

BEML LIMITED

A Govt. of India Mini Ratna Company under Ministry of Defence

BEML Rail plant Bhopal

TITLE

ROLLING STOCK MANUFACTURING PLANT

Engineering, Procurement & Construction pertaining to establishment of Rail coach factory including Civil Construction of manufacturing blocks, testing bay, other utility buildings (Non factory buildings), Railway Track sidings, water supply and distribution System, Roads, Drainage and sewerage systems, General Electric works including regular and emergency power supply and distribution system, related installations & services (Fire, Gas, Compressed air, IT, BMS, etc.), MFA (Miscellaneous fixed assets) and other Land & Site development works including grading, levelling works in connection with setting up of a Rail Coach Factory hereinafter referred as BEML RAIL HUB FOR ADVANCE MANUFACTURING (BRAHMA) near Umaria village, Obaidullaganj, District- Raisen, Madhya Pradesh (India) PIN code 464993 on EPC Mode

DESCRIPTION OF BUILDING / FACILITIES & THEIR BROAD SPECIFICATION

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MEP systems described below has design basis considering one manufacturing block envisaged in near future after 03 years

List of Facilities/Utilities/Buildings, Rail Plant-Bhopal

SL. No.	Facilities / Utilities / Buildings	Dimension	Type of Structure
1.	Car body Fabrication Block	400m x 72 m	Steel Structure (Conventional) / (Hybrid-combination of conventional & PEB)
2.	Car body Inspection & testing Bay	852m x 24 m	Steel Structure (PEB)
3.	Office complex (G+5)	75.6m x 18.9m	RCC
4.	Canteen building (Single Storey)	64.8mx56.4m	RCC
5.	Medical centre	28.8mx10.8m	RCC
6.	Multi-level Parking	61.6mx64.4m	RCC
7.	100 ft road Weight bridge & office	70 Ton	Hard stand
8.	Main Gate complex with Security office	59.1mx14.4m	RCC
9.	Gate complex for trucks with security office	18mx10.8m	RCC
10.	Gate complex at railway siding main gate complex with security office	8mx4.8m	RCC
11.	Fire station	32.4mx10.8m	RCC
12.	Water supply pump house	28m x 11m	RCC
13.	Fire water pump house & sump		
14.	Sewage Treatment Plant (STP) (100 KLD)	15mx13.5m	RCC
15.	Main Receiving Sub Station (MRSS) (33 KVA)	40mx12.5m	RCC/OPEN
16.	Emergency Power Supply System (EPSS)(750x2)	30mx30m	RCC

17.	Compressed air system (12 bar)	20mx12m	RCC
18.	Centralised gas bank (Acetylene + Argon)	40mx16m	RCC
19.	Safety office	25.2mx14.4m	RCC
20.	RO plant (Container based)	15mx10m	RCC
21.	Chiller plant	46.6mx16m	RCC
22.	Railway yard (BG) with OHE	4000 m	
23.	Toilet block & Rest room at parking area	7.6 m X13.6 m	RCC
24.	Traversers (75 Ton)	240m x 32m	RCC
25.	Traversers (75 Ton)	160mx32m	RCC
25.	Raw material storage yard	50mx40m	(Hard Stand)

Note: Facilities' dimensions mentioned at SI No 1 & 2 are center to center whereas for all other facilities it is out to out.

For further Details Refer Drawing for Area, dimensions, Elevation & cross-section.

1. FUNCTIONAL DRAWINGS AND DETAILS

BEML intent to set up world class state of the Art Car body manufacturing facilities at Bhopal to meet the requirement of various types of Car/Coaches both in India as well as overseas.

The objective of this Assignment involves manufacturing of the following type of Car/Coaches to meet the requirement at present & Future:

- (a) Vande Bharat (Both sitting & Sleeper Coaches) & LHB coaches: 400 Coach per Annum
- (b) Metro Car: 400 Coach per Annum
- (c) High Speed Aluminium Coaches: 400 Coach per Annum

The aim of this assignment is to produce 1200 Coaches/Car per Annum.

In order to carry out the above mammoth requirement, the following major technological facility has been considered for the way forward:

- (a) Car Body Fabrication & Assembly line facility
- (b) Car Body Inspection & Testing line facility.
- (c) Inter plant Traverser

The above main technological facility has been planned in one zone which is designated as zone

1.1 BUILDING FUNCTIONAL DESIGN

1. General

Based on the Preliminary engineering undertaken at Bhopal Project site, the building functionality has been derived considering the optimum use of land to achieve the production target of 1200 coaches per Annum.

While designing the Building Functionality lean engineering concept has been introduced for the development of a World class manufacturing facility.

The entire Car body manufacturing area has been divided into 3 functional areas namely Car body Fabrication & Assembly line facility and Car body Inspection & Testing line facility and Inter Plant Traverser.

2. Starting Point for functional Design

2.1 Car Body Fabrication & Assembly line facility:

Considering the Production requirement for the next 10 years, it has been proposed to develop 1 Nos. Car Body Fabrication & Assembly line facility with a provision for 1 Nos. as Future. Each Manufacturing line will have dimension of 400m X 72 m. A road of 8-10m (will be finalised) has been proposed in between the Production line for the logistic support and to meeting the Fire safety norms.

The Plant offices for the above Manufacturing line has been attached as Annex building by the side of the Fire exit staircase for optimum utilisation of spaces.

Phase wise construction of Car Body Fabrication & Assembly line facility is as follows:

- Phase 1: 1 No. (Building Size: 400m X 72m)

2.2 Car Body Inspection & Testing line facility:

Considering the Production requirement, it has been proposed to develop 1 No. Car Body Inspection & Testing line facility having a dimension of 852m X 24m in phase-I with a provision to construct Car Body Inspection & Testing line facility as Future. A road of 10m has been proposed in between the Production line for the logistic support and to meeting the Fire safety norms.

Phase wise construction of Car Body Inspection & Testing line facility is as follows:

- Phase 1: 1 No. (Building Size: 852m X 24m)

3. Design Procedures Adopted

- While designing the building configuration lean engineering concept has been introduced for optimum utilization of space.
- Roof top solar panel has been proposed as a green building & sustainability measure.
- Sleek DG EOT cranes has been proposed for optimum utilization of spaces.
- Multi-layer production facility has been proposed for better efficiency and space utilisation.
- Extensive utilization of MHE for better logistic support.

1.2 BUILDING:

Building List.

S.No.	Name of facility	Zone	Facility Numbering
1)	Car body fabrication & Assembly line facility -01	01	01A
2)	Car body fabrication & Assembly line facility -02	01	01B
3)	Car body fabrication & Assembly line facility -03 (Future)	01	01C
4)	Car body fabrication & Assembly line facility -04 (Future)	01	01D
5)	Car body Inspection & Testing line facility-01	01	02A
6)	Car body Inspection & Testing line facility-02 (Future)	01	02B
7)	Car body Inspection & Testing line facility-03 (Future)	01	02C
8)	Inter plant Traverser	01	21

2. FUNCTIONAL DESIGN APPROACH

2.1 CAR BODY FABRICATION & ASSEMBLY LINE FACILITY:

This manufacturing line consists of 2-layer production facility. The 1st floor is designated for the fabrication and Assembly line facility for Car body. The following major activities has been envisaged in 1st floor:

❖ 1st floor Bay 1:

This is one of the crucial functional bays for the Car body manufacturing facility. Major highlights of this bay are:

- 1) This bay is having configuration of 400m X 24 m
- 2) This bay is envisaged with 10T/2T DG EOT crane with a clear height of lift as 12m.
- 3) An opening of 25m X 6m has been made in one of the bays ends (between column axis No. 1 & 3) for the lowering of the Car body shell to ground floor post assembly at first floor. A hydraulic lift has been envisaged for lifting and lowering of the car body shell.
- 4) This bay has been provided with centralised compressed air facility at regular interval between the column so that tapping can be made at any point to meet the compressed air requirement.
- 5) This bay has been provided with centralised gas line facility at regular interval between the column so that tapping can be made at any point to meet the gas requirement.

- The major functional area of this bay is as follows:

A. Under frame fabrication facility

1. Major functional areas under this segment are Underframe welding facility, Buffer storage for underframe, underframe skin welding facility, Underframe Assembly facility, underframe welding fixture facility, Underframe sub assembly storage facility.

2. Major functional equipment envisaged are standby idle jig, manual MIG/TIG welding, Wire feeder, seam welding machine, C-gun, welding controller with software, cooling unit, Robot gantry system, Jig fixture, grinding tools, Mechanic reverse table.

B. Roof fabrication facility

1. Major functional areas under this segment are Roof keystone seam welding facility, Roof Skeleton Composition (Dome+ Flat+ Cantrail) MIG Welding Cant Rail Sub Assembly, Roof Cantrail Sub Assembly Fixture Tack Welding, Roof Cantrail Skeleton Adjustment Stage, Roof Cantrail Spot Welding (skin+ skeleton, Flat Roof Skeleton, Flat Roof Adjustment, Flat Roof Spot Welding, Robot Gantry Spot Welding, Roof Assembly Spot Welding etc.
2. Major functional equipment envisaged are Seam welding, MIG welding, Tack welding, Roof preparation area, Spot welding etc.

C. Car body assembly welding facility

1. An area of 70m X 10m has been earmarked for the Car body assembly welding facility. There shall 2 arrangement station, out of which one will be at the welding position for the preparation of Car body shell and the other stations will be at preparatory position for welding. EOT cranes will be utilised for the lifting and lowering of the car body shell. Piped gas line and compressed air facility has been planned at columns and can be drawn to the consumer points.

D. Paint shop facility

1. An area of 30mX6m has been earmarked for the Paint shop facility along with Car body shell movement area of 25mX4m. This paint shop is semi-automatic containerised paint shop. A winch system shall be embedded with the Paint shop for the movement of car body shell inside the paint shop.

E. Water leakage testing/inspection facility

1. An area of 30mX6m has been earmarked for the Water leakage testing/inspection facility along with Car body shell movement area of 25mX4m. This facility is closed loop water supply system with RO water will be used for the water leakage testing. A winch system shall be embedded with this testing facility for the movement of car body shell inside the Water leakage testing/inspection facility.

• 1st floor Bay 2:

This bay is exclusive for warehouse facility specifically to store all the items pertaining to the Fabrication Bay. Major highlights of this bay are:

1. This bay is having configuration of 400m X 24 m.

2. This bay has been compartmentalised broadly in 2stage i.e., the heavy equipment will be stored on floor and the smaller equipment below 1 ton shall be stored in racks of various type such as heavy storage rack, medium storage rack and light weight storage rack.
3. The racking shall be both in the form of Pallet as well as in bin capability to store long items with length up to 6m.
4. No EOT crane has been envisaged in this bay. However, the material will be stacked by means of Articulating forklift.
5. An opening of 25m X 6m has been made in one of the bays ends (between column axis No. 1 & 3) for the lifting/lowering of the equipment to the first floor for storage.
6. This bay has been provided with different type of racking system for the storage of all the inventory required for the Fabrication activities.

- **1st floor Bay 3:**

This is also one of the crucial functional bays for the Car body manufacturing facility. Major highlights of this bay are:

1. This bay is having configuration of 400m X 24 m
2. This bay is envisaged with 10T/2T DG EOT crane with a clear height of lift as 12m.
3. An opening of 25m X 6m has been made in one of the bays ends (between column axis No. 1 & 3) for the lowering/lifting of the equipment to first floor by means of hydraulic lift.
4. This bay has been provided with centralised compressed air facility at regular interval between the column so that tapping can be made at any point to meet the compressed air requirement.
5. This bay has been provided with centralised gas line facility at regular interval between the column so that tapping can be made at any point to meet the gas requirement.

- The major functional area of this bay is as follows:

A. Side wall fabrication facility

1. Major functional areas under this segment are side wall skeleton welding fixture, side wall skeleton heat adjustment fixture, Side wall tack welding, Side wall spot welding, Side wall inspection, pass/fail status area,
2. Major functional equipment envisaged are side wall skeleton welding fixture etc.

B. End wall fabrication facility

1. Major functional areas under this segment are side End wall skeleton weld, skin welding & inspection, End wall spot welding.
2. Major functional equipment envisaged are skeleton welding, skin welding & inspection & spot welding.

C. Cabin fabrication facility

1. Major functional areas under this segment are Cabins structure welding, Cabin inspection, cabin overall welding.
2. Major functional equipment envisaged are Cabin structure welding & cabin overall welding.

The Ground floor is designated for the Furnishing line facility for Car body. The following major activities has been envisaged in Ground floor:

- **Ground floor Bay 1:**

This is one of the crucial functional bays for the Car body manufacturing facility. This bay is exclusive designated for Car body furnishing.

Major highlights of this bay are:

1. This bay is having configuration of 400m X 24 m
2. This bay is envisaged with 25T/5T DG EOT crane with a clear height of lift as 12m.
3. An area of 25m X 6m has been earmarked between column axis No. 1 & 3 for the positioning of Hydraulic lift required for lowering of the Car body shell to ground floor post fabrication & assembly at first floor.
4. This bay has been provided with centralised compressed air facility at regular interval between the column so that tapping can be made at any point to meet the compressed air requirement.
5. A high-pressure compressor (pressure 12 bar FAD 100 cfm) has also been proposed for the pipe pressure testing & for the braking system.
6. 2 in No. Combination track (both Broad gauge & standard gauge) of length of 50 m has been earmarked at the other end of Furnishing Bay for the buffer storage and to transport the Car body to inspection & testing bay via Traverser. A pit of 1.5 m clear height has been envisaged within the track bay. This has been earmarked for the Car body underframe fittings installation & inspection.

- The major functional area of this bay is as follows:

A. WATER TIGHTNESS TEST

1. Car body stage & fully furnished car stage Two Water Tightness Test Gantries with 240 water spraying nozzles to spray water at 2 bar pressures at discharge rate of 7.4 lit/min/nozzle as per IEC 61133 standard are available conduct Rain test and ensure cars are leak proof. RO water will be used to conduct this water tightness test. The water used to perform this test will be used again by means of closed loop recycle mode. Make up feed arrangement has been envisaged for the top up of RO water losses due to evaporation and other losses during operation.

B. Under frame fabrication facility

1. Major functional areas under this segment are Anti-drumming facility, Glass wool installation, Floor board installation, Cable cutting & Harnessing, Floor covering, Air duct

- installation, Window glass installation, Roof cable duct installation, Internal Electrics, Upholstery, Under gear equipment assembly, Bogie trucking & Roof equipment installation
2. Major functional equipment envisaged are Anti-drumming facility for underframe painting, cable harnessing equipment, Car Internal Electrics equipment, HVAC equipment, Upholstery equipment, Under gear assembly equipment etc.

C. BOGIE LOAD TESTING

1. A 40 Tons capacity Bogie Load testing facility used to measure various Bogie Design parameters under loaded condition.

• **Ground floor Bay 2:**

This bay is exclusive for warehouse facility specifically to store all the items pertaining to the Furnishing Bay. Major highlights of this bay are:

1. This bay is having configuration of 400m X24 m
2. This bay has been compartmentalised broadly in 2 stages i.e. the heavy equipment will be stored on floor and the smaller equipment below 1 ton shall be stored in racks of various type such as heavy storage rack, medium storage rack and light weight storage rack.
3. The racking shall be both in the form of Pallet as well as in bin capability to store long items with length up to 6m.
4. No EOT crane has been envisaged in this bay. However, the material will be stacked by means of Articulating forklift.
5. An area of 25m X 6m has been made in between column axis No. 1 & 3 for the lifting/lowering of the equipment to the first floor for storage by means of Hydraulic lift.
6. This bay has been provided with different type of racking system for the storage of all the inventory required for the Furnishing activities.

• **Ground floor Bay 3:**

The functionality of this bay is same as Ground floor Bay 1.

2.2 CAR BODY INSPECTION & TESTING LINE FACILITY:

This inspection cum testing bay is a ground floor structural building with Centre-to-Centre dimension as 852m(L)x 24m(W) with a clear height of 10 m. No EOT crane has been envisaged in this building. The entire inspection & testing bay is embedded with 2 nos. Combination track (i.e., combination of broad gauge and standard gauge) in the entire length of the bay for the movement of Metro car and other non-Metro car from Fabrication & Assembly line facility to the Car body inspection & testing line facility and from Car body inspection & testing line facility to the dispatch bay. Each track will have an inspection pit of clear size 1.4m(D)x3m(W).

A. STINGER BOX

A 750 V DC power supply Stinger box has been envisaged inside the Car body inspection bay for the testing facility for Metro car.

B. 25KV TESTING TRACK

A 25 kV AC power supply has been envisaged inside the Car body inspection bay for a distance of 210 m for the testing facility for Commuter rails.

C. INSULATION AND DIELECTRIC TEST

In order to check the Insulation resistance and high voltage withstanding capacity of the Insulation part of Cables. The said equipment checks the insulation resistance via insulation tester and passes the various high voltage for various class of cables as per the IEC standard for 60 Sec and the leakage current value to be within the range.

D. EARTH AND RETURN CONNECTION TEST

To ensure the Earthing system of all the sub systems and Individual car earthing and return path are as per standard.

E. VEHICLE CONTROL CIRCUIT TEST

This test is performed to check the following parameters:

1. The vehicle Control and Safety interlocks of train are as per the design via various Simulations.
2. Interlocks with Brake system, Converter Inverter, Horn, lighting system, Speed Control (Static), Pantograph, Static Inverter System, Door System, Signalling System, Shore Supply, Failure of APS via Simulation, Battery system, PAPIS systems, Coupler system, Rescue Operations etc.

F. HVAC TEST

This test is performed to check the following parameters:

1. To ensure the functionality of various modes of operation of HVAC viz Cool1, cool2, Emergency mode, External and Internal Smoke detection etc.
2. To check the quality of return air viz return air temperature, Humidity and airflow distribution in Saloon area.
3. To check the functionality of Dampers.
4. To check and record the Software Versions etc.

G. WHEEL FLANGE LUBRICATION TEST

The following parameter are checked under wheel flange lubrication test:

1. Oil Level in the tank.
2. Functionality of Wheel Flange and Top of Rail Lubricator System.
3. Spray time in Various Modes.
4. Alignment of Nozzles with the wheel flange and top the Rail.

H. CAR WEIGHING & KINEMATIC ENVELOP CLEARANCE TEST:

This test is performed considering the car Weighing System with 8 Load cells (One for each wheel of 2 Bogies) and 80 Ton capacity measures the total weight of the finished car with 10 Kg accuracy.

Exterior clearances of the car body are ensured in a Kinematic Envelope gauge installed on the track.

I. DOOR SYSTEM TEST

In order to check the functioning of the Door system, the following operations of Door system is checked:

1. Smooth opening and closing of doors.
2. Critical Door dimensions.
3. Closing and opening time.
4. Emergency egress and access.
5. Operation of Door Indicator lamps.
6. Opening and closing Time.
7. Pull Force Exerted on Door leaves while closing and opening.
8. Obstacle detection while door closing operation.
9. To check and record the Software versions etc.

J. PASSENGER ALARM AND PUBLIC INFORMATION TEST

This activity is performed using the following operation:

1. Public Announcement to Passengers.
2. Emergency Communication between passengers and Drivers.
3. To Check Various Displays Viz Dynamic Root map, Public Information Displays, Train Number Indicators, Destination indicator displays etc.
4. To Check the communication between Master Cab and Driver cab.
5. To check and record the Software Versions etc.

K. CCTV TEST

This activity is performed using the following operation:

1. Camera Displays on CCTV POE Screen.
2. Orientation of Cameras.
3. All Cameras Functioning Viz Saloon Camera, Roof Camera, Side Exterior Cameras, Obstacle detection camera, Front Camera, Track Camera etc.
4. To check the Data Recording System and retrieve the recorded video and Audio file.
5. Data Password protection in Data retrieving System.
6. To check and record the Software Versions Etc.

L. CONVERTOR INVERTER TEST

This activity is performed using the following operation:

1. To Check The fitness of the various internal Functional Cards of CI.

2. To Check the Input Supply and the required Output Supply with respect to various modes of operation.
3. Powering and Braking Commands available at Input and Output of CI.
4. To check the Load weight, signal available to CI.
5. To Check the output Signals with respect to PWM or Equivalent Signals.
6. Functioning of Protection System of CI.
7. To check and record the Software Versions Etc.

