valves, gaskets, flanges, nuts and bolts including all materials required for necessary pipe supports and associated civil works, etc., complete.
- Supply, erection and commissioning of all the equipment's required for the sewage treatment plant as per the individual equipment specification and details given.
- All electrical works including all electrical motors for the various equipment, cabling, LT panel, starters, etc., will be provided by the contractor. The scope of work includes all civil works like construction of panel foundations, cable trenches, cable supports, lighting of entire plant as per drawing etc., complete Commissioning of all the equipment.
- The contractor has to mention in his offer, the details of electrical power requirements of the various equipment, total installed load and operational load.
- All temporary sheds, office, godowns, etc. required for storage of materials and for contractors' supervisory personnel at site.

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- Scope of contract for piping includes construction of necessary masonry valve chambers wherever necessary, removable type MS painted covers and extension spindles for valves.
- The entire STP is proposed to construct below ground level. The contractor has to mention the minimum plant area required and total depth.
- Preparing shop drawings for the civil works / units related to the wastewater treatment plant for the work within the plant terminal points, the civil works will be constructed by another agency nominated by the Owner.
- Make of all piping/Equipment's/Motors/Cables and Pumps shall be clearly stated in the offer shall be got approved by the Client / Consultant before Supply & Installation. The decision of consultant in this regard shall be final and binding on the successful Contractor.
- All equipment GA drawings shall be submitted to the Client / Consultant for approval prior to fabrication/ ordering. The fabricated and brought-out equipment's shall be inspected at Contractor/Manufacturers workplace by the Client/Consultant at the cost of contractor and shall be dispatched to site only after obtaining clear dispatch instructions in writing from Client/Consultant.
- It is obligatory on the part of the intending bidder to visit the site of work prior to submitting the offer and familiarize himself with local / site / soil conditions, availability of men, Materials and Machinery for successful and timely execution of the works. No extra shall be paid in case Contractor fails to ascertain correct site conditions before submitting the offer.
- Any other item not specifically / mentioned in this tender but is essential for proper and successful completion commissioning and running of the STP for its commercial utilization is also to be included in the scope of contract.
- Main contractor has to ensure proper coordination between various groups working under them for establishing and running the plant successfully.
- Five years operation and maintenance (DLMP) will be included in the contract after trial run.
- Obtain No Objection Certificate (NOC) that the plant is meeting the State Pollution Board requirements

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12.6 TEST / COMMISSIONING AND TRIAL RUNNING OF INDIVIDUAL COMPONENT

The Contractor shall have to test each equipment used for the plant for at least 72 hours continuous running with designed load and to the full satisfaction of the Client / Consultant. Any defects found, has to be rectified by the contractor at his own cost immediately and within reasonable time to be decided by client.

Necessary Instruments, Gauges, labour / Supervisory Staff, Laboratory analysis etc., are to be furnished / provided by the Contractor free of cost to client. Vendor has to specify the value-added services in his offer letter.

1. TESTS (SAMPLING & ANALYSIS OF TREATED WATER)

EPC contractor shall ensure deputation of OEM's plant operator in all three shifts to take care of operation and maintenance of plant meeting the desired parameter. During the DLMP period, the contractor has to undertake sampling of effluent on monthly basis and get it tested for specified parameters from NABL accredited lab. In case Laboratory Test Report do not reflect desired result, all necessary action followed by laboratory testing till satisfactory result will be the responsibility of the contractor.

Moreover pH, TSS & COD parameters should be checked & logged by the Vendor on daily basis.

2. COMMISSIONING AND TRIAL RUN OF PLANT AND HANDING OVER

After successful commissioning of the plant, the contractor shall trial run it for a period of one month. During trial runs as described above, the Contractor shall satisfy the Client / Consultant in all respects regarding the satisfactory quality of effluent, quality of materials, equipment's and workmanship used in the plant. Only after satisfying itself/ himself regarding the above points, client will take over the plant and such date of taking over shall be deemed as date of completion for all purposes, like guarantees, and payment terms mentioned elsewhere in this tender. The guarantee period described elsewhere in the tender shall start from the date of completion.

3. TRAINING OF OPERATOR

Vendor shall provide necessary training for operators nominated by BEML during commissioning & trial run period. After completion of training to the operators as nominated, the Vendor shall certify the operator's performance to carry over the plant maintenance and operation efficiently. The Contractor to provide 3 operators (1-in each shift) during commissioning stage as well for training purpose.

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4. GUARANTEE

The under mentioned clauses shall govern in case of any contrary provisions given elsewhere in the document.

a. Manufacturer's Guarantees

The manufacturer's guarantee for design, workmanship and performance for all bought out items shall be made available to BEML and shall be valid at least for the entire defect's liability period.

In the event of failure of any particular equipment, which fails more than three times during the guarantee period as mentioned in clause below, the contractor shall replace at his own cost that equipment. Manufacturer's/Contractor's guarantee, as mentioned in clause above, for such replaced equipment shall also be made available to the Owner and should be kept at least for 'one year from the date of last replacement.

b. Performance Guarantee

The Contractor shall give guarantee for a period of one year from the date of successful commissioning and trial run of the treatment plant against design, defective materials, workmanship, performance and guaranteed effluent quality. In the event the commissioning of the plant is not possible due to non-availability of influent, contractor shall be issued mechanical completion certificate by client provided each equipment is tested satisfactorily as directed. However, the contractor shall have to maintain the plant at his own cost. In such a case for a period for three months beyond which period, if he is required to maintain further, he will be paid extra at mutually agreeable rate. However, the Contractor shall carry out testing, commissioning and trial run of the plant during the Defects Liability Period. Any defects found in the workmanship, materials or performance of the plant shall be made good by the Contractor at his own expense within the time specified by client.

The contractor, if directed by the Client, shall at his own cost prove the Oxygenation capacity guaranteed by him for the diffusers provided by conducting Oxygenation capacity tests on the unit by any standard and internationally recognized method to be approved by the Consultants.

12.7 TECHNICAL SPECIFICATION

1. TREATMENT SCHEME: -

The treatment scheme shall be based on Membrane Bioreactor based Biological Treatment followed by UV System. The STP will consist of following stages:

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1st Stage – Primary Treatment, which comprises of screening, oil and grease trap.

2nd Stage – Secondary or biological treatment, which comprises of Anoxic & Aeration Tank, MBR Tank equipped with submerged membrane.

3rd Stage – Disinfection, which comprises of UV System

4th Stage – Sludge Treatment, which comprises of Screw Pumps and Filter Press.

1. TREATMENT UNITS: -

Above Treatment Scheme shall comprises of the following units –

- 1) Bar Screen Chamber with Screen
- 2) Oil & Grease Chamber with Oil & Grease Separator
- 3) Equalization Tank
- 4) Air Blowers
- 5) Fine Screen
- 6) Anoxic Tank
- 7) MBR Module equipped with hollow fiber membranes
- 8) Permeate Suction Pump
- 9) Backwash Pump
- 10) Raw Sewage Transfer Pumps
- 11) Sludge Recycling Pumps
- 12) UV System
- 13) Treated Water Tank
- 14) Sludge Holding Tank
- 15) Screw Pumps with Filter Press
- 16) Piping & Cabling
- 17) Electrical Panel

2. PROCESS DESCRIPTION: -

Screening

The Sewage is led into a Bar Screen Chamber provided with SS Bar Screen. Bar screen shall be provided at inlet point in the bar screen chamber. Screen with openings generally of uniform size having 10 mm opening to remove suspended or floating matters in sewage to be provided. The velocity shall be maintained so as to avoid settling of grit or organic matter. Bar screen shall be so designed that it can be cleaned manually from outside of tank.

Oil & Grease Chamber

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The raw sewage after passing through Bar Screen shall be taken into an oil & grease trap for removal of oil and grease from the effluent. Oil & Grease Separator also to be provided to separate oil & grease from the trap.

Equalization Tank

The Equalization Tank is provided to balance fluctuating flow and engineered to deliver a constant rate of flow to the treatment system. Aeration of Equalization Tank will be kept with adequate numbers of coarse air bubble air diffusers to avoid any smell and sedimentation problems. The raw sewage is pumped using submersible non-clog pumps of suitable capacity.

Anoxic Tank

The Anoxic Reactor will reduce the ammoniacal nitrogen by completing the de-nitrification reaction. The process involves the de-nitrification of waste streams through the use of bacteria which breaks down the nitrate in the waste to use as an oxygen source. This breakdown of nitrate from the waste stream release oxygen and nitrogen gas. The oxygen is consumed by the bacteria and the nitrogen gas releases to the atmosphere. The waste stream then has acceptable nitrogen levels as per the environment requirement.

3. MBR tank with submerged membrane bioreactor

The Sewage will be pumped to aeration tank which comprises fine pore diffusers and PVDF hollow Fiber submerged membrane. The efficiency of BOD removal is considered as between 90 – 97% in this bioreactor.

The MBR tank contains highly concentrated biomass, so called activated sludge, which transforms the organic matter of the wastewater into carbon dioxide, water and biomass. The activated sludge is kept in aerobic conditions at all times by continuous aeration.

The membranes come in stacks called cassettes. The cassettes are mounted on to a skid with an easy removal mechanism. The skid with the cassette construction ensures that the replacement costs for the membrane are kept to the minimum.

The filtrate from the MBR will be removed by MBR filtrate pumps. The suction of the pump is connected to the MBR filtrate headers in the skid. Return activated sludge pumps are provided in the MBR chamber to maintain the continuous circulation of the mixed liquor between the aeration tank and the MBR Chamber.

Permeate of membrane is further treated with UV System and stored in Treated Water Tank.

The excess sludge from the aeration tank will be taken out at regular intervals from the recirculation line. The sludge will be stored in sludge holding tank and then pumped through screw pump to filter press and solid cakes formed are carted out. Sludge cake should be stored in proper place as per the norms and guidelines.

TECHNICAL SPECIFICATION

12.8 DETAILS OF ELECTRICAL WORKS: -

GENERAL SPECIFICATION OF EQUIPMENT

- I. 1 NO. LT Panel, cubicle type suitable for floor mounting and comprising incoming power Control switch, Ammeters, Voltmeter, Phase Indicating Lamps MCBs and Starters for the feeders all complete. Also, to be provided are Automatic Level Controller for actuating the Raw Effluent / Treated effluent. Necessary Auto manual Selector Switches shall also be provided.
- II. Local push button starters shall also be provided near the Aerator equipment's and mounted in weatherproof enclosures.
- III. Necessary power wiring by armoured PVC Cables or by PVC insulated wire in conduit from LT Panel to equipment motors shall be provided with necessary tray/ support etc complete and internal lighting of entire DSTP Plant as shown in the drawing.
- IV. Necessary earthing as per I.E., rules.
- V. Lighting shall be as per IS requirements and fixtures shall be Philips make and the make and size of cables used should be approved from the Client / Consultant.
- VI. Energy meter (approved make) should be provided in the panel.
- VII. The switchboard shall be metal clad, totally enclosed, rigid, compartmentalized design, floor mounting, air insulated, extensible cubicle type for use on medium voltage power, 3 phases 4 wire 50 cycles system.
- VIII. The equipment shall be designed for operation in high ambient temperature and high humidity tropical atmospheric conditions. Means shall be provided to facilitate ease of inspection, cleaning and repairs for use in installations where continuity of operation is of prime importance.

STANDARDS

Following equipment's shall conform to the requirements of:

- a) Moulded Case Circuit Breaker (MCCB) - IS 13947 - 1, 2 / IEC 60947 - 1 & 2
- b) Miniature Circuit Breaker (MCB) - IS 8828 - 1996 / IEC 898 - 1995
- c) Contactors - IS 13947 - 1, 4
- d) Indicating Instrument - IS 1248
- e) Residual Current Circuit Breaker (RCCB) - IS 12640 - 1988 / IEC 1008
- f) HRC fuse link - IS 9224 and BS 8: 8
- g) Current Transformer - IS 2705 and IEC 185
- h) Potential Transformer - IS 3156
- i) Relay - IS 3231 & IS 8686 (For Static Relays)

TECHNICAL SPECIFICATION

12.9 CONSTRUCTION

1. The switchboard shall be-

- a) CRCA Sheet steel enclosed, indoor floor mounted freestanding cubicle type.
- b) Made up of the requisite vertical sections modular type which when coupled together shall form continuous switchboards.
- c) Dust, vermin and damp proof and enclosure protection not less than IP 52
- d) Each feeder / instrument compartment shall be provided with a hinged door interlocked with MCCB/SFU inside the compartment such that door can only be opened when MCCB/SFU in off position.
- e) Readily extendable as required by the addition of vertical sections after removal of the end covers.
- f) Switchboards shall have access to the feeders, bus bars, cable termination, cable alley, etc. as required.

2. Each vertical section shall comprise-

- a) A front-framed structure of rolled/folded CRCA sheet steel. angle section of minimum 3 mm thickness rigidly bolted together. This structure shall house the components contributing to the major weight of the equipment such as circuit breaker cassettes, fuse switch units, main horizontal bus bars, vertical risers and other front mounted accessories.
- b) The structure shall be mounted on a rigid base frame of folded CRCA sheet steel of minimum 6 mm thickness and 75 mm height. The design shall ensure that the weight of the components is adequately supported without deformation or loss of alignment during transit or during operation.
- c) A cable chamber housing the cable end connections and power/control cable terminations. The design shall ensure generous availability of space for ease of installation and maintenance of cabling and adequate safety for working in one vertical/horizontal section without coming into accidental contact with live parts of the adjacent section.
- d) A cover plate at the top of the vertical section, provided with a ventilating hood where necessary. Any aperture for ventilation shall be covered with a perforated sheet having less than 1 mm diameter perforations to prevent entry of vermin.

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- e) Front and rear doors fitted with dust excluding neoprene gaskets with fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors generous overlap shall be ensured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust.
3. The total height of the panel shall not be more than 2300 mm unless otherwise specified and maximum height of switch operating handle shall not be more than 1800mm from FFL. The total depth of the panel shall be adequate to cater for proper cabling space.
4. Doors shall be of minimum 14-gauge sheet steel and covers/partitions of 16-gauge sheet steel. All sheet steel work forming the exterior of switchboards shall be smoothly finished, levelled and free from flaws. The corners should be rounded.
5. The Components in the switchboards shall be so arranged as to facilitate ease of operation and maintenance and at the same time to ensure necessary degree of safety.
6. Components forming part of the switchboards shall have the following minimum clearances:
- Between phases - 32mm
 - Between phases and neutral - 26mm
 - Between phases and earth - 26mm
 - Between neutral and earth - 26mm
- When, for any reason, the above clearances are not available, suitable insulation barrier / shielding shall be provided. Clearances shall be maintained during normal service conditions.
- Creepage distances shall comply to those specified in relevant standards.
7. All insulating material used in the construction of the equipment shall be of non-hygroscopic material treated to withstand the effects of high humidity, high temperature and tropical ambient service conditions.
8. Functional units such as circuit breakers, fuse switches, MCCBs, etc. shall be arranged in multi-tier formation except that not more than two air circuit breakers shall be housed in a single vertical section.
9. Metallic/insulated shrouding shall be provided within vertical sections and between adjacent sections to ensure prevention of accidental contact with:
10. Main bus bars and vertical risers during operation, inspection or maintenance of functional units and front mounted accessories.
11. Fault withstand capacity of Panel including Bus Bar / MCCB / ACB shall be as specified in BOQ.
12. Cable terminations of one functional unit, when working on those of adjacent unit/units.

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13. All covers providing access to live power equipment/circuits shall be provided with tool operated fasteners to prevent unauthorized access.

14. Provision shall be made for permanently earthing the frames and other metal parts of the switchgear by two independent distinct connections.

15. Only CRCA steel sheets shall be used for fabricating the cubicle.

16. Thickness tolerance for sheets shall be as applicable in relevant IS.

17. Metal Treatment and Finish: -

The panel shall have nine tank pretreatment process comprising of degreasing, rinsing, dedusting, rinsing, phosphatizing, rinsing, and passivation followed by powder coat painting having a paint thickness of 60 micron or as specified of approved shade of siemens grey (Shade RAL 7032). The powder paint will be subjected to oven heated process.

Note:

- Provide detailed specification with guarantee details of the equipment's.
- Provide efficiency curves and catalogues for the equipment's used.
- Provide GA drawings and shop drawings before start of the work.
- Provide as built drawing after completion of project.
- Vendor to furnish the manual for operation and maintenance with trouble shooting by his experience.
- Vendor to furnish the list of spare parts, which are frequently required for trouble free operation.

TECHNICAL SPECIFICATION

CHAPTER-13 COMPRESSED AIR FACILITIES

TECHNICAL SPECIFICATION

13.0 General

To cater the plant & instrument air requirement of the proposed Rolling stock commuter Rail and Metro Cars Manufacturing plant oil free screw compressors are proposed. These air compressors will supply single quality dry air to technological equipment's, pneumatic instruments, pneumatic equipment's, pneumatic operated valves, general purpose application like for cleaning etc.in the plant.

13.1 Description of Equipment

1. Refrigerant air dryers.

Suitable capacity refrigerant air dryer with each compressor unit will be provided to supply continuously dry air with a pressure dew point of (+) 3 deg. C. The air-drying unit will be refrigerant type with automatic mode of operation. Design consideration of the drying unit will be as per manufacturing standards available with Approved vendor list of MECON. One air dryer will be provided for each of the compressor installed.

Selection of dryers will be such that performance of the same will not be affected at different loads of the system. The dryers will be installed adjacent to the compressor. The system will be designed such that under no circumstances the dry air supply will be stopped. Selection of refrigerant will be environmentally acceptable. Pressure drop across dryer will not exceed 0.2 kg/sq.cm.

The dryer will be supplied along with all necessary auxiliaries. The operation and controls of the dryers will be fully automatic. The dryer will be complete with following as the minimum requirement.

- Air inlet connection
- Air outlet connection
- Air inlet strainer
- Condensate separator
- Digital pressure dew point indicator

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Air drying unit insulating block housing air to air heat exchanger, air to refrigerant heat exchanger / evaporator, condensate separator, liquid separator, refrigerant distributor, refrigerant injection restrictor.

- Condensate trap with automatic discharge
- Manual condensate drain valve.
- Water cooled (for dryer at sl. no. 2) or air cooled (for dryer at sl. no. 5) condenser.
- Hermetic / semi hermetic refrigerant compressor.
- Liquid refrigerant dryer
- Liquid shut-off valve
- Liquid refrigerant receiver
- Sight glass with moisture indicator
- Refrigerant expansion valve
- Refrigerant circuit access connection
- Capacity bypass
- Temperature and pressure indicators / switches
- The dryers will have built-in control panel with auto/manual operation.

2. Air Receivers

Air receiver will be vertical type & horizontal type conforming to IS: 2825 (Class 2) or ASME Sec. VIII in all respects of design, manufacture, fabrication, welding, testing, mountings, radiography materials, etc. It will be suitable for maximum compressor working pressure with supporting base legs and necessary fittings like safety valves, pressure indicator, manhole (davit type), inspection hole, draining arrangement with auto drain traps with strainer & manual bypass isolation valves, nozzles and access / platform for maintenance etc. The receiver will be fabricated from carbon steel plates conforming to IS: 2002 (latest revision), Gr-2A or equivalent material.

3. Filters

Suitable air filters will be provided at downstream of air receiver. Selection of fine filters will conform to ISO 8573 class meeting the process requirement.

a) Pre filter

Each stream will be provided with one no. of pre filter. This filter will be surface filter renewable / replaceable type with the following parameters:

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1. Material of construction:

- a) Body: Carbon steel
- b) Filtering element: Sintered bronze / borosilicate fiber type.