M. STATIC INVERTER TEST / APS TEST

This activity is performed using the following operation:

1. To Check the fitness of the various Internal Functional Cards of SIV.
2. To Check the Input Supply from Main Transformer and the required Output Supply to the corresponding various Circuits viz Three Phase AC, Single Phase AC, 110 V DC etc.
3. To check the Functionality of Battery charger.
4. Functioning of Protection System of Convertor Invertor.
5. To check and record the Software Versions Etc.

N. TRAIN CONTROL AND MONITORING SYSTEM (PCMS TEST)

This activity is performed using the following operation:

1. Input power Supply of various TCMS System viz RIO, Event Recorder, Control and Diagnostic Unit, POE Switches etc.
2. Software version checks of Various Sub Systems of TCMS.
3. Ethernet Communication within TCMS and Other Sub systems (viz. Propulsion, Door, brake etc.) of the Train.
4. Digital Inputs and Digital Outputs of TCMS System.

O. FIRE DETECTION TEST

This activity is performed using the following operation:

1. Fire and Smoke Sensor Functionality Via Simulation.
2. Functionality of Passive Linear Heat Detector Device.
3. Interlock with HVAC.
4. Availability of Smoke and Fire warning to TCMS system.
5. Addressing of the sensors Located at Various locations in the Train.
6. To check and record the Software Versions Etc.

P. WHEEL FLANGE LUBRICATO TEST

This activity is performed using the following operation:

1. Oil Level in the tank.
2. Functionality of Wheel Flange and Top of Rail Lubricator System.
3. Spray time in Various Modes.
4. Alignment of Nozzles with the wheel flange and top the Rail.

Q. BRAKE PNEUMATIC TEST

This activity is performed using the following operation:

1. Brake Piping and Valve Installations.
2. Compressor Operations.
3. Operation of Various Valves.
4. Operation of Safety Valves.
5. Operation of Pressure governors.
6. Operation of Anti-Skid Valves.
7. Pressure Values of Various Sub systems of brake system.
8. Application of Various Brakes Viz Service Brake, Emergency Brake, Parking Brake Etc.
9. Communication with TCMS System, BECU and Converter Inverter etc.

R. BRAKE ELECTRONICS TEST

This activity is performed using the following operation:

1. Communication within BECU systems
2. Communication with CI and Various Sub systems.
3. Pressure Values Viz MR pressure, BC Pressure, Load Pressure (T Pressure), CV pressure etc.
4. Various Braking Commands (Service Brake, Emergency brake, Dynamic Braking) Depending on the mode of Operation
5. BECU Major and Minor faults.
6. Dump Valve Operation.
7. BECU Bus communications.
8. Resistance Check of the Shields of Communication and Shield wirings etc.
9. Communication with TCMS systems.
10. Software Versions check. etc.

S. RUN TEST

This activity is performed using the following operation:

- a. Smooth rotation of wheels.
- b. Direction of rotation of wheels
- c. Current values of the traction motor, if available.
- d. Hustler mode operation, If available.
- e. Direction of operation (FWD & Rev).
- f. Various Door, obstacles detection, SCS switch, operation of Emergency Switches etc.
- g. Application of various Brakes during Dynamic operation of the train.

2.3 INTER BAY TRAVERSERS:

2-Nos. Traversers has been envisaged under this project.

- 1-No. 75-Ton capacity Traverser has been planned between Car body manufacturing & Assembly line facility. The traverser will have area of 240mX32 m.
- 1 No. 75-Ton capacity Traverser will have area of 160m X 32m has been planned within the Car body Inspection & testing bay for the transfer of car/coaches from bays to the dispatch bay.

There is 2-Mode of designated dispatch bay. The Vande Bharat & LHB coaches will be dispatch from the Northern side of the inspection & testing bay by means of railway track and Roads.

The Metro & High-speed AI coaches will be dispatch from the eastern side of the inspection & testing bay by means of surface transport. A goliath crane has been proposed for lifting and lowering of the car from the dispatch bay to the trailer. Laying of combination track(BG & SG) between two traverser for ease and smooth movement of goliath crane.

2.3.1 TRAVERSER

GENERAL

The scope covers design, supply, installation, testing and commissioning of electrically operated traverser along with standard accessories and items required to make traverser fully functional for traversing of rolling stock.

BROAD PARAMETERS

- a) Traverser should meet broad technical parameters detailed hereunder.
- b) Traverser Pit type, Capacity 75T
- c) VVVF drive: step less speed for all motions
- d) Class of Duty M6, for outdoor operation
- e) With hauling mechanism
- f) rail/ rectangular bar runway tracks
- g) Length of traverser and rail/ rectangular bar-24m excluding length of tongues. Length of tongue applicable in case of Surface Traverser. Traversing speed 0-40 m/min. Traverser controls from cabin and RRC.
- h) Rolling stock to be handled by traverser: coaches, Broad Gauge 1676 mm, Standard Gauge 1435 mm & cape gauge 1067mm, width 3660 mm maximum, height 4265 mm maximum from rail level, length 24000 mm maximum and weight 60T maximum.
- i) Top of traverser rail/ rectangular bar should be same as top of shop rail level (Applicable for hauling mechanism) Traction force required on winch to pull two rolling stocks at a time, rope speed 20-30 m/min, length of wire rope 125 m (Applicable for Pit traverser) Depth of pit from top of traverser rail to top of runway track 350 mm maximum.
- j) surface type traverser or any other design meeting functional requirement can also be proposed.

Standard mandatory spares shall also be supplied along with traverser list.

SCOPE

The scope covers traverser complete in all respect along with necessary accessories and items detailed hereunder to make traverser fully functional.

- a) Supply and fixing of rail/ rectangular bar runway tracks with check/ guard rails, fittings etc for movement of traverser for entire length as specified in layout drawing including civil foundation. Bidder should visit site to assess local conditions and incorporate any special requirement in design of traverser. Bidder should provide necessary foundation design for BEML approval and release of drawing for construction.
- b) Supply and fixing of DSL shrouded type complete with supporting masts, brackets, insulators main current collection gear, power-disconnecting switch immediately after

- the main current collection gear for entire length as specified in layout drawing.
- c) Bidder should provide complete earthing on traverser portion and DSL support masts with earthing connection as per IE rules.
 - d) Scope covers power supply, necessary spares, inspection and test certificates, installation and commissioning, documentation, training and warranty etc.
 - e) Supply of maintenance tools & tackles for each traverser: tool box containing all necessary tools like torque wrenches, portable hydraulic jacks of suitable capacity, hand grease gun, set of spanners, screw drivers, nose pliers, hammer, Allen keys of required sizes etc as required for the maintenance of traverser.
 - f) Portable skids- 4 numbers for each traverser
 - g) Hydraulic lifting jacks- 4 numbers for each traverser

CODES AND SPECIFICATIONS

Traverser should be designed, manufactured, erected, tested and commissioned in accordance with IS codes and specifications detailed hereunder or equivalent international standard like DIN.

- a) IS 3177-1999 (latest) Code of practice for EoT traversers and gantry traversers
- b) IS 807-2006 (or latest) Design, erection and testing (structural portion) of traversers and hoists
- c) IS 2266-2002 (or latest) Steel wire ropes for general engineering purposes
- d) IS 3938-1983 (or latest) Electric wire rope hoists
- e) IS 15560-2005 (or latest) Point hooks with shank up to 160T
- f) IS 2760-1980 (or latest) Steel chain slings.
- g) Traverser structure and parts of traverser mechanism should conform to class of duty specified as per IS 807-2006 (or latest)

If any condition mentioned in this specification is at variance with that of IS standard, technical specification hereunder shall prevail.

DESIGN FEATURES

Traverser should be designed as per codes and specifications (or equivalent international standard like DIN) and broad technical parameters, detailed herein above. Traverser should comply with relevant safety regulations under the Factories Act, Indian Electricity Rules and other statutory regulations as applicable. Traverser shall be manufactured and erected to tolerances:

- a) Span over LT wheels ± 6 mm
- b) Diagonal on wheels ± 5 mm
- c) LT wheel alignment ± 1 mm

Traverser should be simple and compact design with equipment and controls conveniently located to facilitate easy access and maintenance. Controls should be interlocked to prevent accidental movement. Electrical controls and motors should be protected from rain and water logging in pit. Suitable limit switches should be provided to stop over travel of traverser.

Suitable guards or enclosures should be provided to prevent inadvertent contact with DSL or other exposed electrical conductors and cables. Suitable isolation switches and stop buttons should be provided to isolate electric supply for maintenance and or in case of an emergency. Components and equipment provided below platform shall be accessible by opening hinged cover for maintenance.

Open gears should be avoided in wire rope handling area to prevent entangling of wire rope with moving parts. Electrical and mechanical equipment should be protected with weather proof covers, which could be easily removed. Electrical cables should be laid to prevent damage and could be easily inspected and maintained.

Suitable jacking pads should be provided on each four corners of bridge along with four hydraulic jacks of suitable capacity for jacking of traverser. Traverser bridge should be provided with safety stops to prevent traverser from falling more than 25 mm in case of breakage of track wheels or axle. These safety stops should not interfere during removal of wheels. Square/ rectangular bar/ rails should be provided on bridge platform for placement of rolling stock. Suitable skids should be supplied along with traverser to prevent rolling of rolling stock.

Traverser platform covered with chequered plate should have adequate clearances, minimum 600 mm, on all sides after placement of rolling stock. Spring-loaded buffers having contact surface not less than 125 mm diameter should be bolted on four corners of traverser and should have energy absorption capacity for stopping traverser in either direction travelling at speed of at least 40% of maximum rated speed with full load. Safety hand railing of tubular construction should be provided on bridge foot walk staircases, landing in cabin etc where access has been provided. Operator's cabin should have easy access and provide unobstructed view of movement of rolling stock. Cabin should accommodate electrical equipment. Cabin should be double walled construction for roof and side panels (except for glass panel) with thermal insulation. Operator should be able to operate traverser in sitting/ standing position. Cabin should have fan, lighting, fire extinguisher for electrical fire etc. Mirrors shall be provided to assist in viewing.

Scope covers supply of DSL and current collection gears shrouded and color-coded four bar DSL system of suitable rating. Current carrying shunts from collectors should avoid contact with adjacent collectors and ensure operation during rain. Current collectors should be provided with multi-strand 1.1 kV grade PVC insulated cables. Armoured weatherproof 1.1kV grade copper cable of adequate size shall carry current from junction box to isolating switch near current collector on control panel of traverser. Current collector shoe should be sintered copper graphite material. Current collector should have stainless steel arms and stainless-steel spring for pressurized contacts to withstand variation of +100 mm in vertical and horizontal plane. Shrouded bus bar system should be complete with all accessories like end caps, joint covers, power feed kit, jointing tool etc. Bus bar should be protected by galvanized MS hood on top to protect from rain. opposite side when rolling

stock is standing on bridge platform.

Monorail with hoist should be provided to facilitate dismantling / lifting of equipment for repair / maintenance. Alarm should be provided to caution workers. A continuous ringing alarm should be provided for LT motion. Controls should be interlocked to prevent accidental movement of traverser. Suitable limit switches for LT should be provided to stop and to prevent over-travel. A mushroom head type push button shall be provided in operator's cabin so that main incoming circuit breaker can be tripped in emergency condition by pressing operating head. Pilot lamp in control circuit shall glow when any switch is operated. AC variable frequency control (VVVF) for LT should be used by using independent variable voltage variable frequency drives. Common controller for both LT motors may be used. LED lighting should be provided in operator's cabin, staircase etc. Bulkhead fittings with dust proof covers should be used for above areas.

Traverser should be illuminated with LED lights for night operation. Traverser should be fitted with built-in inching device for LT and winch movement for accurate positioning of traverser for loading/unloading of rolling stock. Compact geared motors on LT should be provided with built in electromagnetic fail-safe disc brakes with braking torque not less than 100% of full load torque. Labels of a permanent nature should be provided on switches, fuses, contactors, relays, panels, controllers, resistors etc to facilitate identification of circuits. Earthing should be affected through fourth conductor of DSL and structure. Electrical equipment mounted should be connected to structure by means of electrical earthing links

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 traverser.

- a) Radio remote control shall be provided in addition to main control system through pendent/master controller.
- b) 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 traverser to change frequency or address), two dual axis joysticks, range 100 m, 16 strap for transmitter slinging etc.
- c) Receiver of radio remote control should meet features like power interruption protection, relay's contacted failure detection circuit, shock resistance mounting provision, impact durability up to 20G, external integrated antenna, enhanced watchdog circuit, FDDI (frequency deviation detection indicator) tracing circuit, signal alarm, light and E-stop button etc.

3. ARCHITECTURAL WORKS

3.1 INTENT OF THIS DOCUMENT

This chapter provides the Preliminary Concept plans of Technological and Non-technological buildings which are to be constructed in Greenfield Rolling Stock Manufacturing Plant of BEML at Bhopal.

This document also contains details of finishes such as painting, flooring, doors, windows, false ceilings, railings, partitions, toilet fixtures etc. which are to be followed in all the buildings (Technological and Non-Technological Buildings).

The write up of all buildings which describes the design considerations to be followed during design of building.

3.2 METHODOLOGY OF DESIGN

The following codes are to be followed in the design of the buildings

1. National Building Code 2016
2. Relevant IS Codes
3. Local Bye – laws
4. Aviation Department Rules
5. Fire Departments Standards / Regulations

4. LIST OF FACILITIES

The Following Facilities are being considered.

4.1 NON-TECHNOLOGICAL BUILDINGS:

1. Office Complex
2. Canteen Building
3. Medical Centre
4. Safety Office
5. Fire Station
6. Main Gate Complex with security Office
7. Gate complex for material movement with security office.
8. Gate complex for Railway Siding
9. Multilevel Parking

4.2 TECHNOLOGICAL AND UTILITY BUILDINGS / FACILITIES:

1. Car Body Fabrication & Assembly Line Facility
2. Car Body inspection and testing Bay
3. Water Supply and Fire water pump house
4. Electrical Substation+ EPSS
5. Centralised Gas Bank
6. Chiller Plant
7. Road Weigh bridge and office
8. STP
9. Raw Material Storage Yard
10. Traverser
11. Goliath Crane.

5. DESCRIPTION OF NON-TECHNOLOGICAL FACILITIES

5.1 BUILDING DESIGN CONCEPT

Occupant comfort in buildings is crucial for a positive living or working experience. Biophilic architecture has become a key design strategy in improving occupant comfort. The core idea behind biophilic design is to integrate natural elements into architectural spaces to create a stronger connection between people and the natural. This connection is known to enhance well-being, reduce stress, and improve productivity.

It is hence proposed to provide building designs with “BIOPHILIC ARCHITECTURE”

5.2 GREEN BUILDING

The need for Green Buildings arises from the requirement to create a sustainable built environment that minimizes environmental impact while enhancing human well-being.

5.2.1 ADVANTAGES OF GREEN BUILDINGS

- Lowering of Carbon foot Print
- Significant savings on energy and water.
- Low-VOC paints reduce health issues and increases occupant comfort
- Improves mental health, focus, and productivity due to presence of ample Natural lighting and ventilation.

5.2.2 GREEN RATING SYSTEM

In India, "Green Rating" refers to the evaluation and certification of buildings, companies, and industries based on their environmental sustainability practices. These ratings are awarded by various organizations to promote energy efficiency, resource conservation, and reduced ecological impact.

The following are the types of Rating system available in India

1. IGBC – Developed by CII (Confederation of Indian Industry)
2. GRIHA – Developed by MNRE and TERI
3. GRIHA 3-Star rating has been made mandatory for all new central government buildings and public sector undertakings (PSUs) in India. This requirement was announced in 2010 by the Ministry of New and Renewable Energy.

Hence, all non-technological buildings shall be planned and constructed as a GRIHA rate/certified building with minimum GRIHA 3-star rating.

The Designs are to be complied with all the standards such as orientation of building, building materials, energy usage etc. shall be as per GRIHA Manual.

6. SPECIFIC DESCRIPTION OF FACILITIES

6.1 OFFICE COMPLEX:

The building is a G+5 Configuration (RCC type) which can accommodate 170 occupants. Total Built up area is 5338 Sqm equipped with Fully centralised air-conditioning facility. This

building suite is BMS compliance building. Solar heater on the roof top has been provisioned for supply of hot water.

This building is conceived as an iconic structure and will serve as the face of the BEML's facility. It is designed to accommodate approximately 170 occupants. This facility shall be RCC Framed structure with Ground + 5 Floor configuration. It includes a variety of functional spaces such as:

- Canteen
- Covered parking for senior executives
- Discussion rooms
- Welfare facilities including indoor games, reading rooms, gym, and open gathering spaces.
- Office spaces for various departments (HR, Admin, Purchase, Accounts, Plant In-Charge, Director, CMD's Office cum Lounge).

The layout has been consciously designed with key areas such as the office spaces, canteen, and discussion rooms arranged around a central water body (Triplex), providing both visual appeal and functional connectivity.

The infill material shall be AAC (Auto-Cleaved Aerated Concrete) blocks. All the External walls shall be 200 mm thick AAC blocks. The overall size of building shall be 22m x 36m Approximately. The approximate plinth area shall be 750 Sqm. Overall height of each floor shall be 3900 mm.

OFFICE SPACE DESIGN GUIDELINES:

- **CABINS:**

The Cabins shall be provided with 100 mm thick gypsum dry wall partitions as per requirement to provide flexibility in design. All cabins shall be provided with false ceiling. The area of each cabin shall be a minimum of 17 SQM. The minimum width of cabins shall be 3000 mm The depth of cabin shall be Minimum 4500 mm.

- **CORRIDORS:**

Corridors in office spaces shall be minimum of 1500 mm. All rooms shall be provided with adequate lighting and ventilation as per NBC.

- **BUILDING FAÇADE:**

The facade of the building has to be aesthetically designed. Under no circumstances the utility pipes shall be visible on the main façade.

Grooves in plaster shall be planned at the intersection of RCC elements with masonry work. (Beam wall junctions and wall column junctions). Facade is to be aesthetically appealing and combination of different treatment such as dry-stone cladding, ACP (aluminium composite panel), Rustic textured paint, Exterior grade acrylic emulsion paint. Etc., should be planned in consultation with BEML before execution.

All the beams in Balconies shall have seamless soffit. There shall not be any undulations / variations in the depth of beams planned.

6.2 MEDICAL CENTRE

This facility shall be RCC Framed single storeyed structure. The infill material used shall be AAC blocks. The Overall size of the building shall be 29 m x 10.8m approximately. The approximate plinth area shall be 300 Sqm. The Overall floor height shall be 3900 mm. The building shall have the following minimum facilities.

- Lobby
- Waiting Area
- Consultation Room -2 Nos
- Clinical Test Room
- Treatment Room
- Minor OT
- Recovery rooms
- Toilets
- Utility Rooms

6.3 CANTEEN BUILDING:

Canteen Building has been proposed in strategic locations for the breakfast, lunch, evening snacks & dinner for the personnel / workers working inside the plant premises.

This facility shall be RCC Framed single storeyed structure.

The size of the building shall be 65m x 56 m.

The approximate plinth area shall be 3015 Sqm. Equipped with Fully centralised air conditioning facility. which can accommodate the spaces such as Dining area for 800 occupants, (200) BEML Executives, (200) BEML Workers & (400) Contract workers, cooking area, separate preparation area, cooking area, storage for grains, washing area, hand wash area with toilets etc. adequate cooking equipment's is to be planned / procured. Kitchen Equipment's is a specialized subject, hence the cost of the same is not considered in this document.

This building shall be planned with adequate number of toilets and Shower as per NBC Guidelines.

6.4 SAFETY OFFICE

The functionality of the safety office is to provide a general training on the safety inside the manufacturing plant. The overall building is a ground floor RCC building of size 18m X 15m. The building accommodates the following facilities:

- Office area
- Conference hall
- Waiting area

6.5 FIRE STATION:

This facility shall be RCC Framed single storeyed structure. The infill material used shall be AAC blocks. The Overall size of the building shall be 27m x 12m approximately.

The building shall be planned for accommodating 2 no of fire tender with one bay for inspection. The Overall height of Building for Main fire station part shall be 3900 mm (10.8x12m) and for Fire Brigade area (Parking and inspection area) the same shall be 6000mm (16.2x12m).

The building shall have the following minimum facilities.

- Foyer
- Main Fire Station
- Fire Tender Parking Bay – 2 No
- Inspection Bay – 1 No
- Crew Rest Room
- Toilet

6.5.1 FIRE FIGHTING SYSTEM:

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.