2. Pressure: delivery pressure (Max)

3. Particle size: 1 micron

4. Diff. Pr. gauge: Yes

b) Fine filter

Each stream will be provided with one no. of fine filters at the outlet of air receiver to ensure fine air availability. Fine filter will be replaceable type.

1. Material of construction:

- a) Body: Carbon steel
- b) Filtering element: Borosilicate fibre / equivalent

2. Dust / oil Particle size: 0.01 microns

3. Diff. Pr. gauge: Yes

Quality of compressed air in both the compressors will conform to ISO8573. Compressed air quality will be as per table given below:

Description	Particle size (microns)	Dew point temp. (Deg. C).	Oil (mg/cum)
Dry compressed air (Class: 1-4-1)	0.1	(+) 3 PDP	0.01

compressors & accessories will be installed in separate structural steel shed. 2 Ton underslung crane is envisaged in the shed. Cooling water for the compressors & dryers will be supplied from suitable facilities for cooling.

compressors & accessories will be installed in the respective workshops inspection & testing bays. For air compressor & dryer, HT & LT motor please refer electric chapter of this report

4. Compressed air distribution:

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Medium pressure & high pressure compressed air will be supplied to individual consumer or individual requirement through network of pipelines. The pipelines will be routed overhead along the building columns / walls. Isolating valves condensate drains and compensators, Pressure gauges will be provided in pipeline network as per the process requirements. Platforms, access ladders, etc. will be provided for operation and maintenance of valves, instruments & controls and gauges provided in the compressed air pipeline network. Piping layout will follow good engineering practices. Distribution pipeline & fittings will be MS / CS, Valves shall be CS with SS internals.

Pressure loss in the pipeline is calculated by logarithmic charts.

Reference codes & standards

Sl. No.	Design standard	Standard	Description
61.	API	API: 619	Rotary – Type displacement compressors for petroleum m chemical & gas industry services
62.	API	API: 618	Reciprocating Compressors for Petroleum, Chemical, and Gas Industry Services.
63.	BIS	IS: 2825	Code for unfired pressure vessels
64.	ASME	ASME Sec 8	Rules for Construction of Pressure Vessels.
65.	BIS	IS:7938	Air receiver for compressed air installations
66.	ISO	ISO: 8573.1	Air Quality standards
67.	ISO	ISO: 12500	Filters for compressed air
68.	ISO	ISO: 7183:2007	Compressed-air dryers
69.	IS	IS: 8183	Bonded mineral wool specification.
70.	ANSI	ANSI B 31.1	Power piping code
71.	ANSI	ANSI B 31.3	Process piping code
72.	BIS	IS: 1239 (Part-I)	Steel tubes, tubulars and other wrought steel fittings - Specification
73.	BIS	IS: 1239 (Part-II)	Steel tubes, tubulars and other wrought steel fittings - Specification
74.	BIS	IS: 3589	Electrically welded steel pipes for water, and sewerage (168.3 to 2540 2000).
75.	BIS	IS: 5504	Spiral welded pipes

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76.	ASTM	ASTM A 106 Gr. B	ERW & Seamless CS pipe specification
77.	ASTM	ASTM A 53	MS pipe specification
78.	ANSI	ANSI B 36.1	Welded & seamless wrought steel pipe dimensions
79.	ANSI	ANSI B 36.19	Stainless Steel pipes dimensions
80.	ANSI	ANSI B 16.9	Butt welding pipe fittings dimensional standard.
81.	ANSI	ANSI B 16.11	Forged steel fittings: Socket welded & threaded
82.	BIS	IS: 6392	Steel pipe flanges.
83.	ANSI	ANSI B 16.5	CS pipe flanges & flanged fittings
84.	BIS	IS:13095	Butterfly valves for general purpose.
85.	IPSS	IPSS-1-06-012	Steel industry OPSS specification of Butterfly valves
86.	BS	BS EN: 593	Industrial valves: metallic butterfly valves for general purposes
87.	ANSI	ANSI/AWWA C504	Rubber seated butterfly valves
88.	BIS	IS: 5312	Swing check type reflux (non-return) valves for water works purposes — specification
89.	BS	BS: 5153	Specification for cast iron check valves for general purposes
90.	BIS	IS: 778	Copper alloy gate, globe and check valves for waterworks purposes
91.	BIS	IS: 3042	Specification for single faced sluice gates (200 to 1200 mm size.)
92.	BIS	IS: 13349	Cast iron single faced thimble mounted sluice gates - Specification
93.	BIS	IS: 14846	Sluice valve for water works purposes (50 to 1 200 mm size) — specification
94.	BIS	IS: 14845	Resilient seated cast iron air relief valves for water works purposes — specification
95.	ISO	ISO:17192	Metal ball valves for petroleum, petrochemical and allied industries
96.	BIS	IS: 1703	Water fittings — copper alloy float valves (horizontal plunger type) — specification

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97.	BIS	IS: 2906	Indian standard specification for sluice valves for water works purposes (35-1200mm size).
98.	BIS	IS: 5312	Swing check type reflux (non-return) valves for water works purposes — specification
99.	BS	BS: 5155	CI & carbon steel butterfly valve for general purpose
100.	BS	BS: 5158	CI & carbon steel plug valve for general purpose
101.	API	API: 602	Steel gate, globe & check valves for sizes pns 4 (ND100) and smaller for the petroleum and natural gas industries.
102.	BS	BS: 5352	Steel wedge gate, globe and check valves 50 mm and smaller for the petroleum, petrochemical and allied industries.
103.	API	API: 600	Gate valves for petroleum & natural gas.
104.	BS	BS: 1414	Specification for steel wedge gate valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries.
105.	BS	BS: 1873	Specification for steel globe and globe stop and check valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries
106.	BS	BS: 1868	Specification for steel check valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries.
107.	API	API: 599	Metal plug valves - Flanged, threaded, and welding ends
108.	API	API 598	Valve inspection & testing.
109.	BIS	IS: 2002	Steel plate for pressure vessel for intermediate and high temperature service including boilers.
110.	BIS	IS:2062	Hot rolled medium and high tensile structural steel – Specification.
111.	BIS	IS: 7307	Fusion welding of steel.

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112.	BIS	IS: 7310	Approval Tests for Welders Working to Approved Welding Procedures.
113.	API	API: 1104	Welding of Pipelines and Related Facilities.
114.	ASTM	ASTM Sec. 5	Non-Destructive examination.
115.	ASME	ASME Sec 9	ASME boiler & pressure vessel code.
116.	BIS	IS: 1447	Code of practice for painting of ferrous metals in buildings.
117.	BIS	IS: 5	Colours for Ready Mixed Paints and Enamels.
118.	-	-	Central Pollution Control Board standards.

TECHNICAL SPECIFICATION

CHAPTER-14 EMERGENCY DIESEL GENERATOR SET

TECHNICAL SPECIFICATION

14.0 Technical details of Diesel Generator Set.

Diesel engine shall be of four stroke, turbocharged, radiator-cooled, prime power type and shall be complete with internal combusting engine, fuel oil system, exhaust system along with exhaust silencer, chimney, lube oil system, battery starting system, governing system, alternator and capable of driving continuously the generator to give required output at its alternator terminals without any de-aeration. All the DG sets (along with enclosure / hoods) will be installed outdoor. All DG sets shall have independent stack as per CPCB norms with minimum 30 M height.

14.1 TECHNICAL PARTICULARS OF DG SETS

Sl. No.	Description	Unit	Value
1.	Rated power at the alternator terminals	KVA	2000
2.	Power rating classification	KVA	Prime power with varying load required during power outage.
3.	Fuel	-	High Speed Diesel
4.	DG sets Cooling system	-	Radiator-cooled.
5.	Engine speed	rpm	1500 rpm
6.	Lubrication system	-	Forced lubrication
7.	DG sets Starting system	-	Battery start.
8.	Frequency	Hz	50 Hz
9.	Voltage	KV	11 KV

DG set/s output shall be suitable for emergency application and prime power type & shall be in accordance with ISO 8528 & ISO 3046.

1. Combustion air System

Combustion air to the engine shall be clean air and it will be supplied through exhaust gas driven turbo charger from atmosphere through dry type suction filter. Suction filter & Turbo

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charger shall be mounted on the engine / base frame. Differential pressure gauge or mechanical clogging indicator to be provided across suction filter.

2. Engine governing

The diesel engine shall run steady at any load up to full load. Engine shall be provided with electronic governor with 110% over speed protection. Engine governor shall be capable of maintaining speed within the specified limit as per BS 3046 part 4 classes A1.

3. Lubricating oil System

The diesel engine shall be forced lubricated; the lubrication system shall be self-contained & not limited to the following equipment.

- a) Sump: To store sufficient lube oil for circulation, sump of sufficient capacity for continuous operation. Sump shall also be provided with level gauge or dip stick required for monitoring. Lube oil sump shall be integral part of DG set base frame.
- b) Pump: Shaft driven main oil pump, electric motor driven auxiliary oil pump & oil tank mounted hand pump (as required for priming during startups, oil change etc.) shall be provided in the DG lubrication system. A timer-based control (with manual over ride) shall be provided to start the auxiliary oil pump once in 6 hours and run for half an hour and flush the lube oil in the system.
- c) At the inlet of pumps Strainers to be provided. Necessary differential pressure gauge or mechanical clogging indicator to be provided across lube oil filter.
- d) Lubricating oil cooler with thermal valve or thermostat for Automatic lube oil temperature control to be provided.
- e) Interconnecting piping, valves & fittings.
- f) Breather / suitable oil vapour extraction system shall be provided to remove the oil vapour collected in the lube oil tank. In-case of forced oil vapour extractor, automatic electrical type is preferred over air ejector type vapour extractor.

4. Engine exhaust system

The engine exhaust gases shall be let-off through exhaust system. All the hot parts at the working level shall be insulated. The exhaust system shall include:

- a) Suitable size exhausts duct connecting to engine exhaust manifold and silencer & chimney to be provided to expel the exhaust gases. MOC of exhaust duct & silencer shall be CS.
- b) Exhaust manifold shall be air cooled type – incoming combustion air.

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- c) **Silencer:** After turbocharger turbine, the exhaust gases shall be let off through silencer. Exhaust muffler/silencer shall be for minimum insertion loss of 25 db(A). However maximum level of shall not exceed 85 dB (A) at 1 m from the DG set. Silencer shall be residential type
- d) **Expansion bellows:** Expansion bellows shall be provided on the exhaust duct near the engine exhaust manifold & near chimney connection on the exhaust pipe to absorb the thermal expansion and reduce the thermal loads on engine & chimney respectively.
- e) **Exhaust chimney / duct:** 30 m height exhaust chimney with a cowl (at the top) shall be provided to expel the hot exhaust gases. Chimney shall be structurally supported type & shall be provided with insulation up to 3 m height from ground. Two numbers of always switch on Automatic timer-based Aviation lamps with manual on & off option to be provided at the top of chimney. Chimney shall have sampling ports with proper platforms & approach. Landing platforms & approach ladder shall also be provided to reach chimney top. In general, design of chimney shall conform to IS 6533.

Exhaust duct, exhaust manifold, silencer & chimney and other hot parts which are at lower levels & approachable for normal human height shall be provided with thermal insulation with cladding. Thermal insulation shall conform to IS 8183; thickness of insulation shall be selected such that the skin temperature will not exceed 62°C. Also, hot mineral wool insulation shall be wrapped with chicken mesh and 22 SWG aluminum cladding.

5. Cooling system

Shall have radiator type cooler (includes engine jacket water & cooling water) along with cooling air fan. The air to water / coolant cooler shall be of high efficiency type and the capacity of cooling coils shall be more than required for the DG sets at 110 % operation.

6. Hood

Complete DG Set shall be provided with weather proof enclosure & Acoustic enclosure cum silencing hood. Enclosure shall be provided with acoustic insulation to limit the sound level.

The acoustic enclosures have minimum 25 dB (A) insertion loss. However maximum level of sound at 1 meter from hood shall not exceed 85 dB (A).

Hood shall have suitable ventilation fans to expel the heat generated inside the enclosure. For the ease of erection & dismantling during maintenance the enclosure / panel shall be open able from any side of DG sets. Enclosure shall be provided with the following

- a) Lockable inspection doors.
- b) Sealed glass window for inspection & MP panel vision.
- c) Fresh air inlet acoustic louvers & fresh air chamber as required.

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- d) Hot air exhaust chamber & exhaust acoustic louvers as required.
- e) Lighting inside hood.
- f) Hood panel shall be CRCA sheeting with 1.6 mm (minimum) thickness with rock wool insulation & perforated GI or aluminium sheets as lining material. Weather proof powder coating shall be provided on the outside surface of the hood.
- g) The dimensions of the hood shall be such that there will be sufficient space inside the hood for the maintenance.

7. Fuel oil system

Each DG set shall be provided with 990 Liters Day tank. Day tank shall be provided with flanged fuel inlet, outlet, high- and low-level switches, float valve etc. The day tank shall be provided with level gauge calibrated in liters for easy filling in of fuel. Fuel outlet of day tank to be connected to the fuel supply / feed line of DG set. Fuel return line from the DG set shall be connected back to the day tank. Drain cock shall be provided. The oil tanks shall be mounted on a self-supported steel structure frame.

The fuel oil tanks shall be per IS: 803, 1976 & shall be provided with reinforcement plates (not less than 3mm) inlet & outlet nozzles, hand hole, Vents, drains, earthing etc. Except vent, interconnection and overflow nozzles.

Suitable fuel oil filters (preferably dual filters) to supply clean fuel oil to engine shall be provided in DG set/s. Necessary differential pressure measurement & mechanical clogging indicator to be provided across fuel filter.

A float valve between high level switch & tank overflow in day tank shall be provided so that in case of high-level switch malfunction, the tank will be isolated from incoming fuel oil to avoid over flow.

Fuel oil system shall be complete with oil pipelines (including pipeline from day tanks to engine), fittings, valves, flow meters etc. HSD pipe lines shall conform to ASTM A106 grade B, Sch. 40, ANSI B 36.1 & fittings shall confirm to ASTM A105 / A216, ANSI B16.11 & B16.9 thickness matching to the pipe thickness.

8. Coupling & Base Frame

Coupling of diesel engine & alternator shall be flexible type. The coupling shall be efficient type with minimum loss of power & minimum vibration transmitted during operation due to possible misalignment and unbalances. Anti-vibration pads shall be provided to reduce the vibration to the floor / foundation & other equipment's.

9. Controls & Instrumentation

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DG set shall have Auto Mains Failure feature & can start automatically during power outage. DG set will be provided with Skid mounted control panel controlling the operation & functions of the DG sets.

The D.G. shall be self-sufficient W.R.T system control. DG set/s shall be provided with mounted microprocessor-based control panel. Sufficient measurements, interlocks and controls shall be provided for efficient operation as well as for safety of equipment and operating personnel.

DG set/s & accessories shall be provided with all instruments necessary to check the DG sets system parameters & check its performance continuously.

14.2 Brief technical details of Electrical Equipment

2. Generator

The main parameters of generator would be as follows: -

- i) Power factor - 0.8 (lagging)
- ii) Rated voltage - 11 kV \pm 10%, 3 phases, 50Hz, \pm 3%.

The generators shall be driven by the diesel engine as described above. The generators shall also conform to IEC-34/IS-4722 or equivalent.

Generator shall be capable of carrying an unbalanced load of 20% without injurious heating of any part provided rated current is not exceeded. The generator shall withstand without mechanical injury an over speed of twenty (20) percent for a period of two (2) minutes. The generator stator and rotor windings shall have Class-F insulation meeting the temperature rise limitations for Class-B.

3. Generator Excitation System

A complete generator excitation and voltage regulation system shall be provided with the generator. The excitation shall be of static type or brushless type.

4. Terminal Box

Suitable Alternator Terminal Box duly painted shall be provided towards power output side as well as towards neutral side.

5. Control & Relay Panel

The emergency diesel generator shall be driven from the control panel of the D.G. set to facilitate automatic and manual starting of the set. A composite relay and metering panel housing composite Microprocessor based Numerical generator management relays and metering equipment as well as synchronization arrangement and a separate control cum

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battery charging panel shall be provided individually for the DG set. Including the NGR panels located in the MRSS building.

The proposed emergency power system envisaged will conform to latest norms, as applicable.

6. HT/LT cables:

11 kV (UE) cables shall be heavy duty, XLPE insulated, PVC sheathed multi core, aluminum conductor steel wire/strip armored type.

Power Cables for kV system shall be heavy duty, 1.1 kV grade, XLPE insulated PVC sheathed aluminum conductor, armored / unarmored as required.

The control cables shall be multi strand copper conductor, PVC insulated and PVC sheathed with minimum cross section of 2.5 sq.mm for control circuit and 4.0sq.mm for power circuit. Five to ten core cables will have one spare core, and cables above 10 cores will have minimum 20% spare cores.

14.3 Standards and Regulations

DG set & accessories shall meet the requirements laid down in relevant ISO 8528 & ISO 3046., BS, IEC and other reputed national / inter nation standards as applicable. It shall comply with statutory requirement of Indian Electricity rules, factory inspectorate, CPCB, PESO Government of India and Government of Madhya Pradesh, Indian petroleum act, Indian explosives act.

14.4 Earthing & Lightning Protection.

The lightning protection system of the DG station will be designed based on IS 2309:1969. The Earthing system of the DG station shall be designed based on IS 3043:1987.

Reference codes & standards

Sl. No.	Design standard	Standard	Description
1.	ISO	ISO: 8528	Reciprocating internal combustion engine driven alternating current generating sets
2.	ISO	ISO: 3046	Reciprocating internal combustion engines
3.	IS	IS: 8183	Bonded mineral wool specification.
4.	BIS	IS: 10987	Code of practice for for design, testing and installation of under-ground/above-ground

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			horizontal cylindrical steel storage tanks for petroleum products
5.	BIS	IS: 803	Code of Practice for Design Fabrication and Erection of Vertical Mild Steel Cylindrical Welded Oil Storage Tanks
6.	API	API 650	Welded steel tanks for oil storage
7.	ANSI	ANSI B 31.1	Power piping code
8.	ANSI	ANSI B 31.3	Process piping code
9.	BIS	IS: 1239 (Part-I)	Steel tubes, tubulars and other wrought steel fittings - Specification
10.	BIS	IS: 1239 (Part-II)	Steel tubes, tubulars and other wrought steel fittings - Specification
11.	BIS	IS: 3589	Electrically welded steel pipes for water, and sewerage (168.3 to 2540 2000).
12.	BIS	IS: 5504	Spiral welded pipes
13.	ASTM	ASTM A 106 Gr. B	ERW & Seamless CS pipe specification
14.	ASTM	ASTM A 53	MS pipe specification
15.	ANSI	ANSI B 36.1	Welded & seamless wrought steel pipe dimensions
16.	ANSI	ANSI B 36.19	Stainless Steel pipes dimensions
17.	ANSI	ANSI B 16.9	Butt welding pipe fittings dimensional standard.
18.	ANSI	ANSI B 16.11	Forged steel fittings: Socket welded & threaded
19.	BIS	IS: 6392	Steel pipe flanges.
20.	ANSI	ANSI B 16.5	CS pipe flanges & flanged fittings
21.	ISO	ISO:17192	Metal ball valves for petroleum, petrochemical and allied industries
22.	BS	BS: 5155	CI & carbon steel butterfly valve for general purpose
23.	BS	BS: 5158	CI & carbon steel plug valve for general purpose
24.	API	API: 602	Steel gate, globe & check valves for sizes pns 4 (ND100) and smaller for the petroleum and natural gas industries.

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25.	BS	BS: 5352	Steel wedge gate, globe and check valves 50 mm and smaller for the petroleum, petrochemical and allied industries.
26.	API	API: 600	Gate valves for petroleum & natural gas.
27.	BS	BS: 1414	Specification for steel wedge gate valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries
28.	BS	BS: 1873	Specification for steel globe and globe stop and check valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries
29.	BS	BS: 1868	Specification for steel check valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries.
30.	API	API: 599	Metal plug valves - Flanged, threaded, and welding ends
31.	API	API 598	Valve inspection & testing.
32.	BIS	IS: 2002	Steel plate for pressure vessel for intermediate and high temperature service including boilers.
33.	BIS	IS:2062	Hot rolled medium and high tensile structural steel – Specification.
34.	BIS	IS: 1387	General requirements for the supply of metallurgical materials.
35.	BIS	IS: 7307	Fusion welding of steel.
36.	BIS	IS: 7310	Approval Tests for Welders Working to Approved Welding Procedures.
37.	API	API: 1104	Welding of Pipelines and Related Facilities.
38.	ASTM	ASTM Sec. 5	Non-Destructive examination.
39.	ASME	ASME Sec 9	ASME boiler & pressure vessel code.
40.	BIS	IS: 1447	Code of practice for painting of ferrous metals in buildings.
41.	BIS	IS: 5	Colours for Ready Mixed Paints and Enamels.
42.	-	-	Indian Petroleum rules.
43.	-	-	Central Pollution Control Board standards.

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CHAPTER-15 INDUSTRIAL GASES

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15.0 INTRODUCTION

BEML has proposed Rolling stock commuter Rail and Metro Cars Manufacturing plant (green field) at Bhopal, Madhya Pradesh. Industrial gases like Oxygen, Argon, AOM gas & ACM gas are required in the plant. The said industrial gases are required for the following purposes:

- Laser cutting machine required for cutting operation.
- Argon gas, AOM gas (98 % Argon + 2% Oxygen) & ACM gas (80 % Argon +20% Co2) are required for automatic & manual welding operation.

This writeup specifies the storage handling & distribution of the above industrial gases. The system description will be explained as under:

15.1 Requirement of the industrial gases:

The requirement of said industrial gases is indicated below:

TABLE SHOWING REQUIREMENT OF INDUSTRIAL GASES

Description	Description	Unit	Total Quantity Required (per annum)	No. of days	Per day consumption (320 working days)	Consumption in each shift (Considering 2 shifts)	Consumption per hour, with each shift of 8 hours	No. of cylinders required for 3 days (47 L cylinder holds 7 m3 of gas @150 bar)	
Compressed Oxygen Gas	Compressed Oxygen Gas	Cu.M	70995.00	320.00	221.86	110.93	13.87	95.1	95
Argon Gas	Argon Gas	Cu.M	69048.00	320.00	215.78	107.89	13.49	92.5	95

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98% Argon + 2% Oxygen (AOM Gas)	AOM Gas	Cu.M	18962 7.0	320. 00	592.58	296.29	37.04	254.0	255
80% Argon + 20% Co2 (ACM Gas)	ACM Gas	Cu.M	12254 4.0	320. 00	382.95	191.48	23.93	164.1	165

Gas storage is planned for three days i.e. If gas is continuously consumed stored gas will last for three days. In case if gas is used intermittently the gas storage will be for more than three days depending upon the consumption factor.

15.2 Source of gas

In the proposed plant, gas generation is not envisaged, however gas is supplied from outside in the portable cylinder's receptacles / cylinders. In order to increase the gas storage volume, the pressure of the storage is considered at 150 bar & water volume of the cylinder is considered as 47 Liters.

15.3 Proposed facilities

Various industrial Gas requirements viz. Oxygen, Argon, AOM and ACM gases required for the plant will be met by the gas cylinders to be procured from any reputed vendors. Separate cylinder-manifolds-storage for each gas will be provided. These cylinders & manifolds will be installed in the gas station. Gas will be supplied to various plant consumers from this common gas station.

For a given type of gas, cylinders will be connected to a common Manifold and will be operated Semi- Automatically or manually depending on the needs from the users. The manifold will house the primary regulator, which will bring down the gas pressure from the cylinder pressure to 10 to 12 bar depending on the type of gases. The outlet of the primary regulator will be connected to the gas service pipelines.

The gas regulator as mentioned earlier will be operated as Semi-Automatically and will be operated as continuous source of gas to service side. The Cylinder manifold will have gas cylinders connected on both left and right side of the primary regulator. At any given instance either left or right side of the connected cylinders will supply the gas to service side and will be termed as 'supply mode'. On depletion of the gas from the connected supply cylinders, the supply source will shift and start the flow from the other side of the connected cylinders which where-in standby and termed as 'standby mode'. The change-over of the supply from one side to another side is automatic by means of pressure difference in case of semi-automatic type.

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In Semi-Auto Change over mode of operation, the side that gets gas exhausted in the cylinder will be removed from the manifold after depressurizing the side by closing supply Isolation valve and opening the purge valve on the manifold system. The empty cylinders will be removed and gets replaced with the filled cylinders and the gas line will be flushed for any entrapped gas in the manifold system during the cylinder change sequence. The system will be now ready for supply by opening the supply isolation valve. Now the cylinders changed & filled side will be termed as 'standby mode'. Thus, the change-over will be in tandem with either side delivering the gas un-interrupted on to the service side if the system is semi-automatic.

For Auto-change over type manifold, the change-over alarm and the signal will be provided to BMS.

The manifold system will house the primary regulator having knob to set the outlet pressure, the change-over unit, the gauges (both inlet and outlet) safety relief valves, vent / purge ports, isolation valves for bank isolation and also for cylinder isolations, pig-tails / flexible hose, filters, non-return valves, excess flow valve and other safety devices for flammable gases (viz. vent for Regulator failure conditions, flash back arrestor). The relief and vent outlets of flammable gases shall be terminated at-least 3 mtrs. above top most point of the building. For inert gases the vent outlets will be left above the gas bank level.

The gas having pressure of 10 to 12 bars at the outlet of the primary regulator will be conveyed inside the lab building in a pipeline and is termed as main header. The main header will be piped from gas bank to the plant buildings at various locations. The consumer / group of consumers which needs specified gas will get tapped from this main header and forms as branch header.

The branch header will have a regulator connected, which in-turn will bring down the header pressure from 10 to 12 bars on the upstream to user / user group required pressure at the regulator downstream as per the user / users' needs and this regulator will be termed as 'secondary regulator', which will have a built-in pressure gauge indicating the downstream pressure.

The line outlet from the secondary regulator will get piped and gets finally connected / branched to the respective equipment's which need the specified gas service. If any equipment requires dedicated pressure control using gas regulator, where-in the user required pressure need to be set for the outlet. Then, such line will be taken separately from the main branch header and routed inside the plant building dropped near to the equipment with dedicated gas regulator and isolation needle valve will be provided.

Piping for all the gas bank carrying gases, the MOC of the pipes, fittings & valves will be SS316 tubes for size ranging from ¼" OD to 1" OD and above 1" OD the pipes, fittings & valves will CS type SS internals for valves. For pipeline up to 1" OD The end joints for non-flammable gases

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will be by means of double compression type and for all the flammable gases the joints will be carried out by Orbital weld (Automatic TIG Weld) joint and thread / compression joints used as needed only. For piping above 1" OD all end joints for all non-flammable gases will be threaded type & all end joints for all flammable gases will be by Orbital weld (Automatic TIG Weld) joint.

15.4 General guidelines and safety norms for gas transportation in pipeline

Safety precautions for non-flammable gases & flammable gases

- a. The SS tubes & fittings & CS pipes, fittings provided for the non-flammable gas will be procured from the reputed brands. For all toxic and flammable gases viz. Acetylene precautions will be taken care while design of the pipe routing, installation, testing and commissioning. The entire routing of toxic and flammable line need to be Orbitally (Automatic TIG welding) welded for all joints.
- b. The relief and vent outlet for flammable gases will be piped from the gas manifold outlet and left 3 mtrs. above the building top as per PCB (Pollution Control Board) standard.
- c. All flammable gas pipelines will be installed to the exterior of the building and will enter the building as close to the requirement as possible and the lines will be installed below the false ceiling (as needed / required). All inert gas lines including oxygen will be installed above false ceiling as needed / required).
- d. Gas detectors will be installed for toxic and flammable gases at gas bank, at use point locations and along the pipe routing (in confined areas). The detector outlet will be connected to control panel where-in the unit receives input from detectors and trigger an alarm during the event of leakage. The controller also triggers a signal to close the auto-shut of valves installed at gas bank in the gas pipelines for immediate shut-off of gas supply into the building.
- e. The gas detectors will be considered for all flammable and toxic gases. The gas sensors for all thin gases viz. Acetylene will be installed by mounting the sensors on the false ceiling or true ceiling or at heights as may be the cases. In case of any heavy gases viz. Argon, Oxygen, AOM, ACM the sensors will be installed at 400mm above the FFL on the wall or bench.
- f. The sensors will be connected to the gas detector panel which senses the input from sensors and trigger an alarm and also shuts off the automatic shut-off valve positioned just outside the gas bank. The sensors will be calibrated for 40% of LEL of any given gases as the point for alarm trigger.

15.5 Gas bank and Gas Management system

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The gas will be segregated as “Inert” and “Flammable” banks. In the inert bank all non-flammable gases like Argon, AOM, ACM & oxygen gas will be kept. The two types of banks will be in the common gas bank & no wall between various gases proposed.

The gas bank will have all the safety features in terms of manifold units, the ventilation and the exhaust of the gases. The guidelines that will be applicable for gas storage as per gas cylinder storage rule 2004 will be incorporated to this gas banks also as needed.

Codes & standards

Sl. No.	Design standard	Standard	Description
119.	ANSI	ANSI B 31.1	Power piping code
120.	ANSI	ANSI B 31.3	Process piping code
121.	BIS	IS: 1239 (Part-I)	Steel tubes, tubulars and other wrought steel fittings - Specification
122.	BIS	IS: 1239 (Part-II)	Steel tubes, tubulars and other wrought steel fittings - Specification
123.	BIS	IS: 3589	Electrically welded steel pipes for water, and sewerage (168.3 to 2540 2000).
124.	BIS	IS: 5504	Spiral welded pipes
125.	ASTM	ASTM A 106 Gr. B	ERW & Seamless CS pipe specification
126.	ASTM	ASTM A 312	Standard specification for austenitic stainless-steel pipe intended for high-temperature and corrosive service
127.	ASTM	ASTM A269	Standard specification for seamless and welded austenitic stainless-steel tubing used in general corrosion-resisting and low- or high-temperature service
128.	ASTM	ASTM B75	Copper Tubes
129.	ASME	ASME G93	Oxy cleaning

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130.	ASTM	ASTM A 53	MS pipe specification
131.	ANSI	ANSI B 36.1	Welded & seamless wrought steel pipe dimensions
132.	ANSI	ANSI B 36.19	Stainless Steel pipes dimensions
133.	ANSI	ANSI B 16.9	Butt welding pipe fittings dimensional standard.
134.	ANSI	ANSI B 16.11	Forged steel fittings: Socket welded & threaded
135.	BIS	IS: 6392	Steel pipe flanges.
136.	ANSI	ANSI B 16.5	CS pipe flanges & flanged fittings
137.	ISO	ISO:17192	Metal ball valves for petroleum, petrochemical and allied industries
138.	API	API: 602	Steel gate, globe & check valves for sizes pns 4 (ND100) and smaller for the petroleum and natural gas industries.
139.	BS	BS: 5352	Steel wedge gate, globe and check valves 50 mm and smaller for the petroleum, petrochemical and allied industries.
140.	API	API: 600	Gate valves f or petroleum & natural gas.
141.	BS	BS: 1414	Specification for steel wedge gate valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries
142.	BS	BS: 1873	Specification for steel globe and globe stop and check valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries
143.	BS	BS: 1868	Specification for steel check valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries.
144.	API	API: 599	Metal plug valves - Flanged, threaded, and welding ends
145.	API	API 598	Valve inspection & testing.

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146.	BIS	IS: 2002	Steel plate for pressure vessel for intermediate and high temperature service including boilers.
147.	BIS	IS:2062	Hot rolled medium and high tensile structural steel – Specification.
148.	BIS	IS: 7310	Approval Tests for Welders Working to Approved Welding Procedures.
149.	API	API: 1104	Welding of Pipelines and Related Facilities.
150.	ASTM	ASTM Sec. 5	Non-Destructive examination.
151.	ASME	ASME Sec 9	ASME boiler & pressure vessel code.
152.	BIS	IS: 1447	Code of practice for painting of ferrous metals in buildings.
153.	BIS	IS: 5	Colours for Ready Mixed Paints and Enamels.
154.	BIS	IS-2379: 1990 (R2006), (R2007-05)	Colour Code for identification of pipeline.
155.	Indian std.	-	Central Pollution Control Board standards.
156.	Indian std.	Gas Cylinder Rules	Gas cylinder rules
157.	Indian std.	-	Petroleum & Natural Gas Regulatory Board.
158.	BS and International Std.	BS EN 50073:1999 And IEC60079-29-2 Ed1.0: Explosive atmospheres	Gas Detectors and Detector Panels selection, positioning, installation, commissioning, testing and maintenance.

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The BEML plant for rolling stock manufacturing will consist of industrial units, administrative blocks, utilities and service facilities. The campus is designed to promote sustainability by utilizing green building concepts through

1. Minimum disturbance to landscape and site conditions with better storm water management facilities. Proper care for preventing soil erosion during construction activities shall be taken as well as to protect natural drainage
2. Avoid, reduce and control environmental pollution arising from the plant. As such air pollution is not emanated from the plant. The DG sets employed will conform to CPCB standards
3. Waste water recycling in STP. The recycled water will be used for green belt development and other activities thus decreasing the dependency on fresh water
4. In this site the green belt is planned with native species of the region as they will survive easily in the environment. With the use of native species, the ecosystem is also maintained. Treated water shall be used in arboriculture so as to reduce the consumption of potable water.
5. Rain water harvesting, reuse of treated water and conservation of potable water.
6. Energy efficient and eco-friendly illumination like usage of LED, efficient air condition system with controls.
7. Solar panels are proposed over shop building to harness solar energy in a bid to utilise renewable energy
8. Building orientation to take advantage of solar access, shading and natural lighting and effects of micro climate on building
9. Environmentally friendly building materials for construction like fly ash based cement, low VOC paints, bamboo based/ engineered wood instead of virgin wood.
10. Efficient solid waste management system by minimize landfill by employing reuse, recycling and energy recovery technologies. Some of the practices to be employed are segregation of wastes at source, proper handling and management of hazardous waste, treatment of organic waste. Construction waste management strategy will be developed to reduce construction waste to either reuse them at site for handed over to authorized agencies for recycling.

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CHAPTER-16 FURNITURES

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FURNITURE SPECIFICATION

16.0 For Executives in Grade 4-5: -

L- Shape workstation + Metal Pedestal Unit: as per below specs. (warranty- 5 years)

Partition based workstation with hollow partition of 69-75mm thickness. Partition is Tile based Aluminium Frames of 69-75mm thickness of height 1200mm-1230mm made of 1.2-1.25 mm thick Aluminium Profiles epoxy powder coating including skirting of 100-150mm high with leveller and have 45-50mm clear space between two tiles for wire management facilities. Aluminium parts shall have epoxy powder coating min 45microns. Cover Section (Raceways) coming above/below the worktop 85-100mm height made up of 0.7-1.0mm thick zincd /CRCA powder coated steel and the Worktop 1800x1500mm in one piece is made of 25 mm thick E 1-Grade / Green prelaminated particleboard of approved shade supported by 1.2mm-2mm. thick, epoxy powder coated steel brackets. All flat edges shall be finished with hot melt PVC edge banding of 2mm Thickness on User Side and 0.8mm thick on other sides. Fabric tiles along with One Glass Marker and One magnetic pinup Tile shall be provided for each user above the work surface and Metal Powder Coated Tiles below the worktops. All worktops are closed with 25 mm thick E 1-Grade / Green prelaminated particleboard gable end of approved shade supported by 1.2mm-2mm. thick, epoxy powder coated steel brackets on both sides. Trims: Extruded aluminium, epoxy powder coated colour of min 45microns thickness. Each Workstation has a 3 Drawer (2 Drawer + 1 Filing) Mobile pedestal (Metal) unit of size 450 Width. Height 640-680mm and Depth 500mm, lockable with keys. Front and Body: 0.7 /0.8mm. Powder coated steel. Castors: 2 Front Lockable Castors & 2 Std Castors. Metal Key Board Tray powder Coated and Floor CPU Trolley on Castors is included in each workstation. Workstations should be as per cluster drawings attached with the tender.

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16.1 For Executives in Grade 1-3 and supervisory personnel

L- Shape workstation + Metal Pedestal Unit: - as per below specs. (warranty- 5 years)

Partition based workstation with hollow partition of 69-75mm thickness. Partition is Tile based Aluminium Frames of 69-75mm thickness of height 1200mm-1230mm made of 1.2 - 1.25 mm thick Aluminium Profiles epoxy powder coating including skirting of 100-150mm high with leveller and have 45-50mm clear space between two tiles for wire management facilities. Aluminium parts shall have epoxy powder coating min 45microns. Cover Section (Raceways) coming above/below the worktop 85-100mm height made up of 0.7-1.0mm thick zincd /CRCA powder coated steel and the Worktop 1500x1500mm in one piece is made of 25 mm thick E 1-Grade / Green prelaminated particleboard of approved shade supported by 1.2mm-2mm. thick, epoxy powder coated steel brackets. All flat edges shall be finished with hot melt PVC edge banding of 2mm Thickness on User Side and 0.8mm thick on other sides. Fabric tiles along with One Glass Marker and One magnetic pinup Tile shall be provided for each user above the work surface and Metal Powder Coated Tiles below the worktops. All worktops are closed with 25 mm thick E 1-Grade / Green prelaminated particleboard gable end of approved shade supported by 1.2mm-2mm. thick, epoxy powder coated steel brackets on both sides. Trims: Extruded aluminium, epoxy powder coated colour of min 45microns thickness. Each Workstation has a 3 Drawer (2 Drawer + 1 Filing) Mobile pedestal (Metal) unit of size 450 Width. Height 640-680mm and Depth 500mm, lockable with keys. Front and Body: 0.7 /0.8mm. Powder coated steel. Castors: 2 Front Lockable Castors & 2 Std Castors. Item is inclusive of keyboard tray & CPU trolley; sizes will be as per drawing.