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.

6.5.2 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

6.5.3 FIRE WATER PUMPS & ACCESSORIES

General

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

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)	Qty
1	Electric Driven pump	171	88	3
2	Diesel Driven pump	171	88	2

3	Jockey pump	18	88	2
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Reference of Drawings

The P&ID Diagram of Fire Water Pumping System are shown in the Drawing No. MEC-I0047-01-14-D1-ZZ-ZZZ-DR-N-04001 (Refer Enclosed Drawing).

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.

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.

Fire Fighting Pumps

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

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

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. 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.

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.

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.

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.

Coupling and coupling guard

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.

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.

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 72⁰ C based on continuous operation for anti-friction bearings and 62⁰C 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.

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 conforming 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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6.5.4 FIRE TENDERS

DCP fire tenders

S. N	SCOPE OF WORK / SUPPLY
1	GENERAL: DCP tender contains 4000kg of dry power in 2 vessels (2000kg each). The DCP tender fabricated on tata LPT 2518 / 48 or Ashoka chassis 2516 or Volvo or Mahinda AMW or EICHER. The DCP unit itself will have independent expellant gas assembly to discharge powder through two hose reels fitted with triggered type pistol grip nozzle from each vessel
2	CHASSIS: Modal: TATA LPT 2518 2518 / 48 or Ashoka chassis 2516 or volvo or Mahinda AMW or Eicher. Along with 1-sparer wheel / stepney
3	DCP Tank: 2-Nos
3.1	Material: 2- cylindrical tanks fabricated as per ASME code VIII Div-1 with 10 percent radiography of seams and 100percent radiography of T-joints. Tank hydraulically tested to 35kg/sqcm test certificate also shall be furnished at the time of inspection
3.2	Anti-corrosive treatment: sand blasting / tin coating from inside/ outside synthetic enamel PO-red in colour
3.3	Capacity: 2000kgX2Nos
3.4	Sheet: SA 515 Grade 60/70 or SA 516 GR 60/70
3.5	Shape: cylindrical
3.6	Design pressure: 20 kg/ sqcms
4	Safety disc: 1-no with each vessel
5	Safety valve: burst disc on tank calibrated to 21kg/sqcm
6	Free fluidity of DCP: Perfect fluidisation achieved through a set of diffuser nozzle
7	Working pressure of system: 14kg/sqcm
8.1	Nitrogen cylinders: Each tank mounted on the unit-8 Nos
8.2	Total 16 Nos end to cylinders
8.3	Capacity 56/60 litre (only one capacity to be in tender)
9	Expansion shock device: Independently provide each vessel to ensure that fluidity of dry powder is constantly maintained
10	Hose reel:
10.1	Quantity 2nos for each tank
10.2	Hose size 25mm X 30m long
10.3	Nozzle: trigger type piston grip nozzle
10.4	Discharge rate: 5kg/sec at a pressure of 14kg/sqcm
11	Monitor: 1-having 14kg/sec, 25kg/sec and 15kg/sec discharge rates at 3-position, the throw being approximately 45meter, 30 meter and 20meter respectively. Monitor traversing through 360 degrees in horizontal and +70 degree and -15deg in vertical plain
12	Driver cab
12.1	Type: -Close type with single compartment
12.2	Material: MS square tube 30X30X2mm structure, externally panelled with al sheet 16 SWG, internal panelling al sheet 16SWG
12.3	Seat: 2no plus one full six crew seat
12.4	Flooring: Al chequered plate 16SWG
12.5	Doors and lockers: 2-nos (1 on each side)
13	Controlled panel
14	Aluminium extension ladders 10.5m (IS:4571)—1 NO
15	Shovel (as per IS:274)- 1 NO

16	Pick axe small as per IS:550-1 NO
17	Fire man Access:(IS 926) -2 NO
18	Pick axe large as per IS:550-1NO
19	Accessories
19.1	Electric siren-1NO
19.2	Fog lamps-2NO
19.3	Reversing light-1NO
19.3	Trafficators-1 set
19.5	Trafficators blinker type-1-set
19.6	Wind screen wipers 1-no
19.7	Tools for normal routine maintenance
19.8	Search light with 30meters cable
19.9	Adjustable spotlight
19.10	Inspection lamp
19.11	PA-system suitable for outdoor duty and capacity 1-No
19.12	Tool box for general maintenance kit-1-set
19.13	First aid box-1 no
19.14	Mud guard-1-set
19.15	Hydraulic jack 25-ton capacity-1-no
19.16	Spark and surge arrester: CCE approved spark and surge arrester along with original certificate to be handed over to BEML with supply 1-No
20	Finish 2-coats of primer NC based fire red (PO-red) in middle, inside cabin cream colour
21	Painting: name of department: BEML Ltd in Hindi, and English must be painted on both the side
22	Acceptance tests: The acceptance test mentioned below to be given to complete satisfaction of inspecting officer
22.1	Stability: No overturning of fully Ladden and equipped vehicle at a horizontal angle of 27 degree from horizontal plane
22.2	Gradient: To be tested at an angle of 1:4 as per BIS
22.3	Articulation: to be tested for articulation and should not show any sign of stress during the test the clearance of the wheel wells to be checked for tolerance
22.4	Shower test: after completion of fabrication, the vehicle to be subjected to shower test as per the norms lead down under BIS the plan should not show any sign of leakges during test
22.5	Road Test: Road test to be carried out as per the parameters for breaking acceleration top speed etc...
23	Performance guarantee: manufacturer guarantee for design material workmanship and the performance of the complete unit for the period of 12-months from the date of commissioning of completed vehicle. Any mechanical defect, faulty workmanship or operational defects found during this period to be rectified by the vendor at BEML premises within reasonable time without any extra cost of BEML. The tank to be warranted against leakage for a period of 5-years after supply in writing.
24	Training: After supply of vehicle, vendor will provide training on operation and maintenance including chassis at BEML's site & charge for the same to be included in the price. Additional free training to be given at BEML's site within warranty period & when desired by BEML.
25	Approvals:
25.1	All equipment being quoted by vendor shall confirm to the latest version of relevant Indian standard.
25.2	Vendor shall mention the relevant standard reference, against each item governed by the

	Indian / overseas
25.3	vendor shall agree to provide certificates in original of all necessary or mandatory approvals in respect of the fire tender before dispatch to BEML Bhopal.
25.4	On placement of order, Fire tender is to delivered at BEML Bhopal. Transit insurance shall be included in vendors scope.
25.5	After supply, vendor shall provide training in operation of their systems free of cost to BEML/CISF personnel.
25.6	On final supply, operation and maintenance manual, any electrical system manual etc., shall be handed over to BEML. All guarantee certificated for any/All accessories installed on the fire tender, shall be handed over to BEML.
25.7	Along with Techno-commercial offer, vendor shall submit a separate sheet listing all items (Installed on DCP Tender)
26	INSPECTION: -
26.1	All the inspection shall be carried out against relevant IS & Tender technical specification of BEML Jointly
26.2	Vendor shall agree to offer stage inspection of the fire tender in three stages. a) 1 st inspection for Tank & Allied Accessories. b) 2 nd inspection for body work on chassis. c) 3 rd inspection shall be final Pre- dispatch inspection 3 rd inspection will be done by CISF & BEML jointly.
27.	ERECTION & COMMISSIONING: Since the item is ready to use type and shall be delivered in ready to use condition in BEML, Bhopal. However, supplier's representative shall come & will make all the system fully ready to use again & demonstrate use of all items. And shall import training to our working personnel (Training period 7-days). Defect free & uninterrupted demonstration shall be contributed as successful commissioning. Further, Guarantee period will start after successful commissioning. Fuel required during the demonstration at BEML works shall be arranged by the vendor.
28	Registration at Bhopal: BEML shall arrange registration at Bhopal and annual insurance for vehicle.
29	Transit insurance as applicable for automobiles as per Govt. rules from the point of delivery to BEML CRX shall have to be arranged by vendor.
30	For Delivery: Vendor has to deliver the vehicle at the works of BEML, Bhopal & shall have to arrange driver / fuel / insurance, any other applicable documents etc., and other leviable Govt. Duties from various states where vehicle is passing. All bills' challans, receipts etc in respect of vehicle shall be handed over to BEML by vendor at the time of Delivery.

Water Bowser

1	Chassis: - (included in vendors Scope) capacity = 25T, 280 BHP, type= MAN CLA or TATA or VOLVO or Mahindra or Eicher or Benz or Ashok Leyland along with one spare wheel / stepney. Drag Hook or eye of adequate strength and design to be provided at the rear & front of chasis by vendor
	PUMPING SYSTEM: -
	Type – centrifugal
	Make – Firefly or go-Vida or Rosenbauer
2	Discharge capacity – minimum 6000LPM at 8 kg/sqcm

	<p>Material of construction: The pump body, casing, impeller and delivery outlet to be made of gun metal / bronze / stainless steel only. The pump should not have any aluminium parts. The impeller shaft to be of stainless steel and to be carried in anti-friction bearing as per the manufacturers standard design.</p> <p>Bearing housing to be of CI drain valve to be made of stainless steel.</p>
	<p>Pump suction inlet: The suction inlet of the pump should be capable of being connected either directly to hydrant discharge outlets through header or to the water tanks of the vehicle. Size of inlet should not be less than 140mm or 2X 100mm. The connection from the water tank to the pump to be suitably sized (min 150mm).</p>
3	<p>Pump discharge outlets: there to be 6 outlets of 63mm each of standard size 63 mm with screw down type gun metal (LTB GR.2 of IS 318). Delivery valves having female couplings.</p>
	<p>Pump mounting: the pump to be rear mounted. Pump will have at least 4-mounting points, the mounting to be done on heavy "C" channels / plates only.</p>
	<p>Shaft sealing: self adjusting type.</p>
	<p>Pump control panel: the entire system of control panel to be of open architecture type which will ensure that both the scheduled operation as well as preventive maintenance is affected easily. The control panel will have the following:</p> <ul style="list-style-type: none"> - Pump to delivery outlets - Pump to monitor pump to colling line - Tank to pump suction - Outside source to pump suction - Water level indicator <p>The above-mentioned connections are the min. requirements. Other connections / controls as maybe required can be provided by the manufacturer. The "pump engaged" indicator LED type will also be provided in the driving compartment along with the one mentioned on the control panel above to indicate that the pump shift has been successfully completed to the driver as well as the operator.</p>
	<p>Pump priming system</p> <p>Type: twin piston reciprocating or water – ring or exhaust ejector type</p> <p>Make: firefly or GO-Vida or Rosenbauer or equivalent make</p> <p>Capacity: priming system must be capable of lifting water from 7-meters depth within 24 seconds.</p>
	<p>HP- pump</p> <p>The HP pump to be fully imported, CE certified / UL listed, separate unit driven by the side PTO of the Chassis. The capacity to be 150 LPM @ 100kg/sqcm pressure. The pump will have six plungers & positive displacements, working to its optimum capacity at not more than 1000RPM. Indigenous three piston / diaphragm pumps will not be accepted. The pump to be guaranteed for a min life of 5000HRs of operation.</p>
5	<p>HOSE REEL</p> <p>Two hose reels (High- pressure type) to be provided for the auxiliary pump. The hose used would be minimum R1 type & rated for 130 bar working pressure. Two high pressure fog guns capable of discharging 75 LPM @ 100kg.sqcm pressure in jet or fog patterns to be provided at the end of the reel. The jet range to be minimum 25mtrs.</p>
6	<p>POWER TAKE OFF (P.T.O): The P.T.O of heavy-duty type of a suitable ratio for the rated output of the pump & torque of the vehicle to be provided. The lever / switch for engaging the P.T.O to be provided in driver cabin. Necessary supports for PTO units, propeller shaft coupling, universal joints etc for power inputs to and output from PTO units will have to be provided by vendor.</p> <p>MAKE: WEBSTER 4128 or SYALL or VAS.</p>
7	<p>COOLING SYSTEM: in addition to the radiator cooling. An indirect cooling system of the</p>

	open circuit type to be provided to keep the engine from overheating during extended use in tropical climates & when ambient temperature is over 50degree Celsius. A flexible pipe, atleast 5-meters long to be provided as spare, so that waste cooling water can be discharged away from vehicle. The pipe will have threaded end connectors.
8	Water Tank: the water tank to be of minimum 10000lts. Capacity & to be suitable mounted on the chassis in such way that the weight distribution is optimised. In addition, a 2% expansion space to be made in the tank over & above the water capacity. The tank to be fabricated out of MS plates min 5mm thick (externally epoxy painted & internally FRP Lined) all around except the top and baffle plates which to be of 4mm. the tank to be welded construction & to be die – pressed on all side to prevent distortion & to ensure torsional rigidity. Due care to be taken to ensure that butt-welded joints are minimized. Wherever butt-joints are unavailable, the soundness of weld-joints complete welding to be done using Mig welding process only. The tank to be hydraulically tested at 0.5kg/sqcm pressure to find out if there are any leakages. All the joints to be flanged type and will have O-ring sealing. Rubber gaskets will not be used anywhere in the plumbing. All the outlets and inlets from the tank to be taken by installing nozzles of suitable length and reinforcements pads.
8a	BAFFLES: thickness of baffle plate to be minimum 4mm and should be bolted type, the baffle to be designed that they do not distort / buckle under any circumstance during braking & cornering.
8b	MOUNTING: the tank to be mounted on rigid mountings which will prevent distortion due to chassis flexion. Suitable hooks / lifting eyes. To be provided on top of the tank to enable it to be lifted off the vehicle for maintenance / repairs.
8c	CONNECTION FOR FILLING: the tank to be filling orifice of 250mm & an inspection & maintenance manhole of 450mm at the top. The cover for this port to be hinged or threaded type apart from the above two more filling connection to be provided on the sides of the tank terminating in filling connection of 63mm male instantaneous couplings made of GM or SS material incorporated with a strainer. Valve to be of NRV / Ball / Butterfly type.
8d	DRAINING, CLEANING & REPAIRS: A 50 mm dia drain line with a ball / butterfly valve to be provided to drain the tank for maintenance/ cleaning / repairs etc. A cleaning hoe of 250mm to be provided at the bottom of the tank & to be taken down to a point below the chassis without reducing the effective ground clearance.
8e	OVERFLOW: one overflow pipe of suitable diameter to be fitted to the tank. The diameter of the overflow pipe to be determined as per the filling connections provided. However, it should not be less than 100mm diameter in any case to ensure the tank does not get pressurized. The overflow pipe to be taken up to 2-inches higher than the top of the vehicle.
8f	LEVEL INDICATOR: A water level indicator to be provided near the control panel. The level indicator to be of graduated glass tube, clear acrylic or electronic type as per the manufacturer's standards.
9	FOAM PROPORTIONER: The foam proportioner should provide with the selector valve will have four settings. Each upward setting will result into an equal increase in the foam compound flow rate. The linkages of this purpose to be as simple as possible to avoid distortion due to chassis flexion.
10	MONITOR: the water monitors to be provided at a suitable location on the top of the vehicle the monitor to be of 4500LPM@10Kg/sqcm pressure. It should have provision for jet as well as spray patterns.
10a	MONITOR PERFORMANCE: the monitor to be capable of traversing through 360 degrees in horizontal plane, +75 deg & 15deg in vertical plane with discharge range of at least 65-meters in still air with water. The fog curtain to be 160 deg & the friction loss will be less than 10 psi through the monitor. The monitor to be designed for a continuous working pressure of 8-10kg/sqcm.
10b	MONITOR MATERIAL CONSTRUCTION: the material for the monitor & waterways to be chosen with a view that there will be prolonged use with brackish water & hence corroding materials will not be permitted.

10c	MONITOR COATING / PAINTINGS: Painting of monitor to be done using a good quality paint system. The paint used to be poly urethane only for enhancing fade resistance. The paint will be guaranteed for minimum 5-years against peeling, chipping, cracking and fading
11	PIPING & VALVES: complete pipeline circuit on the vehicle including water lines & fittings will be of SS 316 material only, including all water lines. All valves up to 2" size to be lever operated SS 316 ball valves & all valves above 2" size will be normal ball / butterfly valves but made of SS316. The valves to be of 3-piece design to ensure easy maintenance & repairs. Seats of the valves to be easily replaceable, readily available & at least 2-sets of spare seals to be provided for each size of valves. All sockets welded lines to be dry penetration tested and all the butt-welded joints to be radiographically tested. A flow chart and schematic diagram to be made and submitted with the technical bid
12	BODYWORK: enclosed accommodation for driver, officer in charge & four crew members to be provided in a double compartments drivers cabin as per the below given specs:
12a	INTERIORS OF THE CABIN: the cabin to be internally lined with a good quality PVC Coated aluminium sheets. Alternatively other systems of interiors will be accepted provided the same is on PAR with the latest tender in the latest trends in the international markets & as per newr norms the entire floor of the crew cabin to be provided with a good quality anti-skid type vinyl matting. A first aid box to be provided in the cabin.
12b	STRUCTURE: The entire structure to be of welded construction made from MS pressed section & square tubes of Min 2mm thickness duly treated for corrosion resistance by zinc plating & two other pack epoxy treatment. Angles & channels used for the structure will be min. 3mm thick runners and cross members (wherever used) will be of minimum 6mm thickness.
12c	PANELLING: the outer panelling to be done from 3mm aluminium sheets and the internal panelling to be done from 2mm aluminium sheets treated for anti-slippage or with chequered sheets. The doors will be fitted with winding / sliding safety glasses. Sheets of outer panelling will be glued to the framework. Riveting / bolting / screws of any kind will not be permitted.
12d	SEATING: All the seats would have foam cushions & to be covered with good quality Rexene. The crew seat will have individual seating for the crew fitted with brackets for placements of breathing apparatus in an upright position. The seats to be of the wear and walk away type so that when the crew disembarks from the vehicle the BA sets should easily come off the seats with them. The seat bottom will be theatre type, which will automatically flip-up when the fireman gets up, thereby freeing up the space for easy embarking and disembarking.
12e	LOCKERS: Sufficient lockers to be provided to accommodate all the equipment / accessories accessible manner.
12f	ROLLER SHUTTERS: for easy operation of fire tender MCD (FRANCE) or Fierco (ITALY) make roller-shutters to be installed on both sides of the appliances. These shutters will be rooted inward underneath the roof giving unobstructed access to the equipment's lockers & the equipment accessories fitted in the vehicle. Roller shutters to be made of hollow rectangular shaped aluminium links which should be inter connected with the help of plastic / rubber profiles, sealings the roller shutter water tight when closed. They should be powdering terrain and slopes. a spring mechanism to be fitted so that the shutters are held-up at any point of opening. It would be easy to operate & will ensure that the shutters cab ne easily pulled down. The sections of the shutter to be powder coated / anodized to a smooth finish and aesthetic look. Guide rails should support the shutters over the entire length on both sides & make them torsion free the shutter should have a sturdy locking mechanism which will prevent accidental opening during movement of the vehicle. A master switch for isolating locker lighting circuit should also be fitted in the driver's cabin
12g	STORAGE OF EQUIPMENTS: for all watering fittings like branch pipes etc quick release type couplings on snaps clamps of spring steel (as per the manufacturers standards) to be provided which will be enable the operator to locate the desired equipment instantly & save valuable time.