16.2 For Workmen/Technicians

Linear workstation + Metal Pedestal Unit: - as per below specs. (warranty- 5 years)

Partition based workstation with hollow partition of 69-75mm thickness. Partition is Tile based Aluminium Frames of 69-75mm thickness of height 1200mm-1230mm made of 1.2-1.25 mm thick Aluminium Profiles epoxy powder coating including skirting of 100-150mm high with leveller and have 45-50mm clear space between two tiles for wire management facilities. Aluminium parts shall have epoxy powder coating min 45microns. Cover Section (Raceways) coming above/below the worktop 85-100mm height made up of 0.7-1.0mm thick zincd /CRCA powder coated steel and the Worktop 1200x600mm in one piece is made of 25 mm thick E 1-Grade / Green prelaminated particleboard of approved shade supported by 1.2mm-2mm. thick, epoxy powder coated steel brackets. All flat edges shall be finished with hot melt PVC edge banding of 2mm Thickness on User Side and 0.8mm thick on other sides. Fabric tiles along with One Marker and One magnetic pinup Tile shall be provided for each user above the work surface and Metal Powder Coated Tiles below the worktops. All worktops are closed with 25 mm thick E 1-Grade / Green prelaminated particleboard gable end of approved shade

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supported by 1.2mm-2mm. thick, epoxy powder coated steel brackets on both sides. Trims: Extruded aluminium, epoxy powder coated colour of min 45microns thickness. Each Workstation has a 3 Drawer (2 Drawer + 1 Filing) Mobile pedestal (Metal) unit of size 450 Width. Height 640-680mm and Depth 500mm, lockable with keys. Front and Body: 0.7 /0.8mm. Powder coated steel. Castors: 2 Front Lockable Castors & 2 Std Castors. Item is inclusive of keyboard tray & CPU trolley; sizes will be as per drawing.

16.3 AGM/DGM Workstation & Metal Pedestal unit.

Main Table: Top: 25 mm. thick particle board (E1-Grade) clad with 0.6mm thick post formed laminate with flat edge duly sealed with 2mm thick PVC

Edge-banding: 2 mm. PVC edge-banding

Modesty:18mm thick Particle Board (E-1 Grade / Green). Gable:25 mm. thick pre-laminate particle board (E1-Grade / Green). Edge-banding 2 mm PVC edge-banding. Height adjustable levellers in Gable end.

Side Table:25 mm. thick particle board (E1-Grade / Green) clad with 0.6mm thick post formed laminate with 0.4mm backing laminate with flat edge duly sealed with 2mm thick PVC Edge-banding. Main Table and Side Table Joint are Male /Female Joint for Neat finishing without any gap at Joining of 2 Post formed Worktops.

Back Console:25 mm. thick particle board (E1-Grade / Green) clad with 0.6mm thick post formed laminate with 0.4mm backing laminate with flat edge duly sealed with 2mm thick PVC Edge-banding. Side Table and back Console Joint are Male /Female Joint for Neat finishing without any gap at Joining of 2 Post formed Worktops. Back Console shall be inclusive of storage shelves and shutters (Prelaminated) with necessary edge banding in 18mm thk. & supporting hardware. (handles & Hinges)

Mobile Pedestal: 3 Drawer (2 Drawer + 1 Filing) Mobile pedestal (Metal) unit of size 450 Width. Height 640-680mm and Depth 500mm, lockable with keys. Front and Body: 0.7 /0.8mm. Powder coated steel. Castors: 2 Front Lockable Castors & 2 Std Castors. Item is inclusive of front table, side table, back console, keyboard tray & CPU trolley; sizes will be as per drawing.

(warranty- 5 years)

16.4 GM/Cabin Table:

Manufacturing, providing and placing in position machine made factory assembled Table, (as per finally approved sample by department) of following dimensions with the following specifications. (warranty- 5 years)

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Cabin Table top and under structure should be made of minimum 25mm. thick Particle Board (E-1 Grade), melamine finishes with matched 2 mm PVC edge-banding. E1 grade laminate with zero urea formaldehyde emissions ($\leq 8\text{mg}/100\text{ g}$ oven dry board-perforated method) for better in-house quality. This should comply with (EN 120-1992). The height of table top shall be 740-760 mm from ground level. The particle board should be E-1 Grade with pvc edge banding. Under structure: Melamine legs made of minimum 25mm thick particle board. The exposed edge of worktop shall be secured with 1.5 mm-2 mm thick PVC edge banding tape of approved colour. The modesty panel should be provided with 19 mm thick made of Particle board wood Grade E-1 (Environmentally Friendly) thickness 25 mm., cover with Melamine. The height of Modesty panel should be 600mm. Each table should have 3 drawer pedestals made of 25mm. thick Particle Board (E-1 Grade), melamine finishes with matched 2 mm PVC edge-banding. E1 grade laminate with zero urea formaldehyde emissions ($\leq 8\text{mg}/100\text{ g}$ oven dry board-perforated method) for better in-house quality. This should comply with (EN 120-1992). All hardware shall be of approved make. Wire management: wire management through flat top matching with table top finish.

Providing and fixing Low Height Storages, Body (top, side & back) of storages should be made out of 19 mm thick E1 grade particle board with 2mm thick pvc edge banding & only top thickness is 25mm thick, Shelf of storages should be made out of 16 mm e1 grade particle board with 2mm thick pvc edge banding and able to withstand with UDL of 45 kgs. Doors made out 16 mm thick Particle Board (E-1 Grade), melamine finishes with 2 mm PVC edge-banding fitted with extruded aluminium handle, as per requirement. Storages should be provided with adjustable levellers. Door Lock should be of three-way lock mechanism; the hinged doors can be locked at once. Door should be provided with Hinge-damping mechanism to enable soft closing of doors. E1 grade laminate to be used which provide no urea formaldehyde emission and formaldehyde should be phenol base with emission of not more than ($\leq 8\text{mg}/100\text{ g}$ oven dry board-perforated method) for better in-house quality. This should comply with (EN 120-1992). Item is inclusive of front table, side table, back console, keyboard tray & CPU trolley; sizes will be as per drawing.

16.5 CGM/Executive Director desk

CGM/ED Cabin Table: Manufacturing, providing and placing in position machine made factory assembled Table, (as per finally approved sample by department) of following dimensions with the following specifications. (warranty- 5 years).

Cabin Table top and under structure should be made of minimum 38mm. thick Particle Board (E-1 Grade), melamine finishes with matched 2 mm PVC edge-banding. E1 grade laminate with zero urea formaldehyde emissions ($\leq 8\text{mg}/100\text{ g}$ oven dry board-perforated method) for better in-house quality. This should comply with (EN 120-1992). The height of table top shall be 740-760 mm from ground level. The particle board should be E-1 Grade with pvc edge

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banding. Under structure: Melamine legs made of minimum 38mm thick particle board. The exposed edge of worktop shall be secured with 1.5 mm-2 mm thick PVC edge banding tape of approved colour. The modesty panel should be provided with 19 mm thick made of Particle board wood Grade E-1 (Environmentally Friendly) thickness 25 mm., cover with Melamine. The height of Modesty panel should be 600mm. Each table should have 3 drawer pedestals made of 25mm. thick Particle Board (E-1 Grade), melamine finishes with matched 2 mm PVC edge-banding. E1 grade laminate with zero urea formaldehyde emissions ($\leq 8\text{mg}/100\text{ g oven dry board-perforated method}$) for better in-house quality. This should comply with (EN 120-1992). All hardware shall be of approved make. Wire management: wire management through flattop matching with table top finish.

Providing and fixing Low Height Storages, Body (top, side & back) of storages should be made out of 19 mm thick E1 grade particle board with 2mm thick pvc edge banding & only top thickness is 25mm thick, Shelf of storages should be made out of 16 mm e1 grade particle board with 2mm thick pvc edge banding and able to withstand with UDL of 45 kgs. Doors made out 16 mm thick Particle Board (E-1 Grade), melamine finishes with 2 mm PVC edge-banding fitted with extruded aluminium handle, as per requirement. Storages should be provided with adjustable levellers. Door Lock should be of three-way lock mechanism; the hinged doors can be locked at once. Door should be provided with Hinge-damping mechanism to enable soft closing of doors. E1 grade laminate to be used which provide no urea formaldehyde emission and formaldehyde should be phenol base with emission of not more than ($\leq 8\text{mg}/100\text{ g oven dry board-perforated method}$) for better in-house quality. This should comply with (EN 120-1992). Item is inclusive of front table, side table, back console, keyboard tray & CPU trolley; sizes will be as per drawing.

16.6 SA Cabin Table:

Manufacturing, providing and placing in position machine made factory assembled Table, (as per finally approved sample by department) of following dimensions with the following specifications. (warranty- 5 years)

Cabin Table top and under structure should be made of minimum 25mm. thick Particle Board (E-1 Grade), melamine finishes with matched 2 mm PVC edge-banding. E1 grade laminate with zero urea formaldehyde emissions ($\leq 8\text{mg}/100\text{ g oven dry board-perforated method}$) for better in-house quality. This should comply with (EN 120-1992). The height of table top shall be 740-760 mm from ground level. The particle board should be E-1 Grade with pvc edge banding. Under structure: Melamine legs made of minimum 25mm thick particle board. The exposed edge of worktop shall be secured with 1.5 mm-2 mm thick PVC edge banding tape of approved colour. The modesty panel should be provided with 19 mm thick made of Particle board wood Grade E-1 (Environmentally Friendly) thickness 25 mm., cover with Melamine. The height of Modesty panel should be 600mm. Each table should have 3 drawer pedestals made

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of 25mm. thick Particle Board (E-1 Grade), melamine finishes with matched 2 mm PVC edge-banding. E1 grade laminate with zero urea formaldehyde emissions ($\leq 8\text{mg}/100\text{ g}$ oven dry board-perforated method) for better in-house quality. This should comply with (EN 120-1992). All hardware shall be of approved make. Wire management: wire management through flattop matching with table top finish. Item is inclusive of front table, side table, back console, keyboard tray & CPU trolley; sizes will be as per drawing.

Providing and fixing Low Height Storages, Body (top, side & back) of storages should be made out of 19 mm thick E1 grade particle board with 2mm thick pvc edge banding & only top thickness is 25mm thick, Shelf of storages should be made out of 16 mm e1 grade particle board with 2mm thick pvc edge banding and able to withstand with UDL of 45 kgs. Doors made out 16 mm thick Particle Board (E-1 Grade), melamine finishes with 2 mm PVC edge-banding fitted with extruded aluminium handle, as per requirement. Storages should be provided with adjustable levellers. Door Lock should be of three-way lock mechanism; the hinged doors can be locked at once. Door should be provided with Hinge-damping mechanism to enable soft closing of doors. E1 grade laminate to be used which provide no urea formaldehyde emission and formaldehyde should be phenol base with emission of not more than ($\leq 8\text{mg}/100\text{ g}$ oven dry board-perforated method) for better in-house quality. This should comply with (EN 120-1992).

16.7 CMD desk

Manufacturing, providing and placing in position machine made factory assembled Table, (as per finally approved sample by department) of following dimensions with the following specifications. (warranty- 8 years)

Cabin Table top and under structure should be made of minimum 38mm. thick Particle Board (E-1 Grade), melamine finishes with matched 2 mm PVC edge-banding. E1 grade laminate with zero urea formaldehyde emissions ($\leq 8\text{mg}/100\text{ g}$ oven dry board-perforated method) for better in-house quality. This should comply with (EN 120-1992). The height of table top shall be 740-760 mm from ground level. The particle board should be E-1 Grade with pvc edge banding. Under structure: Melamine legs made of minimum 38mm thick particle board. The exposed edge of worktop shall be secured with 1.5 mm-2 mm thick PVC edge banding tape of approved colour. The modesty panel should be provided with 19 mm thick made of Particle board wood Grade E-1 (Environmentally Friendly) thickness 25 mm., cover with Melamine. The height of Modesty panel should be 600mm. Each table should have 3 drawer pedestals made of 25mm. thick Particle Board (E-1 Grade), melamine finishes with matched 2 mm PVC edge-banding. E1 grade laminate with zero urea formaldehyde emissions ($\leq 8\text{mg}/100\text{ g}$ oven dry board-perforated method) for better in-house quality. This should comply with (EN 120-1992). All hardware shall be of approved make. Wire management: wire management through flattop matching with table top finish.

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Providing and fixing Low Height Storages, Body (top, side & back) of storages should be made out of 19 mm thick E1 grade particle board with 2mm thick pvc edge banding & only top thickness is 25mm thick, Shelf of storages should be made out of 16 mm e1 grade particle board with 2mm thick pvc edge banding and able to withstand with UDL of 45 kgs. Doors made out 16 mm thick Particle Board (E-1 Grade), melamine finishes with 2 mm PVC edge-banding fitted with extruded aluminium handle, as per requirement. Storages should be provided with adjustable levellers. Door Lock should be of three-way lock mechanism; the hinged doors can be locked at once. Door should be provided with Hinge-damping mechanism to enable soft closing of doors. E1 grade laminate to be used which provide no urea formaldehyde emission and formaldehyde should be phenol base with emission of not more than ($\leq 8\text{mg}/100\text{ g}$ oven dry board-perforated method) for better in-house quality. This should comply with (EN 120-1992). Item is inclusive of front table, side table, back console, keyboard tray & CPU trolley; sizes will be as per drawing.

Cabin size as per BEML Policy.

16.8 Director desk

DIRECTOR:

Manufacturing, providing and placing in position machine made factory assembled Table, (as per finally approved sample by department) of following dimensions with the following specifications. (Warranty -8 years)

Cabin Table top and under structure should be made of minimum 38mm. thick Particle Board (E-1 Grade), melamine finishes with matched 2 mm PVC edge-banding. E1 grade laminate with zero urea formaldehyde emissions ($\leq 8\text{mg}/100\text{ g}$ oven dry board-perforated method) for better in-house quality. This should comply with (EN 120-1992). The height of table top shall be 740-760 mm from ground level. The particle board should be E-1 Grade with pvc edge banding. Under structure: Melamine legs made of minimum 38mm thick particle board. The exposed edge of worktop shall be secured with 1.5 mm-2 mm thick PVC edge banding tape of approved colour. The modesty panel should be provided with 19 mm thick made of Particle board wood Grade E-1 (Environmentally Friendly) thickness 25 mm., cover with Melamine. The height of Modesty panel should be 600mm. Each table should have 3 drawer pedestals made of 25mm. thick Particle Board (E-1 Grade), melamine finishes with matched 2 mm PVC edge-banding. E1 grade laminate with zero urea formaldehyde emissions ($\leq 8\text{mg}/100\text{ g}$ oven dry board-perforated method) for better in-house quality. This should comply with (EN 120-1992). All hardware shall be of approved make. Wire management: wire management through flattop matching with table top finish.

Providing and fixing Low Height Storages, Body (top, side & back) of storages should be made out of 19 mm thick E1 grade particle board with 2mm thick pvc edge banding & only top thickness is 25mm thick, Shelf of storages should be made out of 16 mm e1 grade particle

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board with 2mm thick pvc edge banding and able to withstand with UDL of 45 kgs. Doors made out 16 mm thick Particle Board (E-1 Grade), melamine finishes with 2 mm PVC edge-banding fitted with extruded aluminium handle, as per requirement. Storages should be provided with adjustable levellers. Door Lock should be of three-way lock mechanism; the hinged doors can be locked at once. Door should be provided with Hinge-damping mechanism to enable soft closing of doors. E1 grade laminate to be used which provide no urea formaldehyde emission and formaldehyde should be phenol base with emission of not more than ($\leq 8\text{mg}/100\text{ g}$ oven dry board-perforated method) for better in-house quality. This should comply with (EN 120-1992). Item is inclusive of front table, side table, back console, keyboard tray & CPU trolley; sizes will be as per drawing.

Director Cabin Table of size: as per BEML Policy.

16.9 PA Cabin Table:

Manufacturing, providing and placing in position machine made factory assembled Table, (as per finally approved sample by department) of following dimensions with the following specifications. (warranty- 5 years)

Cabin Table top and under structure should be made of minimum 25mm. thick Particle Board (E-1 Grade), melamine finishes with matched 2 mm PVC edge-banding. E1 grade laminate with zero urea formaldehyde emissions ($\leq 8\text{mg}/100\text{ g}$ oven dry board-perforated method) for better in-house quality. This should comply with (EN 120-1992). The height of table top shall be 740-760 mm from ground level. The particle board should be E-1 Grade with pvc edge banding. Under structure: Melamine legs made of minimum 25mm thick particle board. The exposed edge of worktop shall be secured with 1.5 mm-2 mm thick PVC edge banding tape of approved colour. The modesty panel should be provided with 19 mm thick made of Particle board wood Grade E-1 (Environmentally Friendly) thickness 25 mm., cover with Melamine. The height of Modesty panel should be 600mm. Each table should have 3 drawer pedestals made of 25mm. thick Particle Board (E-1 Grade), melamine finishes with matched 2 mm PVC edge-banding. E1 grade laminate with zero urea formaldehyde emissions ($\leq 8\text{mg}/100\text{ g}$ oven dry board-perforated method) for better in-house quality. This should comply with (EN 120-1992). All hardware shall be of reputed make/brand as per sample finally approved by the department. Micromanagement: wire management through flattop matching with table top finish.

Providing and fixing Low Height Storages, Body (top, side & back) of storages should be made out of 19 mm thick E1 grade particle board with 2mm thick pvc edge banding & only top thickness is 25mm thick, Shelf of storages should be made out of 16 mm e1 grade particle board with 2mm thick pvc edge banding and able to withstand with UDL of 45 kgs. Doors made out 16 mm thick Particle Board (E-1 Grade), melamine finishes with 2 mm PVC edge-banding

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fitted with extruded aluminium handle, as per requirement. Storages should be provided with adjustable levellers. Door Lock should be of three-way lock mechanism; the hinged doors can be locked at once. Door should be provided with Hinge-damping mechanism to enable soft closing of doors. E1 grade laminate to be used which provide no urea formaldehyde emission and formaldehyde should be phenol base with emission of not more than ($\leq 8\text{mg}/100\text{ g}$ oven dry board-perforated method) for better in-house quality. This should comply with (EN 120-1992). Item is inclusive of front table, side table, back console, keyboard tray & CPU trolley; sizes will be as per drawing.

16.10 MEETING ROOM TABLES

The under structure should be self-supported/installed first without the Table Tops enabling all wiring and installation of receptacles. Table Top shall be made of 25mm thick made up of Melamine/Veneer as required, E1 grade as per approved colour and texture with matching edge PVC binding in ergonomic profile without cut-out. Di Cast Aluminium /GI, powder coated metal under structure with metal Supporting Legs. The System will have an under counter vertical riser cum table support with service shutters in powder coated metal. These will terminate under the table top. All cable management tray under each desk supported with cable snake. Flip top cover in powder coated finish with soft close hinges. The openable edge to have provision for a brush edge or appropriate bevelled edge of table edge cut profile inside, to facilitate easy cable movement and access. It should be sufficiently sized for adequate and proper access of the above-mentioned data and power provisions. Straight Metal Supporting Legs (powder coated). (warranty- 8 years)

MEETING ROOM - access flap + Box + Switch Mounting Plate (14/16 PAX)

MEETING ROOM - access flap + Box + Switch Mounting Plate (MT Room-4 PAX)

MEETING ROOM - access flap + Box + Switch Mounting Plate (8/10 PAX)

16.11 Conference Room Table

The under structure should be self-supported/installed first without the Table Tops enabling all wiring and installation of receptacles. Table Top shall be made of 25mm thick made up of Melamine/Veneer as required, E1 grade as per approved colour and texture with matching edge PVC binding in ergonomic profile without cut-out. Di Cast Aluminium /GI, powder coated

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metal under structure with metal Supporting Legs. The System will have an under counter vertical riser cum table support with service shutters in powder coated metal. These will terminate under the table top. All cable management tray under each desk supported with cable snake. Flip top cover in powder coated finish with soft close hinges. The openable edge to have provision for a brush edge or appropriate bevelled edge of table edge cut profile inside, to facilitate easy cable movement and access. It should be sufficiently sized for adequate and proper access of the above-mentioned data and power provisions. Straight Metal Supporting Legs (powder coated). (warranty- 8 years)

LINEAR SHAPE

16.12 Storage (warranty- 5 years)

Providing and fixing Medium Height Storages Body (top, side & back) of storages should be made out of 19 mm thick E1 grade particle board with 2mm thick pvc edge banding, Shelf of storages should be made out of 19mm thick E1 grade particle board with 2mm thick pvc edge banding and able to withstand with UDL of 45 kgs. Powder coating should be scratch resistance (cross hatch test 6x6 grid method). Doors made out 25 mm thick Particle Board (E-1 Grade), melamine finishes with 2 mm PVC edge-banding. E1 grade laminate to be used which provide no urea formaldehyde emission and formaldehyde should be phenol base with emission of not more than ($\leq 8\text{mg}/100\text{ g}$ oven dry board-perforated method) for better in-house quality. This should comply with (EN 120-1992). Front of low height Storages should be made out of metal or 16 mm. thick Particle Board (E-1 Grade), melamine finishes with 2 mm. PVC edge-banding fitted with extruded aluminium handle, as per requirement. Storages should be provided with adjustable levellers. Door Lock should be of three-way lock mechanism; the hinged doors can be locked at once. Door should be provided with Hinge-damping mechanism to enable soft closing of doors

Providing and placing Prelaminated Particle Board (E-1 Grade / Green) Overhead storage with openable doors of 600 mm(ht), made up of 18mm thick prelaminated particle board with PVC edge banding and locking arrangement. Storage body is made of 18mm thick pre laminated particle Board conforming to IS: 12823 Interior Grade, the back of the unit is made from 18mm prelaminated board. All the exposed edges are with 2mm PVC edge Imported banding & sealed edges are with 0.8mm thick PVC Imported edge banding. The top, side and hinged shutters are sealed with 2mm thick PVC edge banding. The shelves are height Adjustable. The units are assembled by knock down fittings such as Mini fix & Dowels. All the hardware and Hinges are from Hettich/Ebco. Storage has Brushed SS finish handles and lock.

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16.13 Under Counter Storages (850 mm high and 600 mm deep)

Providing & fixing Under counter storages for pantry & basin as per drawing. The overall Structure made in 19mm thick BWP ply and approved colour Granite slab on top. Storages finished in 1 mm thick laminate from everywhere except outer back side of storages and also including all SS snap hinges, handles, locks etc & all necessary hardware as required. PVC lipping on all edges with matching shade, including laminated skirting in approved shade with all hardware, magnetic catchers, tower bolts, etc complete as per detailed drawings. cost include of Granite Top with half round edge polish as approved

Electrical Panel cabinet made with laminate clad 18 mm MDF /ply, comprising of textured laminated carcass 40mm thick, with laminated shutters including air transfer grill of size 150 x 300 mm-2 nos., hardware- 300mm high SS pull handle, hinges, magnetic catchers. The back of the cabinet to have 12mm thick bison board.

16.14 On Site Furniture

Reception table made as per detail drawing & made in 19 mm thick. Commercial board and finished in 1mm thick laminate from inside as per approved & outer surface will be 18mm thk. Italian marble cladded as per approval, complete with drawer units, shutter and all hardware complete.

Reception table made as per detail drawing & made in 19 mm thick. Commercial board and finished in 1mm thick laminate from inside as per approved & outer surface will be 18mm thk. Italian marble cladded as per approval, complete with drawer units, shutter and all hardware complete.

Librarian table made as per detail drawing & made in 19 mm thick. Commercial board and finished in 1mm thick laminate as per approved & 12mm thick chorion cladding complete with drawer unit, shutter and all hardware complete.

Library reading table made as per detail drawing & made in 19 mm thick. Commercial board and finished in 1mm thick laminate as per approved with drawer unit, shutter and all hardware complete.

16.15 CHAIRS (WARRANTY-8 YEARS)

1. WORKSTATION - Providing medium back revolving chairs for Workstations. Chair seat made up of insert moulded Polyurethane Foam upholstered with foam laminated mesh fabric, insert moulded foam assembled over a load bearing plastic seat cover, back is made up of two-piece injection moulded frame, inner frame upholstered with mesh fabric and mounted on the main assembly, back adjustable lumbar support for achieving comfortable seating posture. Armrests should be adjustable with 120-160 mm adjustability with PU padded. Base: Black

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nylon base with 5 nos. nylon castors. Chair should be of 360-degree swivel Posture Control with multi pointer locking and synchro tilt mechanism and hydraulic gas lift gas lift to allows 90-100 mm. of height adjustment. Seat size 440 - 550 mm depth, Seat width of 530-550 mm Seat Height of 420-510mm with hydraulic height adjustability of 90-100mm. Sub assembly back size 550 - 620 mm height. Effective back height from Seat - 570mm, polyurethane foam for seat having density 65-70 kg/m³. Pedestal made of nylon base fitted with 5 nos. twin wheel castors (castor wheel dia. 60-70 cm), base pedestal Dia 60-70 mm and pitch centre dia. 700-720mm with castors, twin wheel castors injection moulded in Nylon etc. all complete as per manufacturers specification, approved sample and direction of Engineer-in-Charge. Chair should be SGS Gold BIFMA Certified product.

2. AGM/DGM CHAIR - Providing High back revolving chairs for DGM cabins. Chair seat made up of insert moulded Polyurethane Foam upholstered with foam laminated mesh fabric, insert moulded foam assembled over a load bearing plastic seat cover, back is made up of two-piece injection moulded frame, inner frame upholstered with mesh fabric and mounted on the main assembly, back adjustable lumbar support for achieving comfortable seating posture. Armrests should be adjustable with 120-160 mm adjustability with PU padded. Base: Black nylon base with 5 nos. nylon castors. Chair should be of 360-degree swivel Posture Control with multi pointer locking and synchro tilt mechanism and hydraulic gas lift gas lift to allows 90-100 mm. of height adjustment. Seat size 440 - 550 mm depth, Seat width of 530-550 mm Seat Height of 420-510mm with hydraulic height adjustability of 90-100mm. Sub assembly back size 550 - 620 mm height. Effective back height from Seat - 570mm, polyurethane foam for seat having density 65-70 kg/m³. Pedestal made of nylon base fitted with 5 nos. twin wheel castors (castor wheel dia. 60-70 cm), base pedestal Dia 60-70 mm and pitch centre dia. 700-720mm with castors, twin wheel castors injection moulded in Nylon etc. all complete as per manufacturers specification, approved sample and direction of Engineer-in-Charge. Chair should be SGS Gold BIFMA Certified product.

3. AGM/DGM VISITOR CHAIR -Providing medium back revolving chairs for Visitors in DGM/AGM Visitors Room. Chair seat made up of insert moulded Polyurethane Foam upholstered with foam laminated mesh fabric, insert moulded foam assembled over a load bearing plastic seat cover, back is made up of two-piece injection moulded frame, inner frame upholstered with mesh fabric and mounted on the main assembly, back adjustable lumbar support for achieving comfortable seating posture. Armrests should be adjustable with 120-160 mm adjustability with PU padded. Base: Black nylon base with 5 nos. nylon castors. Chair should be of 360-degree swivel Posture Control with multi pointer locking and synchro tilt mechanism and hydraulic gas lift gas lift to allows 90-100 mm. of height adjustment. Seat size 440 - 550 mm depth, Seat width of 530-550 mm Seat Height of 420-510mm with hydraulic height adjustability of 90-100mm. Sub assembly back size 550 - 620 mm height. Effective back height from Seat - 570mm, polyurethane foam for seat having density 65-70 kg/m³. Pedestal made of nylon base fitted with 5 nos. twin wheel castors (castor wheel dia. 60-70 cm), base

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pedestal Dia 60-70 mm and pitch centre dia. 700-720mm with castors, twin wheel castors injection moulded in Nylon etc. all complete as per manufacturers specification, approved sample and direction of Engineer-in-Charge. Chair should be SGS Gold BIFMA Certified product.

4. GM/CGM & ED CHAIR

Providing and placing high back chair for GM's & ED's Cabins room in leather of Reef High Back whose seat is made of medium density foam, moulded plywood and upholstered with leatherette in front and back. Overall dimension: 750 mm(D) X 750 mm(W) X 1180mm (H). Seat Dimension: 520mmW X 480mmD X 520mm H. The backrest is made from moulded plywood and leatherette in front and back. The armrest is made of aluminium with PU padded and adjustable at 70mm. It has aluminium polished base with black nylon castors. It has knee tilt mechanism, 360-degree swivel and back tilt with multiple locking position. Gas lift allows 10mm of height adjustment. Complete as per the direction of Engineer-in-charge. Product should be BIFMA gold rated SCS global certified for in-house air quality.

5. GM/CGM & ED VISITOR CHAIR

Providing and placing high back chair for GM's & ED's Visitors room in leather of Reef Mid Back whose seat is made of medium density foam, moulded plywood and upholstered with leatherette in front and back. Overall dimension: 750 mm (D) X 750 mm (W) X 1020mm (H). Seat Dimension: 520mmW X 480mmD X 520mm H. The backrest is made from moulded plywood and leatherette in front and back. The armrest is made of aluminium with PU padded and adjustable at 70mm. It has aluminium polished base with black nylon castors. It has knee tilt mechanism, 360-degree swivel and back tilt with multiple locking position. Gas lift allows 10mm of height adjustment. Complete as per the direction of Engineer-in-charge. Product should be BIFMA gold rated SCS global certified for in-house air quality.

6. CMD & DIRECTOR CHAIR

Providing & placing Medium Chair Size with Standard Height Range having Tilt Limiter with Fully Adjustable Arms along with Standard Arm pads having Posture Fit Support in Graphite Frame Finish and Graphite Chassis Finish with Graphite Base Finish. 2.5-inch Standard Carpet Casters Black Arm pad Finish Graphite 8Z Pellicle Suspension Material (Seat and Back) CMD & DIRECTOR VISITOR CHAIR- Providing and placing high back chair for CMD & Director Cabins room in leather of Medium Back whose seat is made of medium density foam, molded plywood and upholstered with leatherette in front and back. Overall dimension: 750 mm(D) X 750 mm(W) X 1180mm(H). Seat Dimension: 520mm(W) X 480mm(D) X 520mm(H). The backrest is made from moulded plywood and leatherette in front and back. The armrest is made of aluminium with PU padded and adjustable at 70mm. It has aluminium polished base with black nylon castors. It has knee tilt mechanism, 360-degree swivel and back tilt with multiple locking position. Gas lift allows 10mm of height adjustment. Complete as per the direction of

TECHNICAL SPECIFICATION

Engineer-in-charge. Product should be BIFMA gold rated SCS global certified for in-house air quality.

7. Conference Chair

Providing & placing Task Chair with 5-star base in Polished Aluminium finish with Seat/Back in Mesh with Synchronised Tilt having 1 back Lock with 1 Directional Arms, Fixed Seat Depth, Adjustable Lumbar Superfinish in all Black Colour with Backrest finish in Mesh.

Providing & placing CHAIRS for Library and Dining area as per approved design. Total Length shall be 500. Total Width shall be 450. Total Height shall be 900. Under structure shall be made of hollow Stainless Steel.

Providing & placing Chairs as per approved design. Under structure and back are made of wood, Seat shall be having Fabric Upholstery. Size: (W)460*(D)525*(H)920mm.

16.16 SOFAS

Reception/Waiting: Supplying and Placing Leatherette sofa. The seat should be made of PU foam with Density 32 ± 2 kg/cu.m having an additional top layer of J PU foam with Density 28 ± 2 kg/cu. Seat should be upholstered with fabric or leatherette. 2) BACK FOAM: The back should be made of PU foam with Density 28 ± 2 kg/cu. mtr with two additional top layers of super soft foam of density 23 ± 2 kg/cu. mtr, upholstered with fabric or leatherette. Under structure should be made up of 1.2 ± 0.1 cm. thick hot-pressed plywood OCP-QLTA-PL14-18 4. Dia 4mm zigzag spring assembly should be mounted in under structure for support and additional cushioning purpose it should be a welded assembly made in Stainless steel (grade SS 202) tube & plate.

SIZE: 88.0cm (W), 92.0cm (D), 82.0cm(H), 45.0cm (SH).

Guest Room: Supplying and Placing Leatherette sofa. The seat should be made of PU foam with Density 32 ± 2 kg/cu.mtr having an additional top layer of J PU foam with Density 28 ± 2 kg/cu. Seat should be upholstered with fabric or leatherette. 2) BACK FOAM: The back should be made of PU foam with Density 28 ± 2 kg/cu. mtr with two additional top layers of super soft foam of density 23 ± 2 kg/cu. mtr, upholstered with fabric or leatherette. Under structure should be made up of 1.2 ± 0.1 cm. thick hot-pressed plywood OCP-QLTA-PL14-18 4. Dia 4mm zigzag spring assembly should be mounted in under structure for support and additional cushioning purpose .t should be a welded assembly made in Stainless steel (grade SS 202) tube & plate.

ED Cabin: Supplying and Placing Leather sofa. Seat height 470mm. THREAD: Nylon

Material Handling Data Sheet (MSDS) for Glue

Standard of Plywood used: IS 303 Commercial Plywood

Thickness 12mm

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1. Providing & installing Two-Seater Sofa. -

1) Reception/Waiting: The seat should be made of PU foam with Density 32 ± 2 kg/cu.mtr having an additional top layer of J PU foam with Density 28 ± 2 kg/cu. Seat should be upholstered with fabric or leatherette.

2) BACK FOAM: The back should be made of PU foam with Density 28 ± 2 kg/cu. mtr with two additional top layer of super soft foam of density 23 ± 2 kg/cu. mtr, upholstered with fabric or leatherette. Under structure should be made up of 1.2 ± 0.1 cm. thick hot pressed plywood OCP-QLTA-PL14-18 4. Dia 4mm zigzag spring assembly should be mounted in under structure for support and additional cushioning purpose .It should be a welded assembly made in Stainless steel (grade SS 202) tube & plate.

SIZE : 146.0cm (W), 92.0cm (D), 82.0cm(H), 45.0cm(SH).

Guest Room: The seat should be made of PU foam with Density 32 ± 2 kg/cu.mtr having an additional top layer of J PU foam with Density 28 ± 2 kg/cu. Seat should be upholstered with fabric or leatherette. 2 BACK FOAM: The back should be made of PU foam with Density 28 ± 2 kg/cu. mtr with two additional top layer of super soft foam of density 23 ± 2 kg/cu. mtr, upholstered with fabric or leatherette. Under structure should be made up of 1.2 ± 0.1 cm. thick hot pressed plywood OCP-QLTA-PL14-18 4. Dia 4mm zigzag spring assembly should be mounted in under structure for support and additional cushioning purpose .t should be a welded assembly made in Stainless steel (grade SS 202) tube & plate.

SIZE: 146.0cm (W), 92.0cm (D), 82.0cm(H), 45.0cm(SH).

AGM Cabin: Overall size of the sofa shall

be 144cm(w)*83cm(d)*86.5cm(h)*46cm(sh). Upholstery Material shall be 1 mm thick Fabric

- Breaking Load (N) : Warp 1327 Weft 1228
- Elongation at break (%) : Warp 27.5 Weft Material shall be the Combination of 12mm (moisture resistance and termite free) thick plywood and pine Wood
- Pinewood cross section (without knots)-22x64 mm-34x64 mm-16x35 mm
- Moisture content shall be 10 -12 %. Seat Material shall be Slab stock foam with density Base of 28 kg/m³ and super soft 32 kg/m³ at top. Back Material shall be Slab stock foam with density of Super soft 32 kg/m³ with a layer of siliconized conjugated polyester fiber of 200 gsm.

2. Providing & installing Three-Seater Sofa -

Reception/Waiting: The seat is made of PU foam with Density 28 ± 2 kg/cu. mtr having an additional top layer of super soft PU foam in Density 32 ± 2 kg/cu. upholstered with fabric or leatherette. BACK FOAM: The back is made of PU foam with Density 28 ± 2 kg/cu. mtr with two

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additional top layers of super soft foam of density 32 ± 2 kg/cu. mtr, upholstered with fabric or leatherette. Under structure is made up of 1.2 ± 0.1 cm. thick hot-pressed plywood (moisture resistance & termite proof as per IS: 303) & pinewood of cross section devoid of major knots & surface defects 6 nos. per seat & 3.8 mm Dia zigzag spring assembly is mounted over under structure for cushioning purpose 6 nos. per seat & 3.8 mm Dia zigzag spring assembly is mounted over under structure for cushioning purpose. LEG ASSEMBLY: It is a welded assembly made in Stainless steel (grade SS 202) tube & plate with plastic endcap. (W) 205.5* (D) 90.5(H) 85.5 cm seat (H) 45.0 cm.

3. CMD / Director cabin size:

Supplying and Placing Leather sofa. Total Length and Height shall be -1990*885.Total Width – 935.Seating Area Length – 1450.Seating Area Width – 500.Seating Area Height from Ground – 485.Arm Height and Length – 625*610.Back Height from Arm – 260.Back Width – 335.Arm Width – 300.Leg

Height – 70. Length between Legs – 1645.Width between legs – 800. STITCHING shall be done from nylon thread. LEATHER/PVC/FABRIC: (PU/PVC/Cotton/ Polyester/ Composite)- Thickness (mm): 0.75mm. Weight (GSM): - 500 MIN. Tensile Strength {wrap/weft} (Kg/cm): - 4.0/2.8. Bursting Strength (Kg/cm²): 5.5 MIN. Adhesion (PVC/PU Backing) (Kg/cm): 0.6/0.4. Colour Fastness to Rubbing {Dry /Wet} (Scale 1-5): 3-4. FRAME MATERIAL used shall be 12%. Thick Plywood. Standard of Plywood used: {Required Standard: IS 303 Commercial Plywood} Commercial Grade. SEAT FOAM: (DENSITY, TYPE). Poly in Lumber Partition Back Cushion: 0.8 Kg +0.8 Kgs+ 0.8 Kg. Poly in Upper Partition Back Cushion: 1.7Kg + 1.45Kg + 1.7Kg. ARMREST FOAM: (DENSITY, TYPE)- Poly in Each Arms: 900 grams. LEG MATERIAL: * Fixing of Leg shall be: (Self Tapping Screw / Insert with metric threading). Material of leg shall be Teak Wood. * Bush for Leg bottom shall be: (PVC bush / Felt Pad)

4. ED Cabin:

Supplying and Placing Leather sofa. (L)1820*(H)890*(W)920

THREAD: Nylon

Material Handling Data Sheet (MSDS) for Glue

Standard of Plywood used: IS 303 Commercial Plywood

Thickness 12mm

TECHNICAL SPECIFICATION

5. P/l Five-Seater Sofa. -

Supplying & placing in position modular 4-seater Shape sofa consisting of 1 no One seater sofa and 1 no three-seater along with armrests at both the terminals Seat & Body- Under structure: Under structure is made of combination of plywood & pinewood members. Plywood is 12±1mm thk. [moisture resistance & termite proof as per IS:303] & pinewood are cross section [22x25, 22x40, 25x75 & 25x100mm] are without major knots & defects on the surface. 3mm MDF is stapled on the seat front bottom vertical surface to get the surface to stick the foam. Dia. 3.8mm zigzag spring asly. is mounted on the seat structure with spring mounting plastic bracket for support & additional cushioning purpose. Elastic belt of 2" width is used above the spring asly. to give good sagging effect. Non-woven fabric is stapled on the seat structure frame above the spring asly. to avoid the tearing of seat foam with the surface contact of metal spring. Back vertical surface is stapled with non-woven cloth to get surface to stick the foam. Complete under structure is made by gluing & stapling.