12h	OTHER WORKS: The door of the cabin to be fitted with safety glasses. The driver to be provided with rear view mirror, the cabin to be ergonomically designed for long and comfortable run.
13	Electrical system: all the wiring to be properly fixed and to be protected against heat, oil and physical injury. To the extent possible all wiring will pass through conduits. All wires to be stranded copper or copper alloy conductors of a gauge rated to carry at least 125 percent of the maximum current for which the circuit is protected wiring to be uniquely identified at least every 2ft by colour coding or permanent marking
14	LADDER & LADDER GALLOWS: Ladder gallows with ladder to be provided for carrying 10.5 metres aluminium trussed type double extension ladder. The design to be such that the ladder can be released without difficulty from a reasonably position & will embody rollers to permit easily withdrawal by one man.
15	FITTINGS AND ACCESSORIES: the following accessories to be provided on the appliance <ol style="list-style-type: none"> 1. Spot light in front – 2Nos 2. Fog lamps -2Nos 3. Blinker type traffic indicator -4Nos 4. Search light with 30mtrs cable and tripod stand- 1Nos 5. LED light bar (minimum 75-100 watts) makes grand or equivalent. - 1Nos
16	WORKMANSHIP & FINISH: The GVW of appliance should not exceed the rated GVW of the chassis manufacturer with all equipment's & crew the weight distribution diagram should not be submitted along with the offer.
17	PAINTING AND MARKING: priming the finished material with a zinc rich primer & then finally coated with a two-pack epoxy-based paint.
18	SURFACE PREPARATION: once the panelling is completed, all the outside surfaces should be surface treated & painted with a good quality paint system, like Du-Pont, PPG, sandbox etc, the paint to be polyurethane (PU) finished paint each coat of 50 microns DFT. Water lines to be painted red in colour & foam lines will be painted yellow in colour.
19	VEHICLE EXTERIOR PAINT: The vehicle and monitor should be painted with at least 2-coats of zinc phosphate epoxy primer each of 50-microns DFT and two coats of polyurethane finish paint each coat 50-microns DFT.
20	WATER AND FOAM LINE PAINT: water & foam lines should be painted with zinc phosphate epoxy primer each of microns DFT and two coats of polyurethane finished paint each coat of 50-microns DFT. Waterlines to be painted red in colour & foam lines will be painted yellow in colour.
21	DETAILS REQUIRED: the bidder should give the details of entire painting and process & also the details f in house painting facilities like paint booth etc., the colour for outside tube as per the latest international and Indian norms for the fire brigade vehicles. The user's name to be written on both sides with yellow colour
22	Reflective strips: Reflective stripes to be affixed to the perimeter of the apparatus
23	MARKING / NAME PLATES: shall be provided with stainless steel
24	OWNERS EMBLEM: Owner's emblem in original colour together with name (in HINDI and ENGLISH) to be written in golden yellow/ reflective white stickers / paint on both sides of the vehicle. "BEML Ltd, Bhopal"
25	Acceptance tests: The acceptance test mentioned below to be given to complete satisfaction of inspecting officer. Vendor will ensure that design of tender should not affect chassis parameters such as speed, turning circle, acceleration, endurance test, priming test, hydraulic testing etc all inspections & tests to be carried out by the vendor to the complete satisfaction of BEML representative. All testing parameters should be carried out at manufacturers premises & details of infrastructure to be provided at time of techno- commercial bid.
25.1	Stability: No overturning of fully Ladden and equipped vehicle at a horizontal angle of 27 degree from horizontal plane

25.2	Gradient: To be tested at an angle of 1:4 as per BIS
25.3	Articulation: Vehicle to be tested for articulation and should not show any sign of stress during the test the clearance of the wheel wells to be checked for tolerance
25.4	Shower test: after completion of fabrication, the vehicle to be subjected to shower test as per the norms lead down under BIS the plan should not show any sign of leakages during test
26.5	Road Test: Road test to be carried out as per the parameters for breaking acceleration top speed etc...
26.6	Performance guarantee: manufacturer guarantee for design material workmanship and the performance of the complete unit for the period of 12-months from the date of commissioning of completed vehicle. Any mechanical defect, faulty workmanship or operational defects found during this period to be rectified by the vendor at BEML premises within reasonable time without any extra cost of BEML. The tank to be warranted against leakage for a period of 5-years after supply in writing.
26.7	Training: After supply of vehicle, vendor will provide training on operation and maintenance including chassis at BEML's site & charge for the same to be included in the price. Additional free training to be given at BEML's site within warranty period & when desired by BEML.
27	Approvals:
	All equipment being quoted by vendor shall confirm to the latest version of relevant Indian standard.
	Vendor shall mention the relevant standard reference, against each item governed by the indian / overseas
	vendor shall agree to provide certificates in original of all necessary or mandatory approvals in respect of the fire tender before dispatch to BEML Bhopal.
	On placement of order, Fire tender is to delivered at BEML Bhopal. Transit insurance shall be included in vendors scope.
	After supply, vendor shall provide training in operation of their systems free of cost to BEML/CISF personnel.
	On final supply, operation and maintenance manual, any electrical system manual etc., shall be handed over to BEML. All guarantee certificated for any/All accessories installed on the fire tender, shall be handed over to BEML.
	Along with Techno-commercial offer, vendor shall submit a separate sheet listing all items (Installed on water bowser Tender)
28	INSPECTION: -
	All the inspection shall be carried out against relevant IS & Tender technical specification of BEML Jointly
	Vendor shall agree to offer stage inspection of the fire tender in three stages. d) 1 st inspection for Tank & Allied Accessories. e) 2 nd inspection for body work on chassis. 3 rd inspection shall be final Pre- dispatch inspection 3 rd inspection will be done by CISF & BEML jointly.
29	ERECTION & COMMISSIONING: Since the item is ready to use type and shall be delivered in ready to use condition in BEML, Bhopal. However, supplier's representative shall come & will make all the system fully ready to use again & demonstrate use of all items. And shall import training to our working personnel (Training period 7-days). Defect free & uninterrupted demonstration shall be contributed as successful commissioning. Further, Guarantee period will start after successful commissioning. Fuel required during the demonstration at BEML works shall be arranged by the vendor.
30	Registration at Bhopal: BEML shall arrange registration at Bhopal and annual insurance for vehicle.
31	Transit insurance as applicable for automobiles as per Govt. rules from the point of delivery

	to BEML CRX shall have to be arranged by vendor.
32	For Delivery: Vendor has to deliver the vehicle at the works of BEML, Bhopal & shall have to arrange driver / fuel / insurance, any other applicable documents etc., and other leviable Govt. Duties from various states where vehicle is passing. All bills' challans, receipts etc in respect of vehicle shall be handed over to BEML by vendor at the time of Delivery.
33	Accessories
	Aluminium extension ladder-10.5-metre-long trussed type-1no's
	Heavy duty PVC suction hose with round thread couplings- 2.5 metre long-4no's
	Synthetic jacketed delivery hose as per BIS type 'B' 63mm, 22.5 metre with couplings-10no's
	Suction strainer of gun-metal LTB Gr 2 of IS 318-2no's
	Basket strains for above GM suction strainer-2no's
	Suction wrenches for above GM suction strainer-1pair
	Dividing breaching Gun metal LTB Gr of IS 318-20no's
	Collecting breaching Gun metal LTB GR 2 of IS 318- 2no's
	Hand controlled branch pipe gun metal LTB Gr 2 of IS 318-1no's
	Long line terylene 50 mm circumference 30m long-2no's
	Short line terylene 50 mm circumference 15m long-2no's
	Hose bandages rubberized-12no's
	Hose clamps-6no's
	Branch pipe gun metal LTC Gr 2 of IS 318-4no's
	Nozzle for branch pipe of various sizes gun metal LTB Gr 2 of IS 318-10 no's
	Adaptor double female instantaneous pattern gun metal LTB Gr 2 of IS 318-2no's
	Adaptor double male instantaneous pattern gun metal LTB Gr 2 of IS 318-2no's
	Nozzle spanner gun metal LTB Gr 2 of IS 318-2 no's
	Rubber gloves- 6 pairs
	Light bar installed outside on front top of cabin (Halogen strobe – LED) of red-white -blue colour-1nos
	Electrically operated wailing siren of high pitch to be provided-1no's
34	Spark and surge arrester: CCE approved spark and surge arrester along with original certificate to be handed over to BEML with supply 1-No 1. Taparia / Jhalani make tool kit- 1 no's 2. Hydraulic jack of 25T capacity- 1no's 3. First Aid Box- 1no's

6.6 MAIN GATE COMPLEX WITH SECURITY OFFICE:

There are two entry and exit control points for the plant site, one is the main entry for man and material movement, whereas the other is only for the material movement. The main entry shall also be used for the movement of VIP.

The Main gate complex building is integrated with Security office. This is RCC structure building. This is Ground +1 building structure.

Total Built up area is 863 Sq. m This building has a provision for entry / exit for all employees with access control system.

This Gate will provide access to main security building from employee entry.

The main gate complex is an RCC structure of G+1 floor with gate pass, scanning and security monitoring area.

The building shall have the following facilities:

- Reception and waiting area
- Scanning area
- Staff room
- Monitoring room
- Chief security room

Being the main entrance to the factory, the facia and facade of the gate complex have to be aesthetically beautiful, facade is to be aesthetically appealing and combination of different treatment such as dry-stone cladding, ACP (aluminium composite panel), Rustic textured paint, Exterior grade acrylic emulsion paint. Etc., should be planned in consultation with BEML before execution

The area of parking at entrance gate should be provided with heavy duty paver blocks of approved colour combination and shade

6.7 GATE COMPLEX FOR MATERIAL MOVEMENT WITH SECURITY OFFICE:

This gate complex building is integrated with Security office. This is a Ground +1 building structure. This is RCC structure building.

Total Built up area is 193 Sq. This Gate shall be used exclusively for the Truck entry/exit with a clear width and height of 6 m for Truck/trailer movement.

6.8 GATE COMPLEX AT RAILWAY SIDING MAIN GATE COMPLEX WITH SECURITY OFFICE:

This gate complex building is integrated with Security office. This is a Ground+3 building structure. This is RCC structure building. Total Built up area is 89 Sqm. This Gate shall be used exclusively for the LHB/Vande Bharat coach's entry/exit.

6.9 PARKING FACILITY

The following are the type of parking facility provided for the plant:

- 20 no of covered parking in ground floor of the Main office complex for senior executives.
- 15 no Truck parking near the main gate
- One multi-level parking area with provisions for the following:
 1. Two-wheeler – 285
 2. Four-wheeler – 360
 3. Bus – 09

6.10 CAR BODY MANUFACTURING CUM STORAGE BAY

The Workshops are the most important facilities in Rolling Stock Manufacturing Plant. The proposed Workshop Building is designed as a functional, efficient, and flexible space that

supports hands-on activities, fabrication processes, and training needs while ensuring safety, durability, and user comfort. The architecture emphasizes clarity of circulation, unobstructed work zones, and seamless integration of services, creating an environment that enhances productivity and operational workflow.

The overall built form adopts a simple, rectilinear geometry to maximize usable floor space. The structural grid is optimized to create large column-free spans, supporting overhead movement of materials and machinery. The building envelope consists of durable, low-maintenance materials—such as insulated metal panels, structural steel framing, and high-performance glazing—selected to withstand industrial use and provide long-term resilience.

Natural lighting and ventilation are key design drivers. Continuous clerestory windows and high-level translucent sheets & louvres ensure diffused daylight across the workshop floor while reducing dependence on artificial lighting. Mechanical ventilation systems supplement natural airflow to maintain indoor air quality and temperature control in zones with heat-generating equipment.

The internal planning separates noisy, heavy-duty work areas from cleaner, precision-based tasks. Service cores containing electrical rooms, tool storage, washrooms, and utility shafts are placed along the rear edge, allowing the main hall to remain unobstructed. Safe circulation is maintained through clearly defined pedestrian pathways, dedicated equipment movement aisles, and emergency exits positioned as per NBC guidelines.

Sustainable design principles are incorporated through energy-efficient lighting, rainwater harvesting provisions, solar-ready roofing, and the use of recyclable materials. Exterior landscaping and permeable paving help manage storm-water runoff and reduce heat island effects.

Overall, the workshop building is conceived as a robust and adaptable facility that prioritizes user safety, operational efficiency, and long-term performance, while maintaining a clean, contemporary architectural character.

The workshop is designed as 3-bay structure with each bay of width 24m c/c & a length of 400 m. The workshop is further a two storied workshop having functional relations in both the floors. The structure is designed to take heavy loads considering the functionality. Each workshop is attached with office spaces on one side lengthwise along with the fire escape staircases integrated to it.

The office building annexed to manufacturing bay on the outer side of bays along their length shall have G+5 floors with only Ground floor and Top floor opening into Shop Floors located at ground and First floor of manufacturing block. Each manufacturing shall have 2- such annexe building with approach via lift as well as staircase and 5th floor office opening into shop floor at First Floor. Only Ground and 5th floor (Top floor) shall be used for Housing offices for officials whereas G+2 floor (2nd floor) shall be used for discussion rooms and conference Hall other floors will not have any occupancy, the façade of outer face shall be seen as that of manufacturing block, so that it merges with the side facia of the block. This building will cover an area of 120mx4m on each floor including area of the bay between the columns of

manufacturing bay in the entire width of column. The annexe building will have two passengers' lifts and a central staircase with access to each floor. This building will also have a Service lift to be used for material movements by shop floors. Passenger lift shall have a capacity of 15 persons (Specification shall be followed/ referred with the Elevator specification mentioned at S.No. 19, in accordance to the requirement) and service lift will have a capacity of 1.5 tonne. This annexe building shall have toilet units on both ends. However, size of these toilet units will be based on number of users. Accordingly, the capacity of Ground and top floor toilets shall be much bigger than toilets at intermediate floor to take care of personnel working on these shop floors.

G+2 (third floor) shall be used exclusively for meeting and conferences which shall be provided with 1-no big size conference room to accommodate at least 60-70 persons and two small meeting rooms each having a capacity of 8-10 persons. Same specification as that of Office Building Complex is applicable here. However, the frame can be made up of structural steel.

Note: Lift proposed in this Annexe building is not in the scope of EPC contractor. However, only cabin shaft (Hoist way) is to be constructed by the contractor

Solar panels are also planned on the roof so as to generate renewable energy. Though supply of panels is not forming part of the scope of EPC contractor, he shall make suitable provision while doing roofing for ease of mounting of solar panels at 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, 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 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.
- 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.

7. UTILITY BUILDINGS

7.1 WATER SUPPLY AND FIRE WATER PUMP HOUSE

The Water Supply and Fire Water Pump House are designed to accommodate raw water and fire-fighting water systems within a compact yet accessible layout. The building adopts a single-storey industrial form with adequate internal clear heights for pump installation, maintenance, and overhead piping. This combined pump house is a RCC structure with a height of 6m & pump house of height 8m. Water reservoir is RCC type above ground structure, Pump house is RCC column with brick wall type structure.

The building is RCC structure building with total Built up area is 850 Sq. m.

Ventilation is ensured through louvered openings and mechanical exhaust fans to dissipate heat generated by motors. The pump floor is planned to allow clear access for alignment, routine maintenance, and equipment replacement, with large service doors provided for loading/unloading. The structure is designed as a durable steel framed enclosure with anti-vibration flooring and corrosion-resistant finishes suited for high moisture environments.

Fire pump rooms comply with NBC and NFPA norms, incorporating dedicated separation walls, minimum clearances, and protected cable routing.

Provisions for underground tanks, yard hydrants, and control panels are integrated with the external fire water network. A combined Drinking water & Fire water pump house has been proposed for this Project.

Pump configuration for the combined pump house is as follows:

1. 11 KW x 3 nos. (3w+1s) for VFD motor of hydro pneumatic pumps.
2. 11 KW x 2 nos. (2w+1s) for star delta / DOL motor of air scouring blowers.

7.2 MRSS:

The MRSS is strategically positioned to ensure safe power distribution while maintaining required statutory distances from occupied buildings. The architecture emphasizes safety zoning, with segregation of HT switchgear, LT switchgear, transformer bays, and control rooms.

The building typically adopts a partially RCC / partially steel structure with fire-rated partitions, spill containment pits for transformers, and adequate ventilation through natural louvres and forced-air systems. Cable trenches are laid out for ease of maintenance and

minimize crossing of power circuits.

Service areas such as battery rooms, control rooms, and metering rooms are acoustically treated where required and provided with climate control for equipment integrity. The MRSS façade employs simple industrial finishes—such as metal cladding or textured paint—for long-term durability and low maintenance.

MRSS is a RCC structure building with total Built up area is 300 Sq. m. A Separate 33/11kV transformer area of size 12m X 6 m has been considered. A Satellite office building is also integrated with this MRSS building.

A dedicated 33 kV HT cable will reach to Project site by MP State Electricity Board under deposit basis work. The 33 kV HT line will be terminated at the metering cubicle inside the project area.

33 kV Cable from metering cubicle to the MRSS shall be laid through suitable cable routing by the Construction contracts.

7.3 COMPRESSED AIR SYSTEM

Compressed air system shall be distributed type each manufacturing bay will be equipped with 1-no. oil free screw type compressor of 100CFM rating with delivery pressure of 12-bar. Inspection & testing bay shall also be having 1-no identical compressor.

The pipelines will be routed overhead along the building columns / walls. Isolating valves condensate drains and compensators, Pressure gauges & pressure reducing valves 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. At Every alternate column of the manufacturing bay tap point for compressed air shall be provided. The tap point shall have automatic quick couples.

During detail design stage positioning of these compressors within manufacturing block / Inspection Bay, pipeline routing along with technical requirements & BOM will be finalised. Pressure drop throughout the distribution network should not be more than 0.5 bar.

No separate building is envisaged for this system.

7.4 CENTRALISED GAS BANK

The Centralised Gas Bank is designed in accordance with applicable gas safety codes, PESO guidelines, and fire safety regulations. The architecture adheres to an open or semi-open shed typology with natural ventilation as the principal safety feature.

Cylinder storage areas are segregated by gas type and arranged with safe clearances, bollards, and explosion-relief openings. The floor is finished with anti-spark material, and piping manifolds are mounted for clear visibility and maintenance.

Safety features include gas detection, earthing pits, fire extinguishers, and emergency access routes. The gas bank site layout provides unhindered circulation for cylinder loading/unloading and emergency response, maintaining adequate separation from other buildings

Various Industrial gases like Acetylene, Oxygen, Argon, AOM gas & ACM gas are required in the plant. In view of this, a Centralised gas bank has been proposed for fulfilling the requirement.

The said industrial gases are required for the following purposes:

- a) Acetylene & Oxygen gas are required for cutting operation.
- b) Argon gas, AOM gas (98 % Argon + 2% Oxygen) & ACM gas (80 % Argon +20% Co2) are required for automatic & manual welding operation

8. 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 site 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 around building as per approval.

Decorative water fountains in external area (location to be decided while planning landscaping) shall be provided (2-Nos) with waterproofing treatment, designed for low maintenance and safe operation which is suitable for industrial outdoor conditions in accordance with the BEML.

For landscaping/ Green belt development suitable provision to be made for watering/ Irrigation of green belt development, its maintenance and also installation of “BEML” Logo/signage of appropriate size at the entrance of the plant and other various locations inside the plant and offices.

9. GENERAL SPECIFICATION OF FACILITIES

9.1 DOORS AND WINDOWS:

The Flush doors proposed in buildings shall be provided with frame of approved shade of minimum 30-35 mm thickness. 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.

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 5 mm thick glass as per approval.

9.2 PARAPET WALL:

Height of Parapet Wall shall be minimum of 1050-1200 mm from the Finished Floor Level, depending upon the required constructed buildings.

9.3 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 of SS 304 grade matte finish.

9.4 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

9.5 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 Office buildings. The level of plinth protection shall be 100 mm above finished ground level or landscape level.

9.6 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 manufacturing block and inspection bay the canopy depth shall be 2m.

9.7 SHAFTS FOR UTILITY:

All the services such as Electrical, Communication cables (ELV), Fire hydrants, Plumbing Lines, Rain water down comers etc. are to be routed inside designated shafts. The shaft doors shall be metal fire door with 2 hrs. fire rating. All shaft doors are to be provided with 300 mm high sill with 18 mm thick granite stone coping on top. The shafts shall be accessible from common areas of building.

9.8 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. In addition, an additional tank of adequate capacity for storage of treated effluent shall also be provided for flushing.
- 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 wall hung type of approved make and colour
- 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.
- Pantry shall be provided with stainless steel 304 grade sink with drain board of approved make.

Each Toilet shall have the following Toilet accessories of approved make.

1. Mirror of full width of Granite counter with height of 900 mm with bevelled edges.
2. Chrome finish Soap dispenser, 600 mm long SS Towel ring near wash basin.
3. SS Coat hook in all Water closet room.

All toilet accessories shall be of SS 304 Grade only.

9.9 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.

S. No.	Particulars	Requirement
1	Height of Octagonal Pole (In meters)	9
2	Type of bracket for suitable fitment of luminaire on the octagonal pole	Single Arm/Double Arm/triple arm (As per the design given in the Pole drawing)
3	Each Bracket length	1500
4	No. of LED luminaires can be fitted in the bracket of each octagonal pole (in No's)	01 for single arm 02 for dual arm 03 for triple arm
5	On site warranty (in Months)	60
Pole Construction		
1	Material of Octagonal pole	Grade ISH:430LA as per IS: 5986:2017 latest
2	No. of sections	1
3	Cross section of octagonal pole (no of sides)	8
4	Internal distance between parallel faces at the base of pole (in mm)	150-155
5	Internal distance between parallel faces at the top of pole (in mm)	70-75
6	Longitudinal Welds	Only 1
7	Octagonal pole sheet thickness (in mm)	≥ 3
8	No. of stiffeners per pole	4 (Min)
9	Metal protection treatment of fabricated mast section	Hot dip Galvanized, as per IS:4759 latest:
10	Luminaire carriage / brackets	Fabricated suitably and hot dip galvanized for fixing and holding required no. of light fixtures

11	Door opening on base of the pole	Door opening: 500 mm height from base plate, Size: 100 mm x 500 mm with Gasket
12	Type of locking arrangement for door	Pad lock with key
13	Provision of finial on the pole top	Yes
Earthing		
1	Each Pole earthing shall be made with supply of materials, using copper coil of 10 SWG bare copper wire of 2.0 meter in length.	Yes
Base Plate		
1	Base plate material	Grade: E250, Quality (as per IS: 2062:2011 latest)
2	Base plate size - (Length in mm x Width in mm x Thickness in mm)	250X250X16
3	Necessary accessories on each pole	Suitable foundation Bolts - 4 nos. (min)
4	Foundation Bolt type	J
5	Bolt size	M20x700
6	Conformity of specification for bolts and Nuts	as per IS:1367 (Part 2), Grade B
7	Galvanization of foundation bolts and nuts and octagonal pole shall be galvanized	As per IS:4759 latest
8	Earthing terminals on the base of the pole, for lightning and electrical protection	Using 12 mm Dia SS Bolts of suitable length
Junction Box		

1	Junction box location	on the Carriage Assembly as required, from which the interconnections for the designed number of the light fixtures on the carriages
2	Material of Junction Box	Polycarbonate
3	Ingress protection class of Junction Box	IP-65
4	Cable (ISI Marked Cable) connections from the top junction box to the individual luminaries of each pole	3CX2.5 Sqmm Flexible Copper Cable
5	Terminal Box with Circuit breakers and backlite sheet for cable termination at door opening (Base compartment) for each pole	MCB, 6A, 1P, 240V, AC
6	No. of MCB per Junction Box (in Nos.)	1
Pre Dispatch Inspection		
1	Inspection	Pre dispatch inspection will be carried out at vendor's work with no extra cost. All the acceptance tests as per IS shall be witnessed during the inspection. Vendor shall not dispatch the material without prior dispatch clearance from BEML Official.

Generic	S. No	Particular	Requirement
	1	Each pole shall be supplied with suitable foundation bolts, nuts and washers, Instruction manuals	Yes
High Mast System			
	1	Cross section of mast (no of sides)	20-sided polygon

	2	Top diameter (in mm) - Minimum	150
	3	Plate Thickness for Top (in mm)- Minimum	4
	4	Provision for Cable Termination	MCB Isolator
Lighting Finial			
	1	Heavy duty hot dip galvanized lightning finial shall be provided for each mast (in Nos). It shall be solidly bolted to the head frame to get a direct conducting path to the center of the earth through the mast. The lightning finial shall not be provided on the lantern carriage under any circumstances in view of the safety of the system	Yes
Aviation Obstruction Lights			
	1	Vertical Stand Led Type Aviation obstruction lights shall be provided on top of each mast (in Nos)	Yes
Wind Loading			
	1	Wind loadings as per	IS 875:1987 part 3 or latest
Lantern Carriage			
	1	The Lantern Carriage shall be of steel tube construction, the tubes acting as conduits for wire, with holes fully protected by grommets	Yes
	2	The entire lantern carriage shall be hot dip galvanized after fabrication	Yes
	3	The inner lining of the carriage shall be provided with protective PVC arrangement, so that no damage is caused to the surface of	Yes

		the mast during raising and lowering operation of the carriage	
Junction Box			
	1	IP of the Junction Box	IP 65
		Junction Box Material	Cast Aluminium
Winch			
	1	Minimum working load of winch (in Kg)	750
	2	Motor capacity - Minimum (in HP)	1.5
	3	Suitable rating and connecting copper cable also shall be provided for the motor	Yes
Stainless Steel Wire Rope			
	1	The suspension system shall essentially be without any intermediate joint. The steel wire ropes shall be of suitable construction, the central core being of the same	Yes
	2	Overall Diameter of the Rope	≥ 6 mm
LED Luminaire			

	1	LED luminaire shall be provided with protection against Short Circuit, Overload, Over Voltage, reverse Polarity.	Yes
	2	The Luminaires casing/housing (single piece housing) shall be pressure die casted aluminium alloy with higher thermal conductivity	Yes
	3	The luminaire body must be corrosion resistant epoxy powder coated	Yes
	4	Light Source	SMD LED Chip as per LM80/IS 16106
	5	Test Reports to be submitted (Minimum Life of the LED chip must not be below 50000 burning hours while ensuring at least 70 % efficacy)	LM 79, LM 80 & TM 21,
Earthing			
	1	The digging of Earth Pit, Supply of Earthing Material and all incidental work shall be in the scope of the Vendor. Lightning arrester and the High Mast shall be earthed separately.	Yes

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 estimated as 4000m which 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. All materials used and workmanship shall conform to relevant BIS and IRC standard.

10. SPECIFIC SCHEDULE FOR FINISHES:

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
3	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
4	Staircase	18 mm thick Granite stone slab flooring of approved Texture and shade
5	Flooring for Toilets / Drinking water point, Balcony etc.	1200 x 600 mm anti-skid vitrified tile of approved shade and make
6	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
7	Dado for Pantry	600 mm high Glazed Ceramic tiles of approved shade along wall of granite counter
8	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)
9	Windows, Ventilators and fixed Glazing	Powder Coated Aluminium Windows of approved Extrusions
10	False ceiling	As mentioned in the building description

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,	2 Coats of Premium Acrylic Emulsion paint over white cement-based putty of average thickness 1mm of approved make

	VFD Room, Scada room, Record room	
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	Flooring of Battery rooms	20 mm thick Acid resistance tiles of approved Make
5	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
6	Staircase flooring and skirting	25 mm thick Kota stone slab
7	Flooring of Cable cellar room, Panel Room, Ventilation room / HVAC Room, MCC Room etc.	52 mm thick cement concrete flooring with concrete hardener
8	Store rooms / Record Rooms	600 x 600 mm 20 mm thick pre polished Kota stone
9	Flooring in toilets, Pantry, Drinking Water Area	300 x 300 mm Non-Skid Ceramic tile of approved make
10	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.
11	Dado for Pantry	600 mm high Glazed Ceramic tiles of approved make along wall of granite counter
12	Dado in Battery Room	1800 mm high dado with 20 mm thick Acid-resistant tiles
13	Parapet along internal corridors and all balconies other than terrace area	25 mm thick Kota slab (15 mm projected from edge of wall)
14	Windows, Ventilators and fixed Glazing	Powder coated Aluminium of approved shade

15	False ceiling for Cabins, control rooms, conference halls, console rooms, VFD Room, Scada room	Combination of Gypsum seamless and grid type ceiling
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FLOORINGS

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 consisting of:

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.

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.

Sports Flooring (Indoor games - Room): P/I of vinyl flooring, commercial grade of thickness 5-6.5 mm and wear layer thickness of 0.65mm and weight 2975g/sqm with group T as per EN-651 and with impact sound installation of 19dB and with Protesol surface treatment and Sano sol fungi static/bacteriostatic treatment.

Wooden flooring (applicable to CMD and Director rooms) - Providing & laying of 15mm thick made in India Engineered wood flooring with Plank width of 135mm and length of 1800mm with top layer of 3mm wood over 2mm thick Mikasa VA protect underlay (Combination of PE film and extruded foam). Surface of top layer is pre finished with several layers of UV hardened acrylic lacquer, free from formaldehyde and solvents. Flooring plank shall be interlocked using Plankton system. Average moisture content shall be approximately 7-9%. Engineered wood planks shall be a composition of 3 layers of board with directions of each layer oriented at right angle to the adjacent layer. Bevelled in length and width as specified by the manufacturer including fixing in position, levelling and finishing complete as per manufacturers specifications and direction of Engineer in charge.

SPECIFICATION OF FALSE CEILING

1. FALSE CEILING - Providing and fixing 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 upto 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 the cost of painting with : 12.5mm thick tapered edge gypsum plain board conforming to IS: 2095- part I.
2. 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.
 - 2.1.1 Tile Size: 600 X 600mm
 - 2.1.2 Tile Size: 1200 X 300mm
3. 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.

NOTE: Samples of all finishing material are to be got approved from M/s BEML ltd before using in works. The contractor shall produce samples of all materials and shall obtain approval of EIC in writing before he places bulk order for the material for incorporation in the works. In respect of the material for which samples are not kept to detailed specification or not given herein after, such materials shall comply with latest relevant Indian standard specifications.

The contractor shall on demand produce original receipted vouchers/ invoices in respect of material supplied by them.

Though the condition above has been written for finishing items, the same shall be applicable mutatis mutandis for all materials to be incorporated in works

11. CIVIL WORKS

11.1 General

The project site is located at Umariya Village near Obaidullaganj town in Raisen district, approximately 30 km south-east of Bhopal City, in Raisen District, Madhya Pradesh. The site is strategically positioned along National Highway 46, with good accessibility.

11.2 Descriptions of civil works

The civil engineering works shall comprise of:

Land And Site Development Works

- **Grading and levelling works**

1. Grading and levelling works is to be carried out in accordance with formation level provided for various zones of project site.
2. Rock obtained from cutting can be used in project construction for following purposes:
 - Stone pitching / Construction of toe wall, retaining wall (wherever required) by converting into stone block of sizes suitable for CR/RR-Masonry
 - Sub-base & Base course in road construction.
 - Base / Lean / filling & levelling concrete.
 - Rail track ballasts.
 - Landscaping.
 - For Back filling/bulk filling / levelling low lying area crushed stone can be used. The Size should be chosen such that it compacts well & drains adequately and does not create voids for this well graded crushed stone with maximum size 20mm with adequate fines to fill the voids will serve the purpose.
 - The above application is subject to conversion of quarried rock into usable aggregate of required size as specified under relevant code (IS/ IRC / MoRTH). For this purpose, the contractor at his own expense will install mobile crusher at site.
 - It shall be the sole responsibility if the contractor to dispose the surplus rock.
 - For filling purpose, the contractor can also use good earth mixed with fly-ash and aggregate in permitted size made out of rock obtained from cutting in accordance with relevant IS code and CPWD specification
 - Filling with good earth only or good earth mixed with stone aggregate of allowable size in permitted percentage as per relevant IS Code / CPWD Specification may be adopted in case the contractor has to bring earth from outside for bridging the gap of filling and cutting.
3. For excavation in rock the contractor maybe required to resort to blasting. Utmost care is required to be taken during blasting operations. All rules and regulations are to be

strictly adhered to, including obtaining required licenses and deployment of qualified personnel. Special care needs to be taken when doing blasting near to village area.

4. looking into the huge quantum of cutting and filling envisaged adequate number of required plans and machineries are to be deployed and round the clock working to be ensure for meeting the project timeline open foundation system as per requirement of sub soil condition observed in the adjacent site. Construction of RCC buildings, Steel structural buildings, Roads, Drains and associated facilities etc., including all finishing works, as per technological schemes shall be considered.

11.3 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 any other statutory regulations will be followed. In absence of suitable Bureau of Indian Standard codes and specifications, other international standards and codes shall be used.

All Structures, building foundations, Machines/equipment foundations, Water retaining structures, Trenches, Pits etc. will be designed as per latest relevant Bureau of Indian standard codes.

In general, construction will follow provisions and guidelines of IS: 456 / IS: 800 and IS: 3370 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.

11.4 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

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:

- 1.5 kN/m² for accessible roofs
- 0.75 kN/m² for non-accessible roofs

2) Electrical Building:

- Control room: 10 kN/m²
- MCC Room: 15 kN/m²
- Switchgear room: 15 kN/m²

3) Technological units

Live load and Equipment loads will be considered as per Technological requirement.

4) Other Areas:

- ✓ RCC Floors: 5 kN/m² for offices, laboratories, conference rooms and general floors
- ✓ Stairs and balconies : 5 kN/m²
- ✓ Chequered plate/gratings : 5 kN/m²
- ✓ Walkways : 3 kN/m²
- ✓ Toilet rooms : 2 kN/m²

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

c. 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.

D. 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 39 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.

E. 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.

F. 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.

G. 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.

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

I. 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.

J. 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.

K. 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.

L. 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.

Limit state of Collapse & 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.

11.5 DESIGN METHODOLOGY FOR RCC STRUCTURES

11.5.1 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.

11.5.2 Foundations

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.

11.5.3 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.

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

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

11.6 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 wind load condition.

11.7 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.

11.8 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 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

11.9 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 shall be M25, except for Trenches/Drains/Channels, which will be constructed using M20 grade RCC. 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.

11.10 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. Or OPC (ordinary Portland cement) 43-grade conforming to IS 8112-1989 mixed with fly ash in allowable percentage meeting required properties in accordance with relevant IS codes.

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, Structural flooring, framed structure (Except Equipment foundations, Water retaining structure, etc.)
M-30	Reinforced concrete work for Equipment foundations, Water retaining structure, Roads, etc.

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

11.11 REINFORCEMENT

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

11.12 AGGREGATE

These shall conform to IS: 383 Specification for Coarse and Fine Aggregates from Natural Resources including M-sand. Unless specified, 20 mm and downgraded aggregates will be used for all structural concrete works. However, for levelling and base concrete (lean concrete) up to M-15 grade, downgraded aggregate of nominal size 25mm or above maybe used as permissible under provisions of relevant IS code.

11.13 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.

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

11.14 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.

11.15 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.

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.

11.16 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.

11.17 ROADS AND DRAINS.

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

Internal roads will be RCC roads (M30), laid over a layer of PCC laid over a layer of Wet Mix Macadam laid over a layer of Granular Sub Base. 7.0 M wide Internal roads and approach roads & 4.0M wide peripheral roads are.

- **Roads & Drains**

1. Plant roads are to be invariably designed and constructed as rigid pavement with suitable expansion joints, camber and slope.
2. The width of the internal roads is envisaged as 7m and peripheral road of 4m has been considered with 1.0m wide berm and drains on either side are considered of the road.
3. 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 and strategic locations for proper illumination.
4. In-between the manufacturing blocks 8m wide RCC pavement has been considered.
5. The drainage of RCC / Masonry (CR-Masonry) is envisaged, the contractor is required carry out the detailed hydrological and drainage study for design and construction of drainage system which should also account for envisaged future expansion.

- **RCC Trench**

1. RCC storm water drains are considered, however the same shall be reviewed based on site/design requirement.
2. 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.)
3. Proper slope & drainage provision to be made in design and construction of these trenches for easy evacuation of storm water.

11.18 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.

11.19 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.
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.
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.

12 STRUCTURAL WORKS

12.1 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 tubes. The top rail will be 1.1 m above platforms level. The top rail, knee rail & the posts will be tubes and toe guards will be of steel plates or 4mm thick (i.e.: skelp plate).

12.2 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.

12.3 CODES AND THE STANDARDS

- The following (Indian) Codes and Standards shall be in generally used for design of structural works.

12.4 List of Codes & Standards

Steel structures		
	IS: 875 (Part 1)- 1987	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	Code of Practice for Design Loads (Other than EQ) for Buildings and Structures – Wind Loads
	IS: 1893 (Part 1)- 2016	Criteria for Earthquake Resistant Design of Structures –General Provisions and Buildings
	IS: 1893 (Part 2)- 2014	Criteria for Earthquake Resistant Design of Structures –Liquid retaining Tanks
	SP: 6 (Part 1 to 7)-1964	Hand book for Structural Engineers
	IS: 800 - 2007	General construction in steel – code of practice
	IS: 808	Dimension for hot Rolled steel beam , column, channel and angle sections
	IS: 812	Glossary of terms relating to cutting and welding of metals
	IS: 813	Scheme of symbols for welding
	IS: 814	Covered electrodes for manual metal arc welding of carbon and carbon manganese steel specifications
	IS: 815	Covered electrodes for metal arc welding in mild steel and high strength low alloy steel
	IS: 816	Use of metal arc welding for general construction in mild steel
	IS: 9595	Metal Arc welding of Carbon and Carbon Manganese steels – recommendations
	IS: 2062	Structural steel (standard quality)
	IS: 3502	Steel chequered plates
	IS: 822	Inspection of welds
	IS: 7215	Tolerance of fabricated steel structures
	IS: 7743	Magnetic flaw detection of welds
	IS: 9172	Recommended design practice for corrosion prevention of steel structures

Note: Latest editions of IS Codes shall be followed

12.5 DESIGN LIFE

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

12.6 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.

12.7 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; a aims structures withstand a major earthquake without collapse.

12.8 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

Kc = Combination Factor as per Cl 7.3.3.13

Design Wind Speed (V_z) = $K1 \cdot K2 \cdot K3 \cdot K4 \cdot \text{Basic Wind Speed}$

$$P_z = 0.6 V_z^2$$

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

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

Internal Pressure as per clause 7.3.2

12.9 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 and 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.

12.10 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.

12.11 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.

12.12 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.

12.13 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.

12.14 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.

12.15 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.

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

12.16 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.

12.17 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.

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 Sheeting	Span/180
				Plastered Sheeting	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 (absolute)	Span/400
		Crane + wind	Gantry (lateral)	Relative displacement between rails supporting crane	10 mm
Other Buildings	Vertical	Live load	Floor and Roof	Gantry (Elastic cladding; pendent operated)	Height/200
				Gantry (Brittle cladding; cab operated)	Height/400
		Live load	Cantilever	Elements not susceptible to cracking	Span/300
				Elements susceptible to cracking	Span/360
	Lateral	Wind	Building	Elements not susceptible to cracking	Span/150
				Elements susceptible to cracking	Span/180
		Wind	Inter storey drift	—	Storey height/300

12.18 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.

12.13 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.

12.14 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.

12.15 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.

12.16 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.

12.17 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.

12.18 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.

12.19 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.

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

12.20 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.

12.21 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

12.22 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

12.23 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

12.24 DESIGN LATERAL FORCE

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

$$VB = A_h W$$

Where,

A_h = 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.

12.25 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.

12.26 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.

12.27 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.

12.28 METHOD OF CONSTRUCTION

- a) Fabrication and erection of steel structures shall be in accordance with IS: 800 – 2007 and relevant standards mentioned there in.
- 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.

13. PRE-ENGINEERED BUILDING (PEB)

13.1 GENERAL

The scope covers proof checked design, fabrication, inspection, supply, erection and commissioning of Pre-Engineered Building (PEB) shed complete in all respects as per GADs of sheds enclosed in bid document.

Scope covers all components required to construct primary and secondary framing (wind bents, wall and roof purlins), wall and roof cladding, catwalk with hand rail, staircase, sliding door with frame and all necessary hardware needed for completing building/ shed.

General features of PEB covered in scope are detailed hereunder.

13.2 DESIGN SPECIFICATIONS

DESIGN LOADS (LIVE/ WIND)

Building should be designed and analysed for all possible combinations of live load, dead loads, gravity loads, earthquake loads, crane loads if any, wind loads etc for mean probable life of structure for 50 years.

1. Live load: 0.75 kN/m² as per IS 875-2-1987 Code of practice for design loads (other than earthquake) for buildings and structures, Part 2: imposed loads
2. Wind load: Basic wind speed as per IS 875-3-1987 Code of practice for design loads (other than earthquake) for buildings and structures, Part 3: wind loads
Probability factor k₁ as per codal provision.
Terrain height & structure size factor k₂ as per codal provision
Topography factor k₃ as per codal provision.
3. Seismic Zone: As per IS 1893-2002 (or latest)
4. Crane load Capacity of crane mentioned in Bid Document. Effect of two cranes working under full load in different combination, i.e., same, adjacent and different bays should be considered for vertical loads, lateral surge, tractive effort etc.
5. Dead load All possible weight of building components, electrical cables, pneumatic pipelines, gas pipelines, water pipelines, machinery, equipment, fittings etc should be considered.
6. Load combination All possible load combinations should be considered, i.e., dead load, imposed load, wind load, seismic load, temperature load etc as per relevant IS codes.

13.3 DEFLECTIONS

Main frame as per IS 800-2007 (or latest)

Vertical L/180 as per IS 800-2007 (or latest)

Lateral L/150 as per IS 800-2007 (or latest)

Purlins L/180 as per IS 800-2007 (or latest)

13.4 APPLICABLE CODES

Relevant BIS Codes with latest revision should be used. Wherever other than BIS codes/ manuals are mentioned equivalent BIS Codes may also be used.