- Foam: Seat is made of PU foam with density 28 kg/m³ having an additional top layer of super soft PU foam with density 18 kg/m³. Recron sheet of 230GSM is used above this foam. Seat front bottom vertical surface & back vertical surface is glued with the PU foam with density 22 kg/m³. Side vertical surface, body front taper vertical & top horizontal surface is glued with PU foam with density 16 kg/m³.

- Upholstery: Seat & body upholstery is made in the dual tone colour with fabric / fabric option & fabric / leatherette option. Back Top Cushion- Under structure: Under structure is made of combination 12±1mm & 6±1mm thk. plywood [for 2-Seater, 3-Seater & Chaise Lounge] & combination 12±1mm, 4±1mm thk. plywood & 3mm MDF [for Small Corner & Big Corner] with gluing & stapling.

- Foam: It is made with super soft PU foam with density 18 kg/m³.

- Upholstery: It is upholstered with fabric.

6. Providing & installing Centre Table: -

Supply and placing centre table in position with top made of 19mm thick stone top supported on SS legs under structure. The work shall be carried out as per the instructions received from engineer-in charge. Refer image attached.

LXWXH – 1200X600X450 mm

LXWXH – 1800X600X450 mm

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7. Providing & installing Side Table: -

Supply and placing centre table in position with top made of 19mm thick stone top supported on SS legs under structure. The work shall be carried out as per the instructions received from engineer-in charge. Refer image attached.

LXWXH - 400X400X450 mm

Providing and installing 8 mm thk. Table top glass (Float Type) on all furniture including edge grinding, polishing, labour charge for placing glass tops on designated table/ workstations/ back unit/ side unit at various floors including cartages

16.17 CAFÉ FURNITURE

Café Chair: Providing & installing Product: Tango Single Moulded Polypropylene cafeteria stackable chair with ss legs available in red, green, black, white, orange, grey colour.

Café Table: Providing & installing

PRODUCT - CAFETERIA TABLE (PERFORM) (6PAX)

Size: 1800 x 800 x 750HT

Specification: Table top - PLB 25mm thick pre-lam particle board finished with 2mm PVC edge banding.

Under-structure - Supported on powder coated Ms sq. 50x50 legs & supporting Ms cross beam 40x20.

PRODUCT - CAFETERIA TABLE (4 PAX)

Size: 1200 x 800 x 750H

Specification: Table top - PLB 25mm thick pre-lam particle board finished with 2mm PVC edge banding.

Under-structure - Supported on Powder coated BALL base.

Café Table of 900mm Dia with metallic powder coated under structure of approved shade & 25mm the melamine top as per BEML approval (Executive Dining).

The table to have 25mm x 2mm Rehaul edge banding of matching shade.

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NOTE: All furniture to be supplied by EPC contractor to be BIFMA/ ANSI APPROVED. The List of furniture to be supplied annexed to the tender to be read in conjunction with referred specification. In the list against an official of a particular rank only table would have been mentioned however it shall mean all associated things such as side table, console etc complete as provided in the specification.

In pantry overhead and undercounter storage in required length is to be provided as per referred specification while architectural planning the quantity of same is to assessed and to be included in price break-up.

TECHNICAL SPECIFICATION

CHAPTER-17 GENERAL SPECIFICATIONS

TECHNICAL SPECIFICATION

17.0 GENERAL SPECIFICATIONS - MECHANICAL ENGINEERING WORKS

- a) The bidder should perform all activities necessary in connection with execution of contract and should deem to be responsible for design, manufacture, fabrication, supply, painting, packing, forwarding, insurance, freight, handling, loading, unloading, unpacking, safe custody and storage, erection, testing, commissioning, performance test till final handing over of machines/ equipment/ items to BEML.
- b) Bidder should be responsible for short shipment and any damage including transit, custody, handling, installation, erection and testing damages prior to successful commissioning and handing over of machines/ equipment/ items to the employer/ BEML.
- c) The successful bidder is responsible for proper and secure packing of machines/ equipment/ items to ensure that stores are not damaged during transit, handling and storage. Consignment should be insured by bidder at his own cost. Stores should be delivered at site.
- d) Bidder or his authorized representative should carry out a joint check of materials supplied at site along with authorized representative of the employer after unpacking.

17.1 SOURCING CONDITION

- a) The successful bidder should offer machines/ equipment/ items covered under this schedule from reputed firms, who have successfully supplied and commissioned similar capacity machines/ equipment/ items in past five years.
- b) Bidder should ensure that necessary facilities are available with bidder/ OEM/ or his authorized agent for providing adequate after sales service during warranty and post warranty periods. Bidder should provide details of service organization, which should be responsible for after sales service at the time of commissioning/ handing over of machines/ equipment/ items.
- c) Bidder should offer machines/ equipment/ items covered under this schedule as per Technical Specifications detailed in Bid Document.
- d) The successful bidder should take prior approval from the employer, regarding vendor/ OEM from whom machines/ equipment/ items is likely to be supplied, well in advance so that scheduled time lines of commissioning of machines/ equipment/ items can be adhered to by the bidder. For obtaining approval of vendor/ OEM, successful bidder should submit requisite documentary evidence in support of above to the employer.

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17.2 FOUNDATION (WHERE APPLICABLE)

- a) The successful Bidder should provide and construct necessary foundation works, track works, civil works required for installation and commissioning of machines as per drawings supplied by OEM using expansion type bolts and buffer pads for vibration free operation of machine and cost of the same (bolts, pads, rails, fittings etc.) should be included in the cost of machine.

17.3 POWER SUPPLY TO MACHINE/ EQUIPMENT (WHERE APPLICABLE)

The successful bidder should provide necessary power supply arrangement from distribution panel in the shed to control panel of machine/ equipment.

17.4 STATUTORY GUIDELINES (WHERE APPLICABLE)

The successful bidder should ensure that equipment is designed, manufactured, installed and commissioned in conformity with the latest applicable norms of State/ Central Pollution Control Board, Factory Act, Indian Electricity Rules/ Act, Fire Safety Rules, IS standards, Explosive rules and regulations for gas pipelines, manifolds etc and statutory guidelines applicable in the State.

17.5 GENERAL DESIGN

- a) Machines, equipment, plant, tools and instruments covered in this tender should be designed for high reliability and ease of maintenance. Equipment should be compact, dependable and reliable in operation and should fully meet functional requirement under severe conditions.
- b) Machine should be capable of operating in severe workshop conditions of temperatures 0-50 °C and for relative humidity of up to 98% and dusty atmosphere.
- c) Machine should be robust, rigid and sturdy construction. Machine should be vibration free even when working at full capacity. Machine castings should be made of close grained high-grade cast iron like MEEHANITE or equivalent materials meeting IS210 standards to ensure durability and rigidity. Casting should be stress relieved to ensure stability and continued accuracy. Machine fabrications of critical load bearing assemblies like beds, columns etc should be adequately strengthened and stress relieved.
- d) Change in ambient temperature should not affect performance of machine. Machine performance should not change either on switching on machine or after continuous running. Machine should not have resonant vibrations throughout working range of machine at all load levels.

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17.6 MACHINE MAINTAINABILITY

- a) Machine should be designed to ensure minimum possible maintenance and to give trouble free service. Machine should not require major disassembly for checking and replacement of a particular part, especially for parts requiring periodical checkup and replacement. Assemblies/ parts of machine should be easily accessible for maintenance.
- b) Manufacturer must provide means of access, e.g., stairs, ladders, cat walks etc. to allow access to all areas used for production, adjustments and maintenance operations.
- c) Original built in accuracy of machine should be maintained conveniently and economically by suitable adjustments for taking up wear on slides, bearings and load screws.

17.7 LIGHTING

- a) Integral LED lighting suitable for operations in night should be provided. In addition, where lack of light is likely to cause a risk despite availability of ambient lighting in daytime. Manufacturer must ensure that there is no area of shadow, which is likely to cause nuisance; that there is no irritating dazzle and that there are no dangerous stroboscopic effects due to lighting.
- b) Integral parts and areas requiring frequent inspection, adjustment and maintenance should be provided with appropriate lighting. Machine lighting should be low voltage to prevent any hazard to operator.

17.8 OPERATIONAL CONTROLS

- a) All controls should be governed by push button/ touch controls for all possible operations and should be conveniently located on fixed panel of equipment. Basic rules for direction of operation of controls and corresponding direction of movements of machine tools should be as per IS 2987-1985.
- b) Control devices should be clearly visible and identifiable, ergonomically positioned for safe operation without hesitating or loss of time, and without ambiguity. CNC controls (where applicable) should meet the general requirements of CNC controls.

17.9 SAFETY CONTROLS (As Applicable)

- a) Machine should incorporate safety devices to provide protection to operator and machine against all possible operational and machinery failures. Suitable interlock should be provided to prevent machine operations in case of faulty sequence of operation,

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fluctuation in supply voltage, resumption of power supply after power failure, non-positioning of safety guards, failure of hydraulic system (where applicable), failure of lubricating system (in case of automatic including drop in pressure lubrication). A fault or damage in control circuit or interruption re-establishment after an interruption of fluctuation in whatever manner in power supply to machine must not lead to dangerous situations in particular.

- b) Machine should not start without command. Machine should not be prevented to stop if command has been given. No moving part of machinery or piece held by machinery should fall or be ejected. Protection devices must remain effective. Machine should be fitted with an emergency stop device to avert any actual or impending danger. This device must be conveniently located, clearly identifiable and stop machine as quickly as possible without causing additional hazards. Emergency stop must remain engaged. It should be possible to disengage it only by appropriate operation. Disengaging control must not restart machinery but only permit restarting.
- c) Safety features should also include safety device against overload for mechanical and electric items to extent possible and safety stops against over-running of slides.
- d) Guard and protection devices should protect exposed persons against risks related to moving transmission parts (such as pulleys, belts, gears, rack and pinion, shafts etc.) and moving parts directly involved in process to extent possible and should meet requirements of robust construction, not give rise to additional risk, not easy to by-pass or render non-operational, located at adequate distance from danger zone, minimum obstruction to the view of production process, rigidly connected and not prone to rattling and enable essential work to be carried out without guard or protection device having to be dismantled.

17.10 COOLANT SYSTEM (WHERE APPLICABLE)

Suitable coolant system with pump, motor, tank, filter etc. should be provided. Coolant pump should be as per IS 2161-1962. Filter should be reusable/ cartridge type and indigenously available. Supply of coolant should be in ample volume. Provision to re circulate coolant should be available. A chip and coolant tray should be provided. Volume of coolant flow should be adjustable. An enclosure should be provided to prevent coolant from splashing outside machining zone.

17.11 LUBRICATION SYSTEM (WHERE APPLICABLE)

Machine should be provided with an automatic lubricating system for ensuring delivery of adequate quantity of lubricant to areas requiring continuous lubrication. Suitable arrangements should be provided for indication of failure of lubricating system. System

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should be provided with interlock to prevent machine operating/ starting in case of lubrication system failure. Reusable/ cartridge type filter capable of filtering chips, dust particles etc should be provided. Indicators for showing clogged condition of filters should be available. Lubrication and filter cleaning chart should be provided at conspicuous location on machine indicating

- (a) Specific location of points on machine to be oiled lubricated/ greased
- (b) Periodicity of lubrication of these points
- (c) Filter to be cleaned
- (d) Periodicity of cleaning filters
- (e) Periodicity of replenishing lubricating oil for centralized system
- (f) Any other similar relevant information. Points requiring manual lubrication should be separately indicated with frequency of lubrication.

17.12 PNEUMATIC SYSTEM (WHERE APPLICABLE)

Suitable filter/ moisture trap should be provided in system of pneumatic air intake. Filter should be reusable/ cartridge type. Air pressure regulator, if necessary, should be provided. Pneumatic control equipment should be of reputed make.

17.13 HYDRAULIC SYSTEM (WHERE APPLICABLE)

Hydraulic circuit must be equipped with following safety and inspection equipment:

- pressure gauges where pressure has to be set up or inspected
- safety valves for hydraulic circuit if relief valve does not fulfill this function
- equipment for checking of temperature in circuit/ pump wherever necessary
- arrangement to show if filters (including those in pump set) are choked and need cleaning (filters should be of reusable/ cartridge type)
- Alarm for low oil level.

1. Sump aggregate should have followed:

- oil level sight gauges or any other equipment showing minimum and maximum oil levels in sump

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- drain plug at lowest portion of tank It should be possible to drain oil from tank without disconnecting any pipes or other fittings.

2. Temperature of oil in hydraulic circuits should not exceed 60 °c in any case. Suitable arrangement should be incorporated to avoid overheating of oil under local weather conditions at continuous normal working of machine. Facilities for bleeding of air in case of air lock should be provided. Hydraulic reservoir, pump and allied equipment should be suitably segregated from machine in order to remove major source of heat. Hydraulic oils used on machine should be available in India. Hydraulic system elements should be from reputed manufacturers.

17.14 PAINTING (As applicable)

a) Steel surfaces should be thoroughly cleaned by disc grinding/ sanding/ shot blasting/ sand blasting and painted (except mating surfaces) with two coats of red oxide, zinc chromate primer IS2074. Painted surface of bought out items should not be disturbed. Welded joints should be cleared from slag and spatters before painting.

b) Fixed machine/ equipment/ support structures should be painted with two coats of synthetic enamel paint/ powder coated in apple green color shade #281 IS5-1978. Total dry film thickness on steel surfaces including primer should be about 50 microns.

c) Moving machine/ equipment like crane, traverser, turntable, forklift, trolley etc should be painted with two coats of synthetic enamel paint/ powder coated in color shade RAL 2005, handrails in RAL 3026 and electric panels in RAL 7035. Total dry film thickness on steel surfaces including primer should be about 50 microns.

17.15 STANDARDS (As per Latest applicable IS codes)

Equipment and materials should comply with appropriate Indian Standards (latest). The following standards should be applicable in particular:

IS325-1979 (latest)- Three phase induction motors (corresponding to IEC Pub-34-1) (Latest)

IS1248 (latest)- Direct acting indicating analogue electrical measuring instruments and their accessories (corresponding to IEC Pub-51) (Latest)

IS1231-1974 (latest)- Dimensions for three phase induction motors (corresponding to IEC Pub 72-1) (Latest)

IS1271-1985 (latest)- Classification of insulation material for electrical machinery and apparatus in relation to their thermal stability in service (corresponding to IEC-Pub-85) (Latest)

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IS6875 (latest)- Push buttons and related control switches (corresponding to IEC Pub/73) (Latest)

IS375-1963 (latest)- Marking and arrangement of switch gear, bus-bars, main connections and auxiliary wiring

IS996-1979 (latest)- Single phase small AC and universal electrical motors IS1356 (latest)- Electrical equipment of machine tools

IS2516 (latest)- Circuit breakers (corresponding to IEC Pub-56) (Latest)

IS7752-1975 (Pt-I)- Guide for the improvement of power factor in consumer's installation

17.16 ELECTRICAL

Control gear for AC/ DC motors should incorporate following protection devices:

a) NO VOLTAGE PROTECTION

No voltage protection should be provided so that machine should not start up again by itself when, following an interruption supply is restored. This is achieved by incorporating contactor in control circuit, which goes off when supply interruption occurs. This contactor can be made ON only by pressing push button.

b) SHORT CIRCUIT PROTECTION

To protect against short circuits due to insulation failure or faulty connection HRC type fuses should be provided for each motor. Rating of fuse should be such as to take care of over current due to motor starting.

c) OVER LOAD PROTECTION

To prevent motors from overloading, overload protection should be provided separately for each motor. Three phase motors should be protected by overload tripping devices on each phase. For achieving above function, integrated motor protection relay with suitable contactor can be used.

d) SINGLE PHASING PROTECTION

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A separate current sensitive delayed action single phasing preventer should be provided for each motor separately. Overload protection should not be treated as single phasing preventer.

e) CONTROL EQUIPMENT

Control equipment should be mounted in separate drip proof enclosures. Control enclosures and compartments should be designed to give adequate protection against ingress of dust, oil, coolant or chips and rodent bite. Control devices like contractors etc. should be front mounted on a rigidly fabricated metal panel for ease of operation. All other electrics should be so installed that they are readily accessible when doors and covers are opened. Hinged covers should be interlocked with machine tool control to prevent operation of machine when cover is open. Motor should be energy efficient TEFC type (totally enclosed with or without fan-cooled frame). Screen protected drip proof type motor if used should be mounted inside protective enclosures. Electrical equipment should comply with requirements of Indian Electricity Act and Rules. All instruments should be of industrial grade A (IS 1248) switch board type. Range of instrument should be such that maximum load expected in circuit should produce a deflection 60% to 80% of full scale. For main motor, F-class insulation should be provided. Motors should be designed to withstand frequent starts, stops, and reversals as demanded in operation of machine. Two earthing terminals should be provided on all electric motors including control gear.

17.17 POWER SUPPLY (As applicable)

Machine should be suitable for operation on 415V, 3 phase, 50 cycles AC, 3 wire or 4 wire system with neutral solidly earthed and should accept supply voltage variation up to $\pm 10\%$ and frequency variation up to $\pm 3\%$. However, rated power of the motor should be available at nominal voltage. Bidder should provide voltage stabilizer for machine if electrical motor power requirement is more than 30kW as detailed hereunder:

a) In case of machine not equipped with NC, CNC and Thyristor controlled devices a suitable servo-controlled voltage stabilizer of adequate capacity to cater for entire electrical load of machine having electrical motor load requirement exceeding 30 kW should be offered along with machine. Voltage stabilizer should be from reputed sources. Voltage stabilizer should conform to:

- (i) Input voltage 320-460 V 3 phase 4 wire unbalanced supply
- (ii) Output voltage 415V
- (iii) Regulation $\pm 1\%$ from No load to Full load
- (iv) Rate of correction 20 V per second per phase

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(v) Wave from distortion Nil

(vi) Efficiency not less than 97%

(vii) Winding and class of insulation copper wire wound with B class of insulation or better.

b) In case of machine equipped with NC, CNC, Thyristor controlled devices and other sophisticated electronic gadgets including microprocessors etc, which are susceptible to power line spikes and surges, a suitable voltage stabilizer and ultra-isolation transformer of adequate capacity to cover for entire electrical load of machine should be offered conforming to specification for voltage stabilizer as mentioned above and isolation transformer to parameters

- Transformer ratio 1:1
- Winding copper wire wound with B-class insulation or better
- Protection to arrest spikes and surges to the order of 3 kV for 200-400 micro seconds duration
- Common mode noise rejection 120 dB
- Isolation Capacitance 005 Pf resistance greater than 1000 mega Ohm.

c) Voltage stabilizer should be equipped with a protective relay to trip AC power supply to machine instantaneously with audio and visual indication to operator. Settings of protective relay for low and high voltage should be 320 V and 460 V respectively. Protective relay should be provided on machine having electrical load below 30 kW. Indigenous make voltage stabilizer and isolation transformer from reputed manufacturer are acceptable.

17.18 SPARES, TOOLS & TACKLES AND CONSUMABLES (as Applicable)

1. COMMISSIONING SPARES

a) The scope covers necessary commissioning spares as may be required during erection, start up and initial operation of machine until successful commissioning and performance guarantee/ proving tests.

b) Process related consumables like gas, paint etc. should be supplied by EPC Contractor only and equipment related materials up to performance guarantee tests like lubricant, refractory, hydraulic oil, grinding wheel, cutting tools, inserts, welding electrodes etc. are to be supplied by bidder.

c) Bidder should also supply machine specific consumables as specified in technical specification. Cost of commissioning spares should be included in the cost of machine/ equipment.

TECHNICAL SPECIFICATION

2. OPERATING & MAINTENANCE SPARES

- a) The scope covers supply of normal perishable and non-perishable maintenance spares along with machine for normal operation and maintenance of machine, covering complete range of mechanical, hydraulic and electrical equipment including controls, for two years (warranty period) Cost of spares should be included in the cost of machine.
- b) Bidder should ensure proper identification of operating and maintenance spares.
- c) Spares mentioned in technical specification are minimum spares. Bidder should provide and include cost of additional items/ spares as recommended by OEM over and above the spares provided in technical specification.

3. TOOLS & TACKLES

- a) The scope covers supply of necessary tools, tackles, instruments and appliances for erection, testing, commissioning, operation and maintenance of machine. Cost of the same should be included in the cost of machine.
- b) Bidder should provide specification including names of suppliers giving sufficient details to enable BEML to procure at a later date, when necessary, such special tools, tackles, instruments and appliances.

4. CONSUMABLES (as Applicable)

- a) The scope covers supply of equipment related consumables including oils, lubricants, greases, fuel, chemicals, tools, inserts, welding electrodes, usual stores, materials and other consumables required for flushing/ initial fill/ fitment in machine till successful commissioning and taking over of machine by the employer/ BEML. Cost of the same should be included in the cost of equipment.
- b) Bidder should supply adequate quantities to cover wastage/ breakage during transportation, storage, handling, erection and commissioning until taking over.
- c) Bidder should also furnish optimal consumption rates of consumables along with estimated annual requirement, ordering specification and sources of supply to enable BEML to procure these for uninterrupted operation of machine. Bidder should furnish such information at the time of commissioning of equipment.

TECHNICAL SPECIFICATION

5. INSPECTION AND TEST CERTIFICATES

1. The scope covers supply of all items covered under schedule duly inspected, tested and certified by authorized representative of the employer or any other inspection agency nominated by the employer. Inspection charges of inspection agency should be borne by the employer. However, cost of testing should be borne by bidder.
2. For inspection of equipment as stated in clause #4.1 above, bidder should provide likely delivery and inspection schedule of items to the employer at least 60 days in advance of actual date of inspection for the employer to nominate the inspection agency. Bidder should be responsible for any delay in inspection and supply of equipment arising out of delayed submission of inspection & delivery schedule of equipment to the employer.
3. The employer may authorize the bidder to dispatch item in case it is not possible to carry out inspection as stated in clause #4.1 above. In such cases, after obtaining written permission of the employer, bidder should ensure that items are supplied duly inspected, tested and certified by original equipment manufacturer (OEM) along with bidder's/ manufacturer's test & guarantee certificates.
4. The employer should have the right of inspecting and testing equipment at any time during manufacture or before dispatch. Bidder should carry out such tests in appropriate manner in presence of authorized representative of the employer or any inspection agency nominated by the employer. Inspection, examination or testing carried out by the employer/ inspection agency should not relieve the bidder from any of his obligations under this contract.
5. Where special tests, in addition to agreed tests are required by the employer, bidder should bear the cost of testing only if such special test proves that equipment is not in accordance with specifications.
6. When tests have been satisfactorily completed at bidder/ OEM's premises, authorized representative of the employer or inspection agency nominated by the employer should forthwith issue a certificate to that effect. Issuance of certificate by authorized representative of the employer or inspection agency should not discharge the bidder of his liability should the equipment on further inspection/ test during or after erection found not to comply with requirement of contract.
7. The scope covers supply of wire ropes, hooks, chains, slings, lifting tackles etc along with necessary test certificates, from government recognized test house, for having tested the item in accordance with relevant IS standards. Proof load test as per IS Specification should be conducted, either in-house or from a recognized test house.

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8. The scope covers supply and commissioning of equipment conforming to statutory guidelines detailed in clause #1.5 along with necessary certificates from the concerned authorities for having met the requisite norms.

9. The scope covers supply of electrical and mechanical equipment duly tested in accordance with appropriate Indian Standard and as per technical specification specified in this schedule at bidder/ OEM premises. Bidder should provide relevant test certificates to the employer.

6. INSTALLATION & COMMISSIONING

1. The scope covers installation, erection and commissioning of machine/ equipment/ items under supervision of adequate number of technical experts/ technical advice from OEM (original equipment manufacturer). Bidder should ensure that earthing of equipment is tested as per Indian Electricity Rules. Bidder should ensure that machine has been properly erected and installed and there are no misalignment, slackness, skewness, vibration and unusual noise in equipment.

2. Bidder should commission machine within 30 days from the date of intimation by the employer. Bidder should carry out startup and trial operation tests (commissioning test) on receipt of authorization from the employer. On completion of erection of plant and equipment, tests should be by bidder to prove that unit has been supplied as per contract and after erection is fit for startup and commissioning. Tests should be performed on individual subassembly of unit wherever necessary and should be designed to conduct systematic check of components and functional operation thereof.

3. Trials should be carried out under no load and rated load conditions. During trial operation, all necessary adjustments should be made to ensure compliance with operating characteristics for complete equipment as stipulated in technical specifications. Bidder should demonstrate machine performance for a period of two shifts of eight hours each at site. BEML should associate his operating personnel as may be available for normal operation for purpose of startup and commissioning under guidance of bidder/ OEM.

4. Test results should be recorded jointly by bidder and authorized representative of the employer/ BEML. Bidder should rectify defects observed during commissioning. On completion of tests and liquidation of defects observed, the employer should issue a commissioning certificate within 7 days when the bidder has:

- a) Submitted all documents in compliance with provisions of this contract as per clause #6

TECHNICAL SPECIFICATION

- b) Supplied all accessories/ items/ spares as per specification as per clause #3 and #2.14 above.
- c) Resolved to the satisfaction of the employer/ BEML all objections/ observations, if any.

5. The employer/ BEML should take over machine/ equipment/ item physically after issue of commissioning certificate. After successful commissioning of machine at site, machine performance should be watched by BEML for a period of one month (each working day having two shifts of 8 hours) before final acceptance certificate is issued. Final acceptance certificate should be issued by the employer/ BEML when:

- a) Bidder has rectified in a definitive manner all defects/ objections/ observations mentioned in commissioning certificate.
- b) Bidder has submitted final documentation incorporating latest modifications.
- c) Bidder has met any and all other obligations under this contract.

DOCUMENTATIONS (as Applicable)

- The scope covers submission of necessary documentation as detailed hereunder. Cost of documentation should be included in the cost of equipment.
- Bidder should submit documents detailed hereunder to the authorized representative of the employer at the time of joint check of equipment after unpacking.
- original inspection/ test/ warranty/ guarantee certificates of equipment as per clause #4 above Packing list
- Copy of purchase order detailing specifications only.

Bidder should submit documents detailed hereunder (three copies each in English) to the authorized representative of the employer/ BEML at the time of commissioning of equipment.

- a. Foundation & layout drawings of machine and accessories used in installation and commissioning of machine.
- b. Operating instructions & maintenance manuals including electrical circuitry and wiring, electronic control, safety features and circuitry, hydraulic, lubrication and pneumatic systems. Manual should also cover guidelines for trouble shooting of machine.
- c. Catalogue giving part list number of each component and assembly drawings.

TECHNICAL SPECIFICATION

- d. Complete machine spare's part details indicating part no/ ordering specification and drawings along with list of suppliers to enable BEML to procure operating and maintenance spares post warranty period.
- e. Consumption rates of consumables along with estimated annual requirement, ordering specification and sources of supply to enable BEML to procure these for uninterrupted operation of unit.
- f. Details of service organization (contact person, address, phone, fax, e-mail), which should be responsible for after sales service
- g. For CNC machines following additional documentations are to be supplied:
Operators guide & Programming guide for CNC control system Diagnostic and troubleshooting guide of CNC control system Machine software listing

TRAINING

1. The scope covers necessary training by bidder/ OEM in operation and maintenance of machine for BEML personnel at site premises after machine has been installed and successfully commissioned. Period of training should be adequate and cover all aspects to make nominated staff of BEML to carry out operation, schedule attention, trouble shooting and repairs to these machines as and when required. Training should cover preventive maintenance including electrical & electronic circuit (card/ module replacement), hydraulics etc. Training should be imparted in English/ Hindi. Cost of training should be included in the cost of equipment.
2. The scope also covers training of a group of about eight officials of BEML/ employer for a period of around eight working days in design, operation and maintenance at OEM's premises for machines, which may be imported from abroad by bidder.
3. Boarding, lodging and travel expenses of officials nominated for training will be borne by BEML/ employer. Bidder should bear cost of imparting training including training materials and will provide local transport. While the training program will be drawn in advance through mutual consultations, bidder will have no financial liability if no nomination is made for such training or nominated officials are not able to proceed for training

TECHNICAL SPECIFICATION

CHAPTER-18

LIST OF APPROVED MAKES

TECHNICAL SPECIFICATION

List of Approved Makes		
The following is the list of approved make/ brand of materials (Refer materials, whichever are applicable for the scope of work) for proposed work.		
Sl · N o	Name of materials	Approved Make
Civil works		
1	Cement (PPC/OPC)	ACC/ Ultra Tech/ JK
2	Reinforcement Steel (HYSD/TMT)	TATA/ SAIL/VIZAG/ JINDAL/ JSW
3	White Cement/ Wall putty	Birla wall care/JK White/ Berge/Asian Paints/ShieldmaxX
4	Vitrified Floor Tile	Kajaria/Johnson/ Nitco/ Somany (all first quality).
5	PVC Pipe, CPVC pipes, UPVC Pipes	Supreme/Prince/ Finolex / Ashirvad
6	G.I. Pipes	Jindal/ Tata /Apollo/ Prakash surya
7	C.I. pipe & fitting	KAPILASH/NECO/BENGAL IRON CO./RIF
8	Aluminium Sections	Jindal, Hindalco, Indalco, Nalco
9	Float glass	Modi Guard/ Saint Gobain / HNGIL/ AIS
10	Toughened Glass	Modi Guard/ Saint Gobain / HNGIL// AIS
11	Frameless Glass fitting	Ozone / Dorma
12	Pre-laminated board	Greenlam/ Merino /Kitply/Century
13	POP punning	Sakarni/ Shri Ram/ JK/ Birla
14	All type of Primers / Synthetic Enamel paint	Asian/ ICI (Dulux)/ Nerolac/ Berger
15	Interior Emulsion & Texture paints	Asian Paints (Royale)/ Berger (Silk Glamour)/ Nerolac (Impressions HD)/ Dulux(velvet touch)
16	Exterior Emulsion all buildings	Asian Paints (Ultima)/ Berger (Silk Glamour)/ Nerolac (Excel Anti peel)/ Dulux(Weather shield max)
17	S.S Stair case railings	Jindal Stainless Steel/ SAIL/ ESSAR/ ICIH Industries
18	CI Manhole	NECO/ Kapilansh /SKF/RPMF
19	Stainless Steel Bolts/ Washers & Nuts	Kundan/ Puja/ Atul
20	Chequered Precast Concrete Tile	Hindustan Tiles/ Ultra/ Swastik Tiles
21	UPVC Windows	Fenesta/ Prominace/ Rehau/Torfenster/ Alupast / NCL Veka LTD
22	Admixture	Fosroc/ Sika.
23	Adhesive	Pidilite/ Dunlop/ Sika/ Fosroc/ Endura/ Laticrete
24	Structural & Weather Silicon	Dow Corning/Wacker.

TECHNICAL SPECIFICATION

25	Epoxy/PU Flooring & other specialised floorings.	Berger/ Fosroc/ Pidilite/Sika/MYK/ Ardex Endura/ STP.
26	Flush Door shutters	Duro/ Kitply (Swastik)/ Century/ Durian/ Greenply/ Merino/ Green Panel/ A1 teak/ / JENA
27	Fire rated door	Signum Fire Protection/ Shakti Metdoor/ NAVAIR/ Sukri/ Promat/ Godrej/
28	Acoustic Door	Ica Acoustics/ Oceanz Acoustics/ Acoustical Solution Inc.
29	Flush Door Shutters (Decorative/ Non-Decorative).	Swastic/ Corbett/ Century/ Green/ Archid/Jena
30	Glass FRP Door Shutters	Polyline/ Duroplast/ Cactus.
31	Hydraulic Door Closer/ Floor Spring	Hardwyn/ Godrej/ Dorma
32	S.S. Staircase Railing	Connect Architectural Products Pvt.Ltd/ Jindal Stainless Steel Ltd./ Icich Industries, Essar
33	Door Coordinator	UL Listed/ Monarch/ Dorma.
34	Anodised Aluminum Hardware (Heavy Duty)	Hardima/Everite/ Sigma (ISI Marked).
35	Tempered / Clear Glass	Pilkinton/Saint Gobain/ Asahi.
36	Door Locks	Godrej/Europa/Ozone/Dorset
37	Rolling Shutter Motor	CAME/AUTOZON/ GEAPL
38	Floor spring & Door closure	Godrej/ Dorma/Dorset/ Kich
39	Water proofing chemical	DrFixit /SIKA/ ARDEX/BERGER /FOSROC
40	Tile Adhesive	Lactcrete/ Ardex Endure/ Pidilite/ Sika/Asian Paints/ Fosroc.
41	Acoustic Treatment: Wall Panelling	Armstrong / Anutone / Himalaya / Credenze
42	Heavy Duty Paver Tiles	Johnson-(Endura)/Somany-(Dura Stone)/Pevit,
43	Poly-Sulphide Sealant	Pidilite/ Tuffseal/Sika/ Fosroc.
44	Damp Proof Material	Impermo/Duraseal/ Acco-Proof.
45	Hardware's Door & Windows	Hettich/ Everite/Dorma/ Godrej/Iron mongery
46	PVC casing pipe	Kissan (Agro)/ Appollo/Supreme
PEB/Structural Works		
1	Structural Steel	TATA/ SAIL/ Jindal/ Vizag/JSW
2	Structural Steel- MS pipes only	TATA/ SAIL/ Jindal/ Vizag/ APL Apollo/JSW
3	HR plates for Built-Up Sections	VIZAG/ SAIL/ ESSAR/ TATA/ JSW/JINDAL

TECHNICAL SPECIFICATION

4	Hot Rolled Steel: Beams /Channels / Angles/ Rods / Plates	VIZAG/ SAIL/ ESSAR/ TATA/ JSW/JINDAL
5	Hot Rolled Steel: Circular/Square/Rectangular Tube Sections	VIZAG/ SAIL/ ESSAR/ TATA/ JSW/ APPOLLO/JINDAL
6	Pre Galvanised Cold Rolled Coils:- Purlins /Girts	SAIL/ ESSAR/ JSW/TATA/ JINDAL
7	Galvalume Roof Sheetting / Galvalume Wall Cladding/ Flashing/ Gutter/ and Downspout	TATA BLUE SCOPE/ JSW/ META COLOUR/LLOYD INSULATIONS/ INTERARCH
8	Tube sections	VIZAG/ SAIL/ ESSAR/ TATA/ JSW/ JINDAL
9	High Strength Bolts	Deepak/ Atul/ Panchsheel/ TVS &Pooja
10	Secondary Connections	Deepak/ Atul/ Panchsheel/ TVS /Pooja
11	Sheeting/cladding Fasteners	Fisher/ Hilti/ Corroshield
12	Paint -Epoxy and primer	Asian/ Berger/Dulux/Dupont
13	Welding Rods	Advani Orikon / ESAB INDIA/ EWAC ALLOYS/ HONAWAR ELECTRODES/ D & H Welding Electrodes
14	Life Line System at Roof	3M India Ltd/ Sure safety (Ind) Ltd/ M/s Eklavya Safety LLP/Karam/ (CE certified system).
15	Skylight	VELUX or equivalent
16	Polycarbonate sheet	LLOYD INSULATIONS/ TUFLITE / GE PLASTIC/LEXAN/BAYERS
17	Self-drilling/ tapping Zinc plated screws size 5.5x55mm for Galvalume sheets	TATA/JINDAL/JSW/ HILTI/
18	XLPE Sheet	Supreme/ Green Insu/ Aerolam
Electrical, Data & Voice Networking Works		
1	HT switch gears (VCBs, panels, relays etc)/ RMU	L&T/Schneider/Crompton/Megawin
2	LT switch gears ACBs, relays	L&T(U power)/ Legrand (DMX3)/ Siemens (3WL)/ Schneider (Easypact HVS)
3	HT & LT armoured cables	Finolex/ Polycab/ Havells/KEI/ RR KABEL
4	HT/ LT Electrical Panels	CPRI Approved Manufacturers for approved voltage
5	HT/LT cable joint kits	M-Seal/Raychem/3M
6	MCBs/RCCBs/RCBOs/ DBs & accessories	Legrand (DX3)/ L&T (Exora)/Schneider (Acti9)/ABB- (S200M)/Hager-(H3)
7	MCCBs/SFU/Contactors/Panel board mounting switches/	ABB/ Schneider/L&T/Legrand

TECHNICAL SPECIFICATION

	Single Phase Preventer /Timer	
8	Power Capacitors	EPCOS / Siemens / L & T / Schneider/ Legrand
9	FRLS and PVC insulated stranded flexible copper wires as per IS 694	Finolex/ Polycab/ Havells/ KEI/ RR KABEL
10	PVC rigid conduit heavy duty	Finolex/Precision/Avon Plast/ BEC/AKG/ Vasavi Minimum thickness 2.0mm up to 25mm and 2.5 mm for above 25mm
11	M.S. Conduit pipe and accessories	AKG/BEC/RMCON/NIC with ISI marking
12	Modular type Switches, Socket, Fan Regulator, including Modular Boxes and Plates and accessories	Legrand (Mosaic/Myrise)/ Crabtree (Picadly)/ Schneider (Zencello)
13	Indication lamps / push buttons / selector switch	L&T/Siemens/Schneider/AE/Kaycee/Tecknic/BCH/ IMP
14	LED light Fittings, lamps & accessories	Philips/Havells/Bajaj/CGL
15	Street Light/High Bay light	Philips/Havells/Bajaj/CGL
16	Multifunction meter	El measure/ Schneider/L&T
17	Ceiling Fans	Havells/Usha/CGL/Bajaj/Orient(5 star BEE rated BLDC with regulator shall be used)
18	Exhaust fans/Wall fans	CGL/Bajaj/Havells /Almonard
19	CT/PT	Kalpa/Kappa/L&T/AE/ INDCOIL/Pragati
20	Variable Frequency Drives (VFDs)	Yaskawa/Fuji Electric/Schneider/Danfoss
21	HDPE Pipe	Reliance/Duraline/Supreme/Jain
22	Terminals	Connectwel/ CHHABI/ Cab seal / Wago / Elmex
23	Cable lugs & glands	Dowells/ Jainsons / Asian / Commet/ Wago/ Gripwel / Johnsons/ Smi
24	Cable Tray	RICO/PILCO/VENUS/Profab / Indmark Formtech / UCIC / Kanade Anand / VATCO/ RM Con
25	Rubber Insulation Mat (ISI marked mats only to be used)	Syntex/Jyoti/Tata/Vardhman/Zenith/Kiran/Raychem/Els tomer.
26	UPS/Inverter	Numeric/Fuji Electric/Emerson/ Liebert
27	Battery	Exide/Amaron (Batteries with 3 years warranty only to be used.)
28	Bus Bar Trunking- Sandwiched	Schneider/L&T/C&S/Siemens/Legrand
29	Sensors for lighting	Havells/Crompton/Philips/Honeywell/Legrand/ Schneider.
30	Split type Air conditioner	Daikin / Blue Star /Voltas / LG/ Carrier / Mitsubishi / Godrej /(5 star BEE rated Inverter ACs shall be used)