- a) IS 875-1987 (or latest) Design loads (other than earthquake) for buildings and structures.
- b) IS 1893-2002 (or latest): Criteria for earthquake resistant design of structures
- c) IS 800-2007 (or latest) General construction in steel
- d) IS 801-1975 (or latest) Cold formed light gauge steel structure members in general building construction
- e) IS 12843-1989 (or latest) Tolerances for erection of steel structures
- f) Manual of Steel Construction, 9th Edition, American Institute of Steel Construction (AISC).
- g) Cold-formed Steel Design manual, 1996 Edition, American Iron and steel Institute (AISI)
- h) American Welding Society (AWS D 1.1.2008), Structural Welding Code– Steel

13.5 COLUMN DESIGN

Column design should be such that crane gantry load is vertically transferred directly to ground. Design of gantry girder on brackets fixed on column is permitted for EOT crane capacity.

13.6 SCOPE OF WORKS

Scope covers execution of complete PEB as per GAD of shed enclosed and specifications detailed in Bid Document and comprising items mentioned hereunder. However, the list is not exhaustive and may require some more items, which are not included in the list but are essentially required for completion of the work.

- a. Rigid frame structural for column, rafters with end plates, purlin, girt, bracing preferably piped bracing.
- b. Roof and wall cladding sheet, day light panel, flashing, trim, gutter, downspout Structural hardware, sheeting, fastener, end lap sealant, Anchor bolts and template.
- c. Crane girders/ beams, bracket, catwalk with hand rails at gantry level and
- d. staircase/ ladder to gantry, Framed opening, sliding doors, gravent, louver, turbo vent
- e. Structural members with one coat of factory applied
- f. primer and paint, final painting
- g. False ceiling panel, door, window, ventilator, rolling shutter, masonry brick wall, partition wall etc

13.7 STANDARD MATERIAL SPECIFICATIONS

Relevant BIS Codes latest revision should be used. Wherever other than BIS codes/ manuals are mentioned equivalent BIS Codes may also be used.

13.8 STRUCTURAL

Built-up sections should be fabricated from hot rolled plates conforming to ASTM A572 Gr50 (345MPa)/ IS 2062 E350 MPa steel. Sections should be fabricated from plates joined by continuous automatic submerged arc welding process. Hot rolled sections except beams should be mill sections complying with IS 2062 (240 MPa) steel. ERW pipes, sections and crane beams should be mill formed sections conforming IS 2062 (240 MPa) steel. Pre galvanized Z purlin as per ASTM A653M of thickness 1.6 mm, 2 mm and 2.5 mm of Gr50 (345 MPa) steel should be used. Bracing rods and sag rods should be made of steel bars conforming to IS 2062 (240 MPa).

13.9 FASTENERS

Primary structural connections should be made with electro galvanized (silver) high strength bolts Gr8.8 steel conforming to IS 3757. Purlins and girts should be connected to supporting members by machine bolts Gr4.6 steel conforming to IS 1363 electro-galvanized (yellow). Anchor bolts should be made from rods conforming to ASTM F1554 with a minimum yield strength of 250 MPa. Roof and wall panels should be fastened by No12 carbon steel self-drilling screws hot-dip galvanized with polymer- coated finish with an integral washer head to which an EDPM elastomer layer is bonded.

13.10 PAINTING

Scope covers painting of structural members. Primary steel should be shot blasted and cleaned thoroughly before applying primer coat. One primer coat of red oxide zinc chromate as per IS 2074 should be applied in shop after fabrication with an average dry film thickness (DFT) of 35 microns. Painting covers one shop primer coat and two coats of synthetic enamel paint (RAL 5010) of total DFT thickness of 100 microns on all structural members.

13.11 SHEETING

Scope covers supply and erection of 0.60 mm thick zincalume/ galvalume steel trapezoidal sheeting from reputed manufacturer with nominal 28 mm deep ribs. End ribs should be designed for anti-capillary action to avoid seepage of water through lateral overlap. Feed material of profiled sheet should be zincalume/ galvalume steel with base metal thickness (BMT) of 0.55 mm and total coated thickness of 0.60 mm.

Base metal should be high strength steel of 550 MPa yield strength with hot dip metallic coating of aluminium zinc alloy (55% Al, 43.4% Zn & 1.6% Si) as per ASTM A792M/ AS1397 & AZ150 of 150 gm/m² total on both sides with super durable polyester quality paint coat conforming to AS/ NZS 2728 Type- 4.

Painting should have total coating thickness of nominal 35 micron comprising nominal primer coat of 5 micron on both surfaces, external coat of nominal 20 micron on top surface (RAL 5012) and reverse coat of nominal 5 micron on back surface (RAL 9002). Colour shade for roof and wall cladding sheets should be selected from standard colour shade with approval of the employer.

Paint for exposed coat should be super durable polyester with inorganic pigment and free of lead. Conversion coating should be applied on both surfaces of metallic coating before application of paint as per AS-2728. Sheets should have marking details on backside of sheet at regular intervals indicating steel manufacturers name and product details.

Sheeting should be fastened with nominal 40-micron zinc coated or nominal 25-micron zinc-tin alloy coated Hex head self-drilling screw as per AS3566 2002 Class-3 fasteners of approved make with EDPM washer as per requirement considering profile shape and design load. Fastener size should be selected as per design/ manufacturers recommendations.

13.12 DAY LIGHT PANEL

Scope covers supply and fixing of UV protected polycarbonate day light panel minimum 2 mm thick conforming to classification 14443 PCISP LH49 2521 as per IS 14443 1997 with all flashings, trim closures, caps etc from reputed manufacturer. Profile of day light panel should match roof and wall sheeting panel. Closure strips should match sheeting profile.

13.13 LOUVER

Scope covers supply and fixing of louvers as per GAD of shed with fixed louver blades and border flashings manufactured from same sheeting material with outer side (RAL 9002) and inner side (RAL 5012) as per colour scheme approved by the employer.

13.14 TURBO VENT

Scope covers supply and fixing of gravity flow ridge type turbo roof vents with 600 mm throat and manufactured from same sheeting material. Turbo vents should be lightweight wind driven turbine-based roof vents manufactured from light weight, rust resistant aluminium alloy suitable to wind speed up to 200 km/hr.

Light weight roof vent structure should also assist in producing a low starting torque to initiate ventilation function. Double row ball bearings should be sealed and prepacked for maintenance free operation. Throat diameter of ventilation should be 600 mm with base plate of aluminium alloy. Colour of turbo vents should match with colour of roof sheeting (RAL 5012). Turbo roof vent should cover warranty for a period of 10 years guarantying ventilator turbine to spin when subjected to direct wind under normal conditions.

13.15 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.

13.16 STRUCTURAL CANOPY

Sidewall canopy should be 1500-2000 mm cantilevered rafter attached at eave or any point below eave supporting 200-250 mm deep Z purlins. Soffit panel should conceal canopy purlins leaving rafters exposed unless otherwise specified.

13.17 FASCIA AND PARAPET

Vertical and curve line fascia should be bracketing mounted type. Vertical fascia should consist of hot rolled I section or cold formed C section fascia post supported by hot rolled section bracket that is cantilevered from rigid frames columns at side walls and from end wall posts at end walls with cold formed 200-250 mm deep Z and C sections as top and bottom grits respectively. An intermediate C grit oriented vertically should support valley gutter when required.

Vertical fascia should project 600 mm from steel line. Height of fascia shall vary depending on actual requirement. Fascia cladding should be 0.60 mm thick TCT pre-painted Hi-Rib panels. Soffit panels and backside panels should be provided, if required. Curve line fascia is of same construction as vertical fascia but supplied with curved steel panel having same corrugation profile as Hi-Rib panel.

Parapet should be made from same construction as vertical fascia but without cantilever. Wall sheeting should continue to top of parapet.

13.18 ACCESSORIES (Trims, Flashings, Gutter, Downspouts, Ridge, Capping And Liner Panel)

Scope covers supply and fixing of accessories like louver blades, flashings, gutters, down take pipes, trims, ridges, capping, liner panels etc fabricated from same sheeting material used for roof and wall cladding application. Accessories should be fixed properly with roof and wall sheeting to ensure weather tight PEB shed. Down-take pipes/ downspout should be fabricated in square section (equivalent to 6" diameter pipe) from same sheeting material. Gutter and

down-take pipe system should ensure no water accumulation and stagnation at gutter level. Colour on outer side of accessories should be RAL 9002.

NOTE:

It is up to the bidder to assess the feasibility of adopting PEB technology for design and construction of manufacturing block OR to adopt a combination of both conventional fabrication as well as PEB. (maybe GF can be done using conventional & first floor using PEB).

However, inspection and testing bay has to be necessarily designed and constructed with PEB technology.

The intent of BEML is to get the project completed in time with quality. Bidders are requested to quote in consideration to above aspects.

14 PRESERVATIONS

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

14.1 Inspection

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

14.2 Erection

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

14.3 Painting

The recommended 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.

The paint scheme enclosed in Annexure should be followed invariably, Paints shall be free from VOC / lead free paints.

NOTE: All civil construction works are to be executed in accordance with referred specifications in the absence of specifications provided in the tender, relevant IS Code and CPWD specifications. maybe followed

If IS code or CPWD specification is not available for any work, specifications available elsewhere with best engineering practices shall be followed.

For maintaining quality approved FQP (field quality plan) to be invariably followed. FQP to be got approved before commencement of work.

15 ELECTRICAL WORKS:

15.1 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 etc.,)
- HVAC systems
- Lighting Load
- UPS for Admin building & 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.

15.2 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.

15.3 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.

15.4 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.

15.5 Scope of work and battery limits

Battery limits /scope of work shall start from the 33kV metering cubicle and goes downstream up to user end. 33kV incoming power supply shall be stepped down to 11kV through 33/11kV, ONAN Power transformers and further downstream to 415V through 11/0.433 kV ONAN Distribution transformers. Adequate quantity of Compact secondary substations (CSS) is considered for catering to LT loads of various facilities from MRSS building.

15.6 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 temp of +50 Deg C

15.7 EQUIPMENT SPECIFICATION:

A. POWER TRANSFORMER:

The Power transformer is envisaged to step down the 33kV incoming supply voltage to 11kV voltage at 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
8	<u>Bushing current transformers (LV Neutral side)</u>	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	
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 Top oil by thermometer method over design ambient temp. Any winding (HV&LV) by resistance method over design ambient temp. of 45 ⁰ C Hot spot temp. based on the design ambient of 45 ⁰ C	40 ⁰ C over 45 ⁰ C 40 ⁰ C over 45 ⁰ C 105 ⁰ C
14	Percentage impedance voltage at rated current, frequency, principle tap and 75 ⁰ C Between HV-LV	As per IS
15	Tapping's Off-circuit/ ON load Manual /automatic No. of steps Percentage variation /step	Off Circuit Manual 4

	Winding in which tapping's are required	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 with standard kVP	Switching Impulse withstand
	HV winding 20KV LV Winding 2.5KV	60kV -	NA
18	Winding insulation category 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:		

[illegible]

	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
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

Sl. No.	Particulars	
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
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 ±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

Sl. No.	Particulars	
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.

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 Colour code	RYB
9.	System Earthing	Solidly Earthed
10	Continuous Current Rating at 50 deg 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

Sl. No.	Particulars	11 kV
16.	Impulse withstands Voltage (1.2/50 micro sec) peak	75 kV
17.	Control Voltage	110 V DC / 220V DC
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
- 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
2	Bank rating in kVAR	refer SLD
3	Bank rating in capacitance	As required
4	Method of mounting	In CSS

Sl. No.	Description	415V
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

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
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.

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 (PLANTE)

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.

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.
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. draw out
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.
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.

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 deg.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).

- 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).
- For continuous duty drives like pumps, fans etc. – 115% of motor full load rated current (as indicated in motor data sheet/name plate).
- Current rating of AC drive will be calculated after de-rating to specified ambient temperature.
- 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.
- 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.

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	Motor of rating up to 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	$\geq 160\%$ 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.
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 & BTM (PT100 type)	<ul style="list-style-type: none"> - All motors will be provided with PT100 type (duplex) 6 nos. or (simplex 12 numbers) stator winding temperature detectors & 2 nos. Bearing (DE & NDE) temperature detectors (duplex) for monitoring alarm and trip conditions. - For HT motor temperature alarm, tripping & monitoring, RTDs (for winding/bearing) will be wired to motor protection relay in HTMCC 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.
(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	- Cylindrical. - Shaft will be extended for encoder/tach mounting.
5	Bearing	- 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	- TEFC, Effective bi-directional

		<ul style="list-style-type: none"> - Motor with 20:1 speed range or higher shall have external fan. - 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	- 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.

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).

15.8 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 Sqm) 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
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	Surface mounted (1x2) LED flame proof luminaire fixture
Electrical Rooms	200	Recessed/Surface mounted as suitable (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	
Hospital -Radiology Department	100	
Hospital-Casualty/ OPD	150	
Hospital Dispensaries	300	

HFFR wires shall be used for building electrification. Minimum 1.5 sq. mm. Cu wires for lighting circuits and 2.5 sq.mm. Cu wires for plug circuits.

The voltage drops from LDB and any fixture shall not exceed 3%.

For lighting circuits, the load is restricted to a maximum of 1 kW and for plug circuits it is restricted to 3 kW.

Individual control in office buildings shall be through single pole decorative modular grid mounting snap on type switches 10 Amperes. For high bay fittings where group controls are required, MCBs shall be provided

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.

15.9 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.

15.10 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 shall 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.

15.11 GI OCTAGONAL STREET LIGHT POLES

The Octagonal Poles will be designed to withstand the maximum wind speed as per IS 875 and should have height of 7m approx. in general. 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.

15.12 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 and should have 20m height 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.

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.

15.13 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.

15.14 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 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 Deg. 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.

15.15 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.

15.16 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.

15.17 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.

15.18 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.
- 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.

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.

15.19 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.)

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.

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.

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.

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.

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

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.

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.

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 960°C in accordance with IEC 60 695-2-11 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

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.

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.

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.

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.

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.

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.

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.

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).

16 INSTRUMENTATION & PROCESS CONTROL

16.1 FIRE DETECTION AND ALARM SYSTEM

I. 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.

II. 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.

III. SYSTEM PHILOSOPHY

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

IV. 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.

16.2 DETECTOR INSTALLATION AND SPACING

16.2.1 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.

- 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.

16.2.2 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.

16.3 TECHNICAL REQUIREMENTS

16.3.1 Addressable Fire Alarm Control Panel (FACP)

- a) UL 864-listed, microprocessor-based, modular panel with LCD/LED colour 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).
- 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.

16.3.2 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).

16.3.3 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.

16.3.4 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.

16.3.5 Remote Response Indicators

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

16.3.6 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.

16.3.7 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 analogue signals.
- d) All circuits shall be labelled at both ends and tagged for identification.

16.4 VERY EARLY SMOKE DETECTION ASPIRATION (VESDA) SYSTEM

16.4.1 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).

16.4.2 SYSTEM APPLICATION

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

- a) Server Rooms.

16.4.3 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, annunciates 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.

16.4.4 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
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

16.5 VIDEO CONFERENCE SYSTEM

This Design Basis Document defines the:

- **Technical requirements,**
- **system design philosophy,**
- and
- **configuration methodology.**

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.

16.5.1 Design Objectives

The Video Conference System shall:

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

16.5.2 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.

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 joins 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.

Board Room Configuration

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

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.

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.

16.5.3 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 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, and wireless connectivity (Wi-Fi) 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:

- 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.
- 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.

16.6 NETWORK COMPONENTS AND SUBSYSTEMS

16.6.1 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.

16.6.2 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.

16.6.3 WIRELESS NETWORK (WI-FI)

The Wi-Fi system provides secure and high-speed wireless access across office, meeting, and public areas.

- Dual-band access points connected to PoE switches ensure seamless coverage and mobility.
- Wireless controllers manage SSIDs, authentication, and bandwidth policies for users and guests.
- Wi-Fi is integrated with the intranet for internal users and with internet gateway firewalls for guest access through captive portals.
- RF design ensures uniform signal distribution and minimal interference, supporting roaming and high-density user environments.

16.6.4 REDUNDANCY AND HIGH AVAILABILITY

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

- 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.

16.6.5 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.

SYSTEM SIZING & DESIGN CRITERIA

- 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%.
- Minimum two network drops per workstation and dual network connections for critical systems.
- Fibre backbone between communication rooms and data centre sized for high-throughput (10 Gb/s or higher) with headroom.
- Access switch capacity and PoE budget sized to support all IP-devices with growth.
- Wi-Fi AP density planned for both user access and device connectivity; ensure overlapping coverage and seamless roaming.
- Bandwidth and QoS provisioning to support voice, video, data and IoT traffic; ensure separate VLANs and priority settings to avoid congestion.
- 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.

16.7 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.

DESIGN OBJECTIVES

The primary objectives of the voice communication system are to:

- Provide reliable and high-quality voice communication across all areas of the facility.

- b) Integrate IP-PBX systems, VoIP phones, and analogue 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, analogue, 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, analogue 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

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.

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.

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 analogue gateways located in communication racks.

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.

INTERMEDIATE DISTRIBUTION FRAME (IDF)

Each floor or zone includes an IDF housing PoE network switches and analog 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.

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.

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.

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 analogue extensions. Fiber links connect the MDF to IDFs ensuring scalability and future integration.

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

16.8 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.

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).

b. Zoning:

Facility divided into functional zones (e.g., 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.

16.9 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.

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 (Mi fare):** Installed at entry and exit points for user identification through fingerprint or card credentials.
- 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.
- **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.

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.

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

16.11 X-Ray Baggage Scanners

- Purpose: Non-intrusive inspection of bags for explosives, weapons, contraband.
- Tunnel Size: As per site requirement (e.g., 620×420 mm / 1000×1000 mm).
- Imaging: Dual-energy X-ray, organic/inorganic material discrimination, threat image projection (TIP).
- Safety: AERB compliance, leakage <1 µSv/hr, emergency stop, lead shielding.
- Throughput: ≥550 bags/hour (model dependent).
- Connectivity: Networked for image storage, operator console, central security room.

16.11 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.

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 ±10%, 50 Hz or per OEM.
 - UPS-backed for critical units (30–60 min).

- Surge protection for outdoor installations.

16.12 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.

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.

SCOPE OF IBMS

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

- a. HVAC System – AHUs, FAHUs, VRV/VRF, chillers, pumps, cooling towers, 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.

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.
- 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.

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.

HVAC Integration Criteria

- a. Monitor and control all major HVAC equipment such as AHUs, chillers, pumps, fans and valves.

- b. Real-time temperature, humidity and airflow monitoring.
- c. Demand-based and schedule-based automation for energy efficiency.
- d. Fault, status and operating hours logging for predictive maintenance.

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.

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.

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.

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.

Field Devices & Sensors

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

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

Controllers & Panels

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

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

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

17 HEATING, VENTILATION AND AIR CONDITIONING (HVAC) SYSTEM:

17.1 GENERAL

- 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. The ACVS plant rooms will be integral with and adjacent to the served premises and will be located based on the convenience of routing of ducts, availability of fresh uncontaminated air and creating least disturbance to adjacent premises in terms of vibration and noise. ACVS will be provided with adequate measures for safety.

17.2 DESIGN BASIS

1. Air Conditioning Systems

- 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.
- 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, Server room, PLC rooms, UPS Rooms, VFD Rooms cum IMCC panel rooms & any other room where electronic panel / equipment is located	$23 \pm 2^{\circ}\text{C}$	$55 \pm 5\%$
2	Office rooms, Conference rooms, etc.	$24 \pm 2^{\circ}\text{C}$	$<70\%$

- Outside design Condition: As per the Meteorological data of site.
- 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.
- A minimum of 50% standby capacity is provided for the air conditioning 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.
- Premises to be Air conditioned & System Description

Table-2

S. No	Room/Area / Premises	Equipment / System Proposed	Equipment Capacity
1	Office complex	Central chilled water-based system comprising of chillers, pumps, cooling towers, piping, valves, AHUs, ducting, dampers, diffusers etc.	a) Water cooled screw Chillers - 280 TR x 4 Nos (3W+1S)

2	Canteen		b) Chilled water pumps (120 m ³ /hr) - 2 Nos. (1W+1S) c) Condenser water pumps (140 m ³ /hr) - 2 Nos. (1W+1S) d) FRP Cooling towers (~225 TR) - 2 Nos. (1W+1S) e) Air handling units i) AHUs - 30 TR x 12 Nos. Office complex - (Main Admin Building) ii) AHUs - 35 TR x 4 Nos. (Canteen) iii) AHUs - 20 TR x 2 Nos. (Medical Centre) iv) AHU 20 TR (02) - Safety Office
3	Medical Centre.		
4	Safety Office		
5	Main security Complex	Air Cooled VRF Type System	40 TR (60 HP) outdoor unit & suitable capacity Indoor units to various rooms
6	Annexe Building	Air Cooled VRF Type System	50-No's

Note: The Capacity of equipment indicate in above table are indicative and for reference only. The system is to be designed to arrive at desired capacity of each equipment. The bidder to consider this aspect and quote accordingly.

17.3 Ventilation systems

- Ventilation facilities shall be envisaged for the premises as per the relevant standards for creating efficient environment for the working personnel & equipment.
- 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.
- 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. In manufacturing blocks for proper ventilation for both the

- floors (Ground and First) adequate number of wall mounted propeller / axial flow fans of suitable capacity with cowl and Bird screen to be provided.
- 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, 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 of suitable capacity 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.
- h) Ducting (common to Air conditioning & ventilation systems): The velocities in the duct shall be as follows:

Table-3

Description	Air velocity	
	Ventilation system	Air Conditioning system
Main Duct	8 – 10 m/sec	6 – 8 m/sc
Branch Ducts	6 – 8 m/sec	4 – 5 m /sec
Diffusers / grilles	4 - 6 m/sec	3 - 4 m/sec

- The ducting shall be designed as per latest editions of SMACNA and manufacturer standards / data.

17.4 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:

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

Standard	Particulars
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
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

17.5 Technical Specification of the equipment

17.5.1 Water Chilling Package

The chilling package shall include the following major components: -

- Semi-hermetic Twin-Screw Compressors
- Shell & tube Flooded type evaporator
- Shell & tube water-cooled Condenser
- Associated refrigerant piping, valves, fittings, accessories and controls
- Condenser water pumps & Chilled water pumps
- GS-FRP-fill ID Cooling towers
- Expansion tank
- Inter-connecting piping network
- Electrics & controls

17.5.2 Screw Compressor

- a) The compressor shall be of multi-circuit twin screw, semi - hermetic screw compressor type suitable for HFC -134a / Env. friendly refrigerant and should offer economical part load operation.
- b) The motor should be cooled by independent refrigerant supply to ensure it always runs at the ideal temperature. Mixture of oil and liquid refrigerant shall be injected in the compressor in order to get high COP at high condensing pressure.
- c) The unit should be provided with an integral oil separator and it shall be of high efficiency, augmented gas impingement type to maximize oil extraction. The compressor shall have an in-built oil separator for oil separation before the refrigerant enters the condenser.
- d) The unit should be with electronic expansion device for optimized refrigerant metering to the evaporator - ensuring maximum utilization of heat exchange surface.
- e) The unit shall use the latest microprocessor-based control technology – which constantly monitors all machine parameters and precisely manages the operation of Compressors & expansion devices for optimum energy efficiency. The control system shall offer chiller protection during fault conditions arising from high condensing temperature.
- f) The unit shall have automatic capacity control through regulation of slide valve in the compressor based on requirements of the cooling capacity thus ensuring proper control on leaving chilled water temperature.
- g) The refrigerant shall be environment friendly with zero ozone depletion potential and minimum global warming potential. Refrigerant containing chlorine CFC and HCFC shall not be acceptable.

17.5.3 Shell & Tube Chiller

- a) The units shall be supplied with shell and tube Flooded type evaporator. Replaceable tubes shall be fabricated from integral finned copper and mechanically bonded to steel tube sheet. Waterside working pressure should be designed for 10.5 bar. Pressure relief valve shall be mounted on the suction side of the refrigerant circuit. Evaporator shall be insulated as specified elsewhere.
- b) The chiller shall be designed, manufactured & tested as per the ASHRAE / ARI standards.
- c) The tubes shall be of copper of min. dia. $\frac{3}{4}$ " having minimum wall thickness of 0.63 mm.
- d) The chiller shall be designed / selected with an adequate overloading factor to account for scale formation on the waterside.
- e) The chiller assembly shall be tested hydraulically for strength & pneumatically for leakage pressures as per code of unfired pressure vessels.
- f) Suction line and chiller insulation complete as required Suction line & Chillers shall be adequately insulated with minimum 19mm thick polyvinyl Nitrile rubber insulation finished with 0.63mm thick G.S.S cladding or equivalent insulation material as per standard procedures.
- g) Chiller shall be equipped with the following controls / accessories / safety devices:
 - Cooling & anti-freeze thermostats

- Water inlet / outlet connections with flanges & shut-off valves
 - Vent connections with valves
 - Pressure & temperature gauges at all the water inlets / outlets
 - Relief valve, purge valve, drain valve, and shut off valve
 - Refrigerant charging connection with valve
 - Pressure & temperature gauges at the refrigerant inlet / outlet
 - Flow meters & switches on the water lines
- h) A liquid level sight glass or view port shall be provided on the side of the chiller to determine proper refrigerant charge. Fouling factor of $0.0001 \text{ ft}^2 \cdot \text{hr.}^\circ \text{F} / \text{BTU}$ may be considered for selection / sizing of Chiller. Pressure drop of water across the cooler shall be limited to 0.5 kg/cm^2 .

17.5.4 Condenser

- a) The condenser shall be of water-cooled horizontal shell & tube type construction with water flowing inside the tubes and the refrigerant gas condensing outside the tubes. A discharge gas baffle shall be incorporated to prevent direct impingement on the tubes. This baffle shall be designed so as to distribute refrigerant gas properly for most efficient heat transfer.
- b) The condenser shall be equipped with integral finned type, solid drawn, seamless copper tubes. Minimum tube thickness shall be 0.63 mm with internal turbulator. (Minimum number of fins shall be 25 per inch).
- c) The condenser shall be of water-cooled horizontal shell & tube with refrigerant & water connections, integrally finned copper tubes with adequate surface area to provide sub-cooling at 2°C (min.) being imparted to refrigerant liquid within the condenser shell only. Temperature raise across condenser shall not be more than 5°C . Pressure drop of water across condenser shall be limited to 0.9 kg/cm^2 . Fouling factor of $0.00025 \text{ ft}^2 \cdot \text{hr.}^\circ \text{F} / \text{BTU}$ may be considered for selection / sizing of Condenser.
- d) Multi-pass construction is desirable for the condenser. It shall be designed for proper number of passes to give optimum water velocity; efficient heat transfer & allowable pressure drop. Adequate baffling arrangement shall be used in the condenser to improve heat transfer. Condenser tubes shall be adequately supported to prevent sagging & vibration. A purge connection shall be located in the condenser for efficient elimination of non- condensable.
- e) The condenser shall be equipped with the following accessories / safety devices:
 - Purge valve
 - Charging valve
 - Relief valve / fusible plug
 - Liquid level indicator
 - Hot gas inlet / liquid outlet connections on the shell with flanges
 - Water inlet / outlet connections with flanges
 - Hand shut-off valve for water inlet & outlet

- Flow switches for the condenser water
 - Pressure & temperature gauges for water inlet & outlet / refrigerant gas inlet & liquid outlet
 - Vent valves, drain valves
 - Charging valves
- f) Condenser assembly should be tested hydrostatically for strength and pneumatically for leakages at pressures as per latest codes of unfired pressure vessels.

17.5.5 Micro-Processor based Control Panel

- a) Each unit shall be provided with a Micro-processor-based control Panel, factory mounted, wired and tested. The control panel shall include alphanumeric display showing all system parameters in English language with numeric data in English (FPS) units.
- b) All safety and cycling shutdowns shall be annunciates through the alphanumeric display and consist of day, time, cause of shutdown, and type of restart required.
- c) Safety shutdowns shall include: - high compressor discharge temperature, low evaporator pressure, motor controller fault and sensor malfunctions, Loss of chilled water flow, loss of condenser water flow.
- d) Cycling shutdowns shall include: - low water temperature, low oil temperature, chiller/condenser water flow interruption, power fault, internal time clock and entire cycle.
- e) Control panel shall be able to interface with the Centralized Monitoring System to monitor operating parameters of chiller and status messages indicating chiller is ready to start, chiller is operating, chiller is shutdown on a safety requiring reset.
- f) Security access shall be provided to prevent unauthorized change of set points to allow local or remote control of the chiller and to allow manual operation of the oil pump.
- g) The microprocessor shall ensure even compressor loading and optimal energy efficiency through microprocessor controls.
- h) The display shall have operating parameters like: -
 - Entering and leaving chilled water temperature.
 - Entering and leaving condenser water temperature.
 - Refrigerant Suction Pressure.
 - Refrigerant Discharge Pressure.
 - System Voltage.
 - Actual current drawn by compressors.
 - Loading / unloading status.
 - Compressor running hours.
 - Other display / functions which are essential for operation and safety of Chiller.

17.5.7 Inter-connecting refrigerant piping, fittings & valves

- a) Refrigerant piping is required to interconnect the compressor, condenser & the chiller into a closed network.
- b) Suction line shall be thermally insulated with polyurethane of 50 mm thick. The piping design shall be carried out in conformity with the (ANSI – B-31.5-1962) codes applicable & sound engineering practice. Heavy-duty seamless steel pipe shall be used for pipe network. While seamless solid drawn copper tubes shall be used for refrigerant liquid line.
- c) The piping network shall be adequately supported to ensure rigidity, strength & isolated by means of suitable isolators.
- d) The tenderer shall furnish complete piping & instrumentation diagrams showing the arrangement of piping inclusive of all materials, instruments & controls proposed to be included in the bid. The entire piping network shall be pressure-tested, leak tested, dried, evacuated & charged with the refrigerant after erection.
- e) All bolts & nuts shall be of black hexagonal carbon steel type as per IS: 1363 (1992) & with the material & other requirements as per IS: 1367- 1992.
- f) Velocity in the discharge & Suction pipe of the refrigerant shall be such that no undue vibration & noise are generated.
- g) The piping network shall incorporate loops in the circuit to efficiently separate oil and liquid refrigerant from hot gas and suction vapor respectively.
- h) All horizontal lines shall be pitched to 12 mm for every 3.0 m in the direction of refrigerant flow. All necessary loops and bends shall be provided to ensure proper return of oil to the compressor.
- i) Each refrigerant circuit shall be suitable for operation on HFC-134a and shall include the following items:
 - Electronic expansion valve
 - Removable liquid line drier / strainer
 - Liquid line sight glass with moisture indicator.
 - Hand shut off valves
 - Liquid to suction heat exchanger

17.6 Water pumps (Chilled water & Condenser water re-circulation)

- 17.6.7** The pumps shall be designed, manufactured and tested as per latest editions of IS 5120, IS 9137, IS 6595: part 2 or as per other international standards acceptable to the Purchaser and shall be suitable for the duty conditions and capacities as indicated in this specification.
- 17.6.8** The Horizontal / Vertical Split Casing type centrifugal pumps along with their auxiliary equipment shall be designed and manufactured for continuous duty at full load.
- 17.6.9** Pump head capacity characteristic shall be gradually rising from operating to shut-off point without any zone of instability. The pump BHP - flow characteristic shall preferably be non-overloading type beyond rated capacity point. Pumps shall be rated for continuous operation.

- 17.6.10** Pumps shall be capable of developing the required head at rated capacity for continuous operation. The pumps shall operate satisfactory at any point on the H-Q characteristic curve over a range of 70% to 130% capacity corresponding to 75% of the total head whichever is lower.
- 17.6.11** Capacity vs discharge pressure curve for each pump shall preferably be continuously drooping from the shut-off point to the rated operation point and be suitable for parallel operation. The pumps shall be designed to avoid cavitation at any of the operating points.
- 17.6.12** 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.
- 17.6.13** The equipment and auxiliaries shall be designed for quick and economical maintenance. The equipment shall be easily dismantle-able without disturbing the suction, delivery pipe connections and motor.
- 17.6.14** Operating speed of the pumps shall not be more than 1500 rpm & the equipment design shall incorporate provisions for reduction in noise level.
- 17.6.15** The required NPSH at duty point shall be at least 1.0 m lesser than the available NPSH.
- 17.6.16** The power rating of the pump motor shall be larger of the following
- ✓ 110% of the power required at the duty point.
 - ✓ For parallel operation, motor rating should be sufficient enough for running of single pump also.
- 17.6.17** All moving parts and items of the equipment, which can conceivably cause injury to the operator or otherwise authorized personnel within the vicinity of working area, shall be adequately guarded.
- 17.6.18** The equipment shall be designed for continuous duty to run 24 hours a day & 365 days a year.
- 17.6.19** The common base frame for pump and motor shall be in one piece with suitable holes for grouting. Adequate space shall be provided between pump drain connections and base plate for installation of minimum 15mm drain piping. Pumps shall be supplied with suitable drain pans or drain rim type base plates with valved drain connections.
- 17.6.20** Coupling guard, made of expanded metal and bolted to the base plate shall be supplied for all pumps.
- 17.6.21** Standard hydrostatic test shall be conducted on the pump casing with water at 1.5 times the maximum discharge head or twice the rated discharge head whichever is higher. The hydrostatic tests on the casing shall be conducted for a minimum duration of 30 minutes.

17.7 Casing

- ✓ The casing shall be of cast iron and shall be designed for a pressure not less than the shut-off pressure at the highest operating speed plus the maximum pressure that may

be encountered at the pump inlet. In addition, CI casing shall have corrosion allowance of not lower than 3 mm.

17.8 Impellers

- a) Impeller shall be of bronze/SS. Impellers and balancing drums (if provided) shall be statically and dynamically balanced. Dynamic balancing shall be at the operating speed of the pump. For multi stage pumps, all the impellers shall be assembled together for balancing. Provision shall be made for adjusting the clearance between the impeller and the casing to compensate for wear.
- b) The impeller shall be keyed or screwed on to the shaft in such a way that it does not come-out due to reverse rotation of the pump.

17.9 Shaft

The shaft shall be of AISI-410 and shall be designed for critical speed. The ratio of critical speed to speed of shaft shall be not less than 1.2 for solid shafts.

17.10 Shaft sealing

Mechanical type Shaft seals shall be provided to prevent leakage out of, or into, a pump over the range of specified operating conditions. 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.

17.11 Bearing

Two bearing assemblies shall be provided, one within the frame to carry radial load only and the other to carry both radial and axial thrust. Bearings shall be of manufacturer's standard design, antifriction type, oil / grease lubricated. Suitable thrust bearings shall be provided in the pump to take total thrust of the pump including hydraulic thrust. Thrust bearings shall be of oil lubricated type with suitable cooling arrangement. Motor thrust bearing shall be designed without water cooling arrangement. Suitable tapped holes shall be provided for refilling of oil in the bearing housing.

17.12 Base plate

All pumps shall be supplied with sturdy base plates, as per manufacturer's standard, common to pump and drive. Base plates and pump supports shall be constructed so rigidly and the unit so mounted as to minimize misalignment due to piping strain, internal differential thermal expansion, etc. Base plates shall be fabricated from MS channels.

17.13 Companion flanges, bolts, nuts & gaskets

- a) Plate flanges having raised face shall be provided at suction and delivery side of pumps and they shall be of mild steel and conform to table 17 of IS 6392:1971 (RA1998). Slip

on raised face flanges to 150 Lbs. class conforming to ANSI B16.5 shall also be acceptable.

- b) Black bolts and nuts conforming to relevant part of IS 1367 shall be provided for the companion flanges.
- c) CAF gaskets of 1.5 mm thickness conforming to IS 2712:1998 (RA 1999) shall be provided for the companion flanges.

17.14 Materials of the pump shall preferably be as follows: -

Casing	:	Cast iron
Impeller	:	Bronze / SS
Impeller ring	:	White metal
Shaft	:	EN8
Shaft sleeve	:	Bronze
Bearing	:	Heavy-duty ball / Roller bearing
Stuffing box bushes	:	White metal.
Base plate	:	Cast iron / fabricated MS
Gland	:	Cast iron
Flanges	:	IS: 1536
Coupling	:	Flexible
Packing	:	Mechanical seals

Each pump shall be complete with pressure gauge at the suction & discharge complete with Flow control valves, isolating valve, non-return valves & Y-Strainer. All inte-

gral piping required for sealing, cooling etc. should be supplied with the pump.

Dial type pressure & temperature gauges should be provided for suction & discharge sides.

Each pump set shall be tested for mechanical running for at least 4 hours at site.

To protect from any condensation, chilled water pump (casing) should be thermally insulated with minimum 25 mm thick polyvinyl closed cell Nitrile rubber insulation & finished with 0.63mm thick G.S.S cladding or equivalent insulation material as per standard procedures.

17.15 Cooling Tower

- a) Induced draft, Cross flow type, Factory assembled, GS FRP-fill cooling tower shall be provided for the cooling of condenser water with 4 deg. C approach temperature.
- b) Cooling tower shall be designed, manufactured, performance tested as per CTI codes & CTI certified. The Cooling towers shall comply with Energy efficiency requirements as per ASHRAE std. 90.1.
- c) The cooling towers shall be provided with FRP cold water basin, with internal partition for each cell of the cooling tower. The make-up water to be tapped from the make-up water tank located on the roof of the Chilled water plant. The construction should be such

as to eliminate the danger of drawing air into the pump when operating with minimum water in the basin.

- d) The cold-water basin shall have accessories & connections for makeup, quick fill, drain & overflow. Ball & float valve is to be provided for makeup water line. The makeup water supply pipe shall be positioned at least 2 meters above the maximum level in the basin. Pressure reducing valve (6.0 bar to 0.5 bar) may be provided to reduce the pressure of make-up water.
- e) The cooling towers shall be mounted on masonry pillars / Stools on the terrace of Chilled water Plant.
- f) The filling shall be of PVC. Thickness of PVC fills shall not be less than 0.2mm. These shall be of such construction as to provide low air resistance, large wetted surface for a high heat transfer efficiency, and easy replace ability.
- g) The water distribution system shall be either open basin with gravity feed nozzles or pipe system with nozzles requiring not more than 0.5 kg / cm² water pressure at rated capacity. The nozzles shall be spaced to give even distribution of water. The nozzles shall be self-draining, non-clogging and designed for flexible operation & ready accessibility. Suitable measuring orifices shall be provided. All main piping connections shall be brought out & shall end in flanges to facilitate connections.
- h) Drift eliminators of PVC shall be provided for maximum removal of entrained water droplets. The spacers and tie rods used shall be of plastic material. Eliminators shall be provided in removable sections & installed in the cell of the tower. The number of deflections in the eliminators shall be so arranged as to limit the drift loss to 0.2 % of the water circulated.
- i) All the fasteners shall be of stainless steel. Rubber / Neoprene gaskets must be used on all bolted joints as a seal against water leakage.
- j) Motors of induced draft fan shall be of weatherproof construction. The fan motor shall be totally enclosed air over (TEAO), reversible, squirrel cage, ball bearing type designed specifically for cooling tower duty. The motors shall be furnished with special moisture protection on windings, ball bearings & shafts and labeled appropriately for cooling tower service.
- k) Fans shall be of heavy duty, multi blade, axial flow, Aluminium alloy blades. Fans & shafts shall be supported by heavy duty, self-aligning, grease packed ball bearings with moisture proof seals and integral slinger collars.
- l) The cooling tower shall be complete with ladder, access platform for maintenance & service requirements.

17.16 Chilled Water / Condenser water Piping with Accessories

- a) MS Medium Class piping is to be used as per IS: 1239 Part - I for interconnecting chilled water - piping network. Pipes above 150 mm diameter shall conform to IS: 3589 & shall have minimum 5 mm thickness.
- b) Velocity of water in pump suction line and delivery line will be within 1.2 and 2.0 m/sec respectively. Velocity in pipes shall be maximum 2.0 m/sec.