TECHNICAL SPECIFICATION

31	Voltage stabilizers	Godrej/ V-Guard/ Microtek/ Voltas
32	Industrial Insulated sockets & Plugs	Schneider/ Legrand/ CAPE/Mennekes
33	ABS enclosure for Industrial sockets	Hensel/Mennekes/CAPE/Legrand/Schneider
Telephone, Network, Access control/ CCTV systems		
1	PIJF underground telephone cable	Polycab/Delton/Finolex/KEC/Paramount
2	Optical Fiber Cable	Finolex / KEC/ Paramount / Birla Ericsson / Aksh Optifibre
3	Telephone cable	Finolex/Havells/Polycab/RR cable/Molex
4	Telephone Crone Connector	D-link /systemax/digilinc/molex/Krone or equivalent.
5	Telephone/Cat6 IO/ LIU/CAT 6 Jack Panel	Molex/ Systimax/Tyco/Panduit
6	CAT-6 LAN Cable	Molex/ Systimax/Tyco/Panduit
7	Network Rack	Net Rack/ Wall Rack/Panduit/Rittal
8	LAN / Data/ Voice Networking components	D-Link/Digilink/Molex/Panduit/Systimax/ Tyco
9	Network switches-L3 Managed switches	CISCO/Juniper/Fortinet/ HP/
10	CCTV/ Video surveillance all types of cameras	Axis/CP Plus/Sony/Honeywell/Pelco
11	Access control system	Bosch/Matrix/ Axis/Honeywell
12	Electromagnetic locks	Dorma/Godrej/Algatec/Assa-Abloy/BEL
13	NAS Storage system for CCTV	Seagate/ WD/ Honeywell/ HP/ EMC2/ Axis/ Pelco
14	Video surveillance hard disc	Seagate-Sky Hawk/WD-Purple
15	Outdoor pole mounted enclosure and wall mounted enclosures for faulty housing	Hensel/Hoffman/Panduit
16	IP66 rated external splicing kit for outdoor fibre optics cable	3M/Raychem/Tyco
17	IP EPABX System	Unify/ Alcatel/ Nortel/
Road Works		
1	Paver Blocks (M40 or M50 Grade)	KK / UltraTech / Local ISI vendors
2	Road Marking Paint	Asian Paints / Berger / Shalimar/ Dulux/ Nerolac

TECHNICAL SPECIFICATION

3	Sign Boards & Delineators	3M/ Avery Dennison / Local IS codes
Firefighting		
1	M.S Pipe	TATA /Jindal / Suryaprakash / Asian
2	M.S Fittings	R-brand / Koel /Swastik
3	Hydrant Valve (ISI Mark)	Fire squad/ WINCO/ / Newage / Priyanka/ Minimax
4	CI Butterfly valves	Leader /Audco /zoloto/ Kirloskar
5	Fire hose (ISI Marks)	Fire squad/ WINCO/ / Newage / Priyanka/ Minimax
6	Hose Cabinet	Newage/ Firesheid/ Guard Fire/ Minimax / Priyanka
7	Fire bridge inlet	Fire squad/ WINCO/ / Newage / Priyanka/ Minimax
8	Branch Pipe & Nozzle	Fire squad/ WINCO/ / Newage / Priyanka/ Minimax
9	Hose Reel Drum	Fire squad/ WINCO/ / Newage / Priyanka/ Minimax
10	Ball Valve	Leader /Audco / zoloto/ Kirloskar
11	Portable Fire extinguishers	Fire squad/ WINCO/ / Newage / Priyanka/ Minimax
12	Paint (Enamel)	Asian / Nerolac / Burger/Dulex
13	Passive Fire protection	3M / Promort /Metacaulk (UL Listed)
14	Wrapping & Coating	IWL / Pypokote
15	Sluice valve / Non return valve	Kirloskar of Class PN 1.6 /Equivalent in Audco/Leader/ Advance
16	Gun Metal Valve (ISI marked)	Kirloskar / Sant/Leader
17	Pressure Switch	Danfoss / Honeywell / Indfos / Fiebig / HGuru
18	First aid hose reel drum	Dunlop / Newage/ Minimax / Ceasefire / Mitras /Safeguard
19	Cushy foot / Anti vibration pads	Dunlop / Resistoflex / GERB
20	Firefighting pumps	Kirloskar/ MATHER & PLATT/ Crompton
21	Motor starter	L&T/ Siemens/Crompton/ Schneider
Fire Detection and Alarm System		
1	Analog Addressable fire alarm system (Fire control Panel / Sounder / Manual Call box & accessories)	Notifier (Honeywell)/Cerberus (SIEMENS)/ SIMPLEX/ Edwards/ COOPER
2	UL approved Fire alarm detector (smoke / heat / optical / multifunction etc.)	System Sensor/ Apollo/ Edwards/ Notifier (Honeywell)/Simplex/ cooper
3	Industrial siren	ASES/AGNI/ISI make
4	Fire alarm cables	Polycab/ Havells / Finolex/ RR KABEL
5	PA Speaker & Console	Bosch/ Philips/ Siemens/ Bose
Plumbing Drainage & STP Works		
1	Sanitary Fittings (EWC/IWC/Washbasin/Urinals)	Hindware/ Parryware/ Jaquar/ Cera
2	CP sanitary pipe fittings	Hindware/ Parryware/ Jaquar/ Cera

TECHNICAL SPECIFICATION

3	All types of Valves	Zoloto/Apollo/Leader/Audco /Kirlokar
4	Solenoid valves	Dwyer/Taylor/Audco
5	Cast iron pipes and fittings	NECO/ RIF/ BIC/ KAPILANSH,
6	Injection Grouting	Fosroc/ Sika/ MYK/Pidilite.
7	Grab bars for Disabled	Dorma/ D-line/ Cera/ Jaquar/ Hindware
8	Water dispenser	Crossfields/Aqua clan/ Conway/ Voltas/Thermax/
9	Water storage tank	Sintex/Aquatech/Vectus/Plasto/Supreme
10	Galvanised Iron pipes	Jindal/ Techno flex
11	Wall Mixer, Kitchen sink,	Hindware/ Parryware/ Jaquar/Cera
12	Electromagnetic flow meter	Reputed make with NABL calibration
13	RCC Hume Pipes (NP2/NP3 Class)	Spun Pipe/KK/ISI-approved vendor
14	Precast RCC Drain Covers	KK / Local Precast ISI vendor
15	Stoneware Pipes (if used in gravity drains)	Supreme / Prince / Local ISI
16	Sump / Catchpit Precast Chambers	KK Manhole / Local Precast
17	Drainage Inspection Chamber Covers	Neco/ Skf/Rif/Rpmf/ Bic/ Kapilansh/ Nfl
18	Manhole Steps (FRP/GRP coated or MS)	Neco/ Skf/Rif/Rpmf/ Bic/ Kapilansh/ Nfl
19	Drainage Waterproofing Compound	Fosroc / Cico/ Dr. Fixit/ Sika
Interiors		
1	False Ceiling/ Panels of all types	Gyproc/ India Gypsum/ Usg Knauf/ Armstrong
2	Workstations And Senior Executives Room Tables	Featherlite/ Godrej Interio/ Haworth/ Wipro/ Durian/Damro
3	Loose Furnitures - Like Chairs, Sofa, CRCA storage cabinets	Featherlite/ Godrej Interio/ Haworth/ Wipro/ Durian/Damro
4	Plywoods	Greenply/ Kitply/ Sharonply/ Centuryply
5	Fluted Panels	Rang/ Gloirio (Emporio)/ Mag Veneer
6	Laminates	New Mika/ Greenlam/ Merino/ Dorby Mica/ Formica
7	Window Blinds	Mac/ Trac/ Vista Levelor
8	Texture Painting	Asian Paints (Royale)/ Berger (Silk Glamour)/ Nerolac (Impressions HD) / Dulux(velvet touch)
9	Decorative LED Light Fittings	Havells/ Bajaj/ Phillips/White Teak Company (Asian Paints)/Hybec
10	Locks And Hinges for Cabinets And Cupboards	Godrej/ Ebco/ Hettich
11	Cabinet Handles, Tower bolts, Door Closers	Godrej/ Ebco/ Hettich

TECHNICAL SPECIFICATION

12	Melamine Polish	Asian Paints/Berger/ICI
Pumps		
1	Centrifugal Pumps	Kirloskar/Grundfos/Xylem/Ebara
2	Centrifugal	Grundfos/Xylem / Ebara
3	Screw Pumps	Roto/Positive/Tushaco/Rotomac
4	Submersible Pumps	Grundfos/Xylem/KSB/Ebara
5	Dosing Pumps	Asia LMI/Emec Italy / Toshcon
6	Dewatering Pumps	Grundfos/Xylem/KSB/Ebara
7	Sludge Pumps	Kirloskar/Tushaco
8	Hydro-pneumatic pump	Grundfos/ Kirloskar/ KSB/ Mather Platt
9	Sewage pump and other pumps	Grundfos/ Kirloskar/ KSB/ Lubi
Piping		
1	Blowers	Everest/Usha/Kay/Beta
2	Diffused Aeration	EDI/Thermax/Geo Miller/Micro/ITT System/Envirotech/Norton/Rehau/MM Aqua
3	Tube Settler media / Media for Bio	MM Aqua/Thermax/Geo Miller/Cooldeck
4	Reactor	
5	U V Sterilizer	Creative/Alfa
6	Filter Press	Sachin Filtech/Pharmatech
7	Membrane Module	GE/Siemens/Huber
8	Mechanical Step Screen	Jash/Wastech/Ecologix
9	PVC Sch 40 & 80 Water Supply Pipes & fittings	Supreme/Astral/Finolex / Ashirwad
10	C1/Cast Steel/Bronze Gate construction of Butterfly/Globe/Butterfly/N RV	IVC/Venus/Audco/Advance/SKS/AIP/Kirloskar/Sant
11	Strainer	CIM/Audco/Advance/AIP
Instrumentation		
1	Pressure Indicator	Manometer India/ H Guru Instruments/ General Instruments/AN Instruments/ Forbes Marshall / Bells / Emerald / Jepson / Warea Instruments
2	Level Sensor & Indicator	Toshniwal Bros./ABB/ Bells Controls /Marshall / Pune Techtrol / Level tech / Elegant / Forbes Cirrus
3	Flow Instrument System	Resemount (I) Pvt. Ltd/ABB/ E&H/ Forbes Marshall / SB Electromech /Warea Instruments/ Level tech Systems
4	Gas Meter	Fluid Components/ MKS Instruments/ Kurtz Instruments /Forbes Marshall/ABB

TECHNICAL SPECIFICATION

5	pH meters	A-LMI/ Rosemont / Toshniwal /E&H/ Forbes Marshal / Ultra line
6	Analyser- Conductivity	Fobes Marshall / . A- LMI / Rosemont / Forbes Marshall / Kent
7	Bulk Water Meter	Aquamet / Kaycee / Kent
8	Electro-magnetic type Flow Meter	Forbes Marshall / ABB
9	DO Sensor	Forbes Marshall / Hach / Electronet
10	MCB/RCCB/RCBO/DB	L&T/Hager/ABB/Legrand/Schneider
11	Industrial outlet	L&T/Hager/ABB/Legrand/Schneider
12	Electrical Control Panel	Advance/Adlect/Ambit/Trico lite/Milestone/Vidyut control/RST/Dynamic
13	Switchgear & Accessories	ABB/Schnieder/L&T/Siemens
14	MCCB (Microprocessor)	ABB (Tmax)/L & T (D sine) / Schneider (Compact NXS/NS)/Siemens (3VL)/Legrand (DPX)
15	Switch Fuse Unit with HRC Fuses	L&T/ABB/Schnieder/Siemens/GE
16	Contactors/Relays	L&T/Siemens/ABB/Schneider
17	Ammeters/Voltmeters and metering equipment's	L&T/Siemens/Automatic Electric/Neptune Enercon
18	Selector Switches	Kaycee/Salzar/L&T
19	LED lights	L&T/Vaishno/Siemens
20	PVC Insulated Copper Conductor Wires	Finolex/Polycab/Skystone/RR
21	Lugs	Dowell's/3D/C.C.I./3M/Comet/Hex
22	Cable Glands	Siemens/Comet/Grippwel
23	MS Conduits and Accessories	B.E.C./AKG/MK
24	Fluorescent Tube Fitting	PHILIPS/WIPRO/Bajaj
25	Ceiling Fans/Exhaust Fans/Air Circulators	Crompton/Bajaj / Usha
26	Air compressor system	ELGI, Ingersoll rand, Atlas Copco, Kirloskar pneumatic, FS-curtice India.
27	Turnstile gate	Godrej Security, Entero System India Pvt. Ltd., Toshi Automation Solutions, Dormakaba, Cronax Industries.
28	EOT	Cranex, Reva Industries, Unique Industrial Handler, Sparkline Equipment Pvt. Ltd. GRIP Engineers, Anupam Industries limited, Smaco Engineering Pvt. Ltd., Mukund Cranes, Fafeco Engineers Pvt. Ltd.
29	Traverser	Reva Industries, Cranex, GRIP engineers, Electro Mech, Sparkline Equipment Pvt. Ltd, Metco.Pvt.Ltd.
30	Water purifier	Eureka Forbes, Kent, Purit.
31	Water Heater	Racold, V-guard, Jaquar
32	Lifts	Johnson/ Kone/ Shindler/ OTIS

TECHNICAL SPECIFICATION

33	Current Transformers	Automatic Electric/Kappa/L&T
34	Potential Transformer	Automatic Electric/Kappa/L&T
35	Diesel Engine	Cummins/Perkins /Caterpillar/ Kirloskar/ Baudouin/ Mitsubishi
36	Man cooler	Greenberg, Can-fan Pvt.Ltd, Air zone, Brian engineering
Miscellaneous		
1	Vinyl Flooring	Responsive Industries LTD, Gerfloor, Armstrong, Polyflor India Pvt Ltd
2	Rolling Shutter	Popular, Gandhi Automation Pvt Ltd, Falcon, Jacob Engineering
3	Auto Closer Hinges	Blum, Hafele, Ozone overseas Pvt Ltd
4	Patch Fittings	Dorma, Savex, Niki, Ozone, D-line
5	Glazed Doors with patch fittings	Dorma, Ozone overseas Pvt Ltd, India Private Ltd, ASSA ABLOY India Pvt Ltd, Dorset Kaba Security Systems Pvt Ltd
6	Pre-engineered Building system	Kirby, Tata Blue Scope, Lloyd (India) Ltd, Octomec, Apex Buildsys Ltd, Alfa PEB
7	Veneers	Century, Kit ply, Anchor, Green ply, Kenwood, Jacsons
8	Sun control film	Garware, 3M, or equivalent as approved
9	GI Section for Partitions & False Ceiling	Saint Gobain Gyproc or equivalent as approved
10	Aluminium Louvers	Hunter Douglas, Euro Building or equivalent as approved
11	Expansion Joint Filler	Sil Fex of Supreme Industries Ltd. or equivalent as approved
12	Fixtures for specially abled	Hind ware, Toto, Cera, Roca.
13	Anti Vibration	Mountings As Per Manufacturer Standard Practice
14	PUF sandwich Panel	Alfa/Karthik/ Lloyd/Kirby/ Metecno/ TATA BlueScope
15	Galvalume Roof Sheeting / Galvalume Wall Cladding/ Flashing/ Gutter/ and Downspout	TATA BLUE SCOPE/ JSW/ META COLOUR/ Metecno/ LLOYD INSULATIONS/ INTERARCH
16	Duct Thermal & Acoustic insulation / AHU Rooms acoustic insulation, under-deck insulation	U.P.Twiga, Rockwool India, Lloyds, Owens Corning, Bakelite, Hylam, Beardshell, Malanpur Entech, ALP Aeroflex, Armacell, K- Flex, Polybond Insulation, Thermobreak, Paramount
17	Pipe Insulation	Beardshell, Lloyds, Bakelite, Hylam, Paramount, Armacell, K-Flex, Superlon, Malanpur Entech, Pplybond Insulation, FGP, UP Twiga, Rockwool India, Jayashree Insulators, ALP Aeroflex, Armaflex, Zeneith, Zeco or Equivalent
18	Coupling	Bibby (Wellman), Fenner, GBM
19	SS Sheets for duct	Jindal, SAIL, TATA, Bhushan, Ispat or Equivalent
20	Vibration isolators	DUNLOP, EMERALD, GERB, GETZNER

TECHNICAL SPECIFICATION

21	Grilles / Diffusers / Fire (Motorized) Dampers / VCD / Louvers	Ravistar, Dynacraft, Cosmos, Airflow, Caryaire, Airmaster, System Air, Ruskin Titus, Greenheck, Southern Cougen, Aquaflex, Vedha, Entech or equivalent
22	Actuators	Siemens, Belimo, Honeywell, Johnson Control
23	Fabricated Duct	Rolastar, Camduct, Ductmaster, Western Air Duct, ZECO, Vedha Entech, Radiant, Nutech, Spiro, Saiductfab, Ravistar, Ruskin Titus
24	Strip Heater / Pan Humidifier	Alco Heating, Das Pass, Rapid Control
25	3 way / 2 way Control Valve / Differential Pressure Control valve	Honeywell, Johnson Controls, Siemens, Advance, Sauter, Belimo, Danfoss, Flowcon, or Equivalent
26	Globe / Gate / Ball / Check Valves	L&T, Audco, IVC, Intervolve, KBL, Advance, Fouress, BDK, Honeywell or Equivalent
27	Butterfly Valves	Fouress, BDK, Intervolve, Audco, Advance, L&T, Honeywell or Equivalent
28	Balancing Valve	Honeywell, Advance, Castle, FlowCon, Audco or Equivalent
29	Float Valve	Leader Engineering, IVC, Levcon, Shiva Durga
30	Automatic Air Vent	Anergy, Rapid Control or equivalent
31	Y – Strainers / Pot Strainer	Honeywell, Emerald, Leader, Sant
32	Temperature / Pressure gauges	Ashcroft, Tedington, A. N. Instruments, Mass, Waree
33	Expansion Bellow	Flexican, Flexatherm, SUR Ind., GBM Mfg., TI Flexible Tube, Madras Hydraulics, Lonestar, Anup industries, Indo Thai flexible tubes, Cori, Easyflex
34	LT Panels (MCC / VVFD / HVAC Panels)	ABB, Siemens, Schneider, L&T, C&S, BCH
35	Motors	ABB, Siemens, CGL, Bharat Bijlee, Kirloskar
36	Local Push Button Station	BLEP/Flexpro/Flameproof Equipment / Pushton / L&T / ABB / SIEMENS
37	1.1 kV PVC/XLPE Cable (Power & Control)	Universal / Polycab / Finecab / Crystal / KEI / KEC / GEMSCAB
38	Chlorpyrifos	DE-NOCIL, Cyanamide, Bayer India Ltd, Bhagiradha Chemicals Ltd.
39	Ready Mix cement concrete	ACC Concrete, UltraTech concrete, L&T concrete or equivalent
40	Bitumen Impregnated Board	Shalitex, Sika or approved equivalent
41	Waterproof Ply	Green, Century, Duro, Marino
42	AAC Blocks.	BILT, JK, KJS
43	Expanded Polystyrene (Thermocole)	Beardshell, BASF or approved equivalent
44	Extruded Polystyrene	Iso board ND, BASF or approved equivalent

TECHNICAL SPECIFICATION

45	Commercial Quality White Glazed Ceramic Tiles	Kajaria, Somany, Jhonson
46	Structural Sealant	Wacker, Dow Corning, GE