- c) Y-Strainer / Pot strainer to be provided in suction line of pump and gate valve and non-return valve to be provided in the delivery side of pump.
- d) Gate valve will be provided in water pipeline for Shutoff & Partial flow control and Globe valves for flow regulation purposes.
- e) Pipe fittings like bends, elbows, flanges, sockets, nipples, etc. will be as per relevant IS/BIS standards.
- f) Matching flanges shall be as per IS: 6392. All bolts & nuts shall be black hexagonal carbon steel type conforming to IS: 1363 for material & other requirement as per IS: 1367.
- g) Drain piping network is to be included as required for condensate drain, with isolation valves at proper places.
- h) Pipe supports will be steel, adjustable for height and coated with rust preventive primer and finish coated with aluminium paint. Where pipe and clamp are of dissimilar material a gasket will be provided in between.
- i) Spacing of pipe supports will not exceed the following:

Pipe (mm)	Spacing (Metres.)
3 to 12	1.25
19 to 25	1.85
32 to 150	2.50
150 and above	3.00

- j) All piping shall be tested to hydrostatic test pressure of at least one & half times the maximum of operating pressure but not less than 7 kg/ cm² for a period of not less than 24 hours. System may be tested in sections & such section shall be securely capped. No insulation shall be applied to piping until the completion of pressure testing to the satisfaction of the owner.
- k) The Tenderer will provide all materials, tools, equipment, instruments, services and labour required to perform test and remove water resulting from cleaning and/after testing.
- l) Pressure gauge dial dia. will not be less than 150mm. The pressure gauge will be with appropriate working range and be complete with shut off gauge cocks, etc. duly calibrated before installation.
- m) Gunmetal gate & globe valves are to be used up to pipe sizes 50 mm & butterfly valves are to be used above these pipe sizes. Gunmetal valves shall be as per IS: 778 Class - I with screwed ends.
- n) Chilled water piping laid indoor shall be as follows: -

Pipe size	Material	Joints / Fittings	Sealing material
Up to 65 mm	M.S tube Medium IS-1239 Part –1	a) Welded fittings b) Unions c) Slip on flanges d) Welded joints	a) Non-hardening b) Lubricant c) 3 mm - 3 ply Rubber insertion d) -----
75 to 200 mm	---- do ----	a) Welded b) Slip on flanges c) Screwed GI flanges for GI pipes	a) ----- b) 3 mm - 3 ply rubber insertion c) -----

17.17 Thermal Insulation of Chilled water pipes

- Clean the pipe surface with wire brush and apply a coat of bituminous primer.
- Apply a thick coat of bituminous cold adhesive over the surface.
- Fix pre-formed pipe sections (Polyurethane / phenolic foam of min. 32 kg/m³ density) minimum 50 mm thickness / 75 mm thk (outdoor / exposed / buried piping) secured in position by means of aluminum band of size 20 mm x 24 swg at 300 mm center to center.
- Wrapping the pipe with Aluminum foil laminated Kraft paper as vapor barrier over the insulation with proper overlaps and joints sealed by means of self-adhesive Aluminum foil tape.
- Provide the surface with Aluminum band of size 20 mm x 24 swg at 400 mm center to center.
- Fix plain Aluminum sheet 0.5 mm thick with self-tapping screws to the floating rings made of MS flat 25 x 3 mm at 400 mm center to center. The sheet joint shall be sealed with suitable sealant.
- For pipes buried in ground outer protective insulation jacket shall be seamless, extruded, black, UV resistant, high-density polyethylene (HDPE).

17.18 Thermal insulation for GI class B piping for drain

- Clean the pipe with wire brush and apply a coat of bituminous primer.
- Apply thick coat of adhesive.
- Insert the preformed pipe sections of Aluminum foil faced Nitrile rubber 25 mm thick on the surface.
- Cover the joint with 50mm Aluminum Adhesive tapes at all places circumferential and longitudinal.

17.19 Valve & Accessories

- Balancing Valve

The balancing valve shall be fitted in to the pipeline system for balancing, control and shut off. These shall have in-built flow measuring port to measure flow and pressure drop for proper

balancing and control of water. The body shall be made up of Gun metal / cast iron body that is corrosion resistant with EPDM coated disc with long pitch with protected out pipe insulation. Pressure rating of valve shall be PN16.

b. Butterfly Valve

The Butterfly valve shall comprise of a standard one-piece body casted out of graded Cast iron, the disc shall be made out of casted stainless steel/ Bronze, seat made out of Nitrile rubber for proper isolation/ seal. The coating on the body and disc shall be either epoxy or PTFE material. Pressure rating of valve shall be PN16. Butterfly valve shall perform the function of isolating valves. All Butterfly valves shall be provided with locking devices.

c. Globe Valve

The Globe valve shall have a forged casted brass or bronze body, the packing and the seat shall be made out of Teflon material for valve seat tightness. The valve shall have a large flow chamber to enable minimum pressure drop and maximum flow. The seals for the body and bonnet shall be of fully retained gasket. Pressure rating of valve shall be PN16.

d. Ball Valve

The ball valve shall have a forged casted brass or bronze body, PTFE Disc & packing along with MS nut and handle. Pressure rating of valve shall be PN20.

e. Non-return (check) valves

It shall be provided conforming to BIS 778 and IS 5312 (Part I) and in accordance with the following specifications.

Size	Construction	Ends
50 mm to 150 mm	Cast iron/Gun Metal plate	Flanged
200 mm to 450 mm	Body cast iron, plate carbon steel with 13% chrome overlay	Flanged

The spring and hinge / stop pin shall be SS 304 and bearing fine material. Non-return valves shall be disc type. Swing check valves shall normally be used in all water services. Lift type valves may be used in horizontal runs. Valves shall be suitable for not less than 15 kg per Sq.cm gauge working pressure.

f. Three-way modulating valves

These shall be provided in chilled water lines as diverting valves at each air-handling unit and shall be actuated by a space thermostat. Space conditions shall be maintained by continuous proportional modulation of the chilled water through the coil. The valve shall revert to fully

bypass position when fan is shut off. Maximum pressure drop across valve shall not exceed 0.85 kg/ sq.cm.

g. Thermostats

- Thermostats shall be electric fixed differential type as indicated below, with sensing element located in the return air stream.
- All thermostats shall be supplied with the standard mounting boxes as recommended by the manufacturer. The profile, mounting arrangement and exact location of the thermostat shall be such as to suit the site.
- Proportional control thermostats shall be provided for actuating the three way modulating valve at each air handling unit. Thermostat shall provide manual switching (heat-off-cool-in heating-cooling system).
- Thermostat shall have temperature adjustments "Warm-Normal-Cool" settings and fan switch. Switching off must break fan circuit.
- Air-stat shall be provided within air handling unit containing electric heating or reheat coils to prevent heaters from energizing unless the air flow is established.

h. Strainers

- Strainers shall be of 'Y' type or pot type.
 - 'Y' strainers shall be provided on the inlet side of each air-handling units and pumps in chilled water and condenser water circuit.
 - Pot strainers, shall be provided in return water header, for chilled water and condenser water.
 - The strainers shall be designed to the test pressure specified for the gate valves.
 - Filtration area of Y-strainer shall be minimum four times the connecting pipe size.
 - Strainers shall have a removable bronze/ stainless steel minimum 1mm thick screen with 3 mm perforations and permanent magnet.
 - Strainers shall be provided with flanges or threaded sockets as required. They shall be designed so as to enable blowing out accumulated dirt and facilitate removal and replacement of screen without disconnection of the main pipe.
 - Strainers shall be provided with equal size isolating gate valves on either side so that the strainers may be cleaned without draining the system.
- i. Balancing valve, Butterfly valves, globe valve, Ball valve conforming to the following specifications shall be provided-

Size	Construction	Ends
15 To 40 mm	Gun Metal	Screwed
50 mm and above	Body cast iron spindle and valve seat of Bronze or Gun metal or Nitrile rubber (in case of butterfly Valve)	Flanged

- j. All valves shall be heavy duty conforming to BIS 780, BIS 5152, and BIS 5155. Valves shall have non rising spindles unless otherwise specified and shall be suitable for not less than 15 Kg per sq.cm gauge working pressure. Valves above 250 mm dia. shall be gear driven.
- k. Flanges shall be of slip on raised face type. The supply of flanges shall also include supply of bolts and nuts and suitable non-asbestos / fiber rubber insertion gaskets (minimum 3 mm thick).
- l. Auto Air vent / drain valve of suitable size shall be provided in the chilled water piping at highest point and at lowest points in the risers respectively.
- m. The automatic air vent valve used for venting of air from water distribution piping to avoid damage due to corrosion, cavitation and loss of efficiency in air conditioning system. When there is air in the pipe line / valve, the float weight acts on the lever which is integral with the plug moves down and allows the air to vented outside. As soon as, the trapped air discharged, the water pushes the float up and lever moves the plug against the seat ensuring tight sealing of the system.
- n. The valve maximum operating pressure shall be 16 bar. MOC of Valve body & cover shall be of brass, Float: High density expanded Polyethylene, Spring: SS and Seal: Nitrile rubber.
- o. Water flow switch / differential pressure switch

The water flow switch/ differential pressure switch along with the pressure difference scale will be suitable for installing in the condenser and chilled water lines across the condenser and evaporator respectively, with the necessary interlocking mechanism.

17.20 Air-handling Units (AHU)

17.20.7 General

- a) Chilled water based, floor Mounted Horizontal AHUs are to be provided for the Air conditioning facilities.
- b) The Air Handling units shall be of factory built thermal break double skin construction of approved make comprising of Pre-filter & Fine-Filter Section, Chilled water Coil Section, stainless steel drain pan, Fan Section with Centrifugal fans. The complete unit shall be installed on spring / vibration isolators / mountings for eliminating vibration to the civil structures. The total units shall be AHRI / Euro vent certified. The description of the units is as follows:

17.20.8 Casing

- a) The casing shall be of sandwich panels fixed on modular frame design. The frame shall be made of non-corrosive extruded Aluminium channels fitted with extruded Aluminum / PVC (Polyamide) corner pieces and insulated with 50 mm PUF injected having Min. density of 40 Kg/m³ insulation.
- b) The structure shall be having thermal break for total unit. Panels shall be 50 mm thick sandwich type with injected polyurethane foam insulation for rigid non-vibrating construction. The insulation shall not absorb moisture and should be rot resistant.
- c) The panels shall be flush mounted to the casing with no sharp edges/corners. They shall be rapid access type fitted from inside with Allen screws to have flush finish from outside. The sealing of frame to panel shall be by means of non-hygroscopic seal compressed between the panel and the Aluminium frame channels to prevent cold tracking and air leakage between panel & frame.
- d) The panels shall be mounted using SS screws onto 1.6 mm thick extruded Aluminium-alloy box section/channel frame or Galvanised steel frame with suitable height legs for adequate U-trap for the AHU static pressure rating.
- e) The inner / outer sheet 0.8 mm thickness wall shall be of galvanized 120 gm/m² sheet chemically treated, having scratch free, pre-plasticized coating and plain GI inner sheet.
- f) Suitable compression glands for cable entry and nozzles for pressure measurement / filter testing shall be provided with closure for unused nozzles.
- g) The AHU shall be provided with electrical power / control junction box on external side of the unit conveniently mounted for cable connections.

17.20.9 Condensate Pan

Sandwich insulated Condensate drain pan shall be fabricated from minimum 18G stainless steel sheet (SS 304) with all corners welded with uniform slope from all side s leading to drain point ensuring no stagnation of condensate water. Drain point/pipe coming out from AHUs should be also of SS 304. It should be isolated from bottom floor panels through 25 mm heavy duty TF expanded polystyrene or polyurethane foam. Drain plug shall be provided in the bottom of the coil section.

17.20.10 Fan Section

- a) Fan shall be draw-through type, high efficiency, dynamically balanced, centrifugal, forward / Backward curved type. Fan Casing shall be made of galvanized steel sheet. Fan wheels shall be made of galvanized steel. Fan shaft shall be of ground C40 carbon steel and supported in pre-greased ball bearings operating at less than 75% of the first critical speed. Fan wheels and pulleys shall be individually tested and precision balanced dynamically.
- b) Fans shall be VFD driven forward / back ward curved as required for stable operation. The blades shall be made of heavy gauge of steel treated and painted after manufacturing.

- c) The fans shall be statically and dynamically balanced at the factory as complete fan assembly should have AMCA approval. The fans shall be equipped with self-aligning bearings. The static efficiency of fan shall not be less than 70%.
- d) Fan / motor assembly shall be mounted on a common framework entirely isolated from the unit by cushy foot/spring isolators to avoid transmission of vibration.
- e) The fan discharge shall be isolated from the casing by a vibration absorbing connection.
- f) The fan section shall have outlet dampers as deemed fit for connecting the supply ducts.
- g) The Critical speed of the fan shall be minimum 125% of the operating speed.
- h) The fan outlet velocity shall be within 10 m/s & Fan RPM shall be limited to 1450.
- i) Fan motor shall be selected for 25% margin on fan shaft power. Fan motors shall be VFD driven and suitable for 415V \pm 10%, 50 Hz, 3 phase, AC supply. It shall be squirrel cage, totally enclosed fan cooled, motors with efficiency class of IE2 with class F insulation and IP-55 protection.
- j) Motors shall be specially designed for quiet operation and motor speed shall not exceed 1450 RPM.
- k) Fan motors shall be mounted inside the AHU on spring mounts with belt drive facility with easy belt tensioning. Drive arrangement shall be with dynamically balanced, constant pitch pulleys and oil-resistant belts, with the drive selected at 110% of motor horsepower. Drive motor shall be flaming proof & corrosion protection with standby arrangement (as per requirement).
- l) Drive to fan for backward curved shall be provided through belt-drive with a standard belt guard housing the bolt and adjustable motor sheave.
- m) Belts shall be of the oil-resistant type. The frame for mounting the fan and motor shall be isolated from the double skin casing with spring isolators.
- n) Interlocking arrangement shall be provided to stop the fan motor when the access doors in the fan section or adjoining sections are opened, with a manual overriding provision.

17.20.11 Coil Section

The coil boxes housing cooling coils shall be of the same construction as of the AHU casing.

17.20.12 Cooling Coils

- a) Chilled water coils shall have 12.7mm dia. Copper tubes with thickness as per OEM standards, with Aluminium fins firmly bonded to copper tubes assembled in zinc coated steel frame.
- b) Face and surface areas shall be such as to ensure rated capacity from each unit and such that the air velocity across each coil shall not exceed 500 FPM.
- c) The coil shall be pitched in the unit casing for proper drainage.
- d) Each coil shall be factory tested at 21 Kg/Sq.cm, air pressure while submerged in water.
- e) Tubes shall be hydraulically expanded for minimum thermal contact resistance with the fins.
- f) Fin spacing shall be 13 fins per inch. (4-5 Fins/CM.). The coil shall be minimum 6 Rows for the Cooling coil.

- g) Additional cooling coil may be provided in fresh air chamber for pre-cooling of fresh air to meet high latent load requirement.

17.20.13 Filter Section

- a) The filter section shall be same as that of casing and panels of AHU but with an access door for withdrawal / fixing of filters.
- b) Each unit shall be provided with a factory assembled pre-filter & fine filter section containing min. 50mm / 150mm / 300mm thick washable synthetic type air filters assembled in anodized aluminium / SS frame. The media shall be supported with HDP mesh on one side and aluminium / SS mesh on other side. Filter banks shall be easily accessible and designed for easy withdrawal and replacement of filters. Filter framework shall be fully sealed and constructed from aluminium alloy.
- c) The Filter section shall be 2 stage one is Pre filters of capacity 90% down to 10 Micron (MERV-7) and other is fine filter 90% down to 3 Micron Filters (MERV-13).
- d) The maximum velocity of air across the pre-filter and the fine filter shall not exceed 500 FPM.

17.20.14 Isolator

The complete assembled AHU shall be floor mounted on spring isolators to avoid transmission of vibration to the floor.

17.20.15 Performance Data

- a) Air handling units shall be selected for the lowest noise level (<60 dBA) of the equipment.
- b) Fan performance rating and power consumption data with operating points clearly indicated shall be submitted for review and the same shall be verified at the time of testing and commissioning.

17.21 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.
- 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/m³ 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 ± 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.
- 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.

17.22 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.
- 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.
- 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

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)

- i. 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.
- ii. The Indoor units shall be ceiling mounted cassette type/ wall mounted type.
- iii. 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).
- iv. 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.
- v. The cooling coil shall be made out of seamless copper tubes and have continuous aluminium 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.
- vi. Unit shall have cleanable type filter fixed to an integrally moulded Plastic / Aluminium frame. The filter shall be easily serviceable.

- 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 pan 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.

17.23 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.
- 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.

17.24 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: -

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.
- 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.

17.25 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).
- 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
 - Back plate: 4 mm
 - Impeller: 4 mm
 - Capacity above 50,000 m³/hr
 - Casing: 6 mm
 - Back plate: 8 mm
 - Impeller: 6 mm

17.26 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.

17.27 Air Intake Louvers

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.

17.28 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.

17.29 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.

17.30 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.

- 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.

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
Diffusers / grilles	4 - 6 m/sec	3 - 4 m/sec

- p. Measuring hatch shall be provided after the fan in the ducting network at convenient locations for measurement of air quantity.
- q. 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:

- (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 is 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
- (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	Upto - 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)

- 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)

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

17.32 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.

17.33 Fresh Air Filter at Package AC / AHU Room

- b. Fresh Air filter shall comprise of Pre-filters with damper, cowl, bird screen & mounting frame.
- c. Size of filter panel shall be preferably of standard size - 610 x 610 x 50 / 150 mm thick for Pre filter.
- d. Pre-filter shall be of 3 ply HDPE panel type with efficiency of 90% down to 10 microns.
- e. Velocity of air across the filter shall be in the range of 2.0 - 2.5 m / sec.
- f. Filter panel shall be cleanable and washable type for reuse.
- g. Cleaning efficiency of the Pre filter element shall be 90% down to 10-micron size of dust particles.
- h. 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.
- i. Proper sealing shall be ensured to prevent leakage of air between mounting frame and filter panels.

17.34 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.

17.35 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.

17.36 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.

17.37 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: -

- b. Fix MS cleat made out of 50 x 50 x 3mm MS flat to the underside of the slab at 600 mm centre to centre using MS dash fasteners of size M6 x 40 mm long.
- c. 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.
- d. Fix GI wire netting of size ½” x 22 SWG on to the MS cleats ensuring proper contact of insulation with ceiling.

17.38 Acoustic Insulation of AC / PAC room walls

Suitable acoustic insulation shall be carried out for PAC / Fan / AHU Rooms which are located near to Office / conference Rooms. Details of acoustic treatment of such premises shall be discussed and finalized at the detailed design of the system during the execution.

17.39 List of Preferred Makes

Sl. No.	Item Description	Preferred Makes
1.	Water Cooled Packaged Screw chiller	Blue star, Carrier, Trane, York, Voltas, Kirloskar, Duham-bush, Hitachi. Daikin, Climaveneta, LG
2.	Centrifugal Pumps	Armstrong, Beacon weir, Grundfos, Mather & Platt, KSB, Kirloskar, Sulzer, Ebara, Flow serve, Crawley & Ray, Johnson, Maxflow, Voltas, Xylem, Wilo, Sintech Precision products, Bareja Pumps, Viraj Electricals, Process Pumps, Flow more
3.	Cooling Towers	Paharpur, Mihir, Himgiri, Advance, Gammon India, Southern Cooling Tower, Shri Ram Tower Tech, Bell, Roos Tempkool
4.	Centrifugal fans for Ventilation	CB Doctor, EFE, Flow Link, Rieco, Howden, Reitz, Accel, Dustven, Patel Airflow, NADI, Pasko Engg. Pvt. Ltd., Scintillant Projects, Soil & Enviro Industries, FMI, Aerocon Corp, TLT, Laxmi Engg., S.K. Systems, Suvidha Air Engineers, FMI, Max flow fans, Flakt, S H Engineering, Advance Ventilation, Witt India, Kruger, System air

Sl. No.	Item Description	Preferred Makes
		<u>FOR AHU FANS:</u> Nicotra, Kruger, COMFERÉ, Ruskin Titus, Flakt Group
5.	Tube axial fans / Propeller Fans / Cabinet fan	CB Doctor, Flow Link, Almonard, Accel, Khaitan, Aerovent, ISEL, Marathon, LM Engg., Suburban Industrial works, Patel airflow, Pasko Engg. Pvt. Ltd., Scintillant Projects, Turboflow, Indvent fans, Aerocon Corp, Laxmi Engg., SH Engineering, Air Technikon, C. Doctor, Dustven, NADI, Flakt, EFE, SK System, Advance Ventilation, FMI, Witt India, Andrew Yule, System air, Kruger, Marut Air
6.	Panel filter for air (Pre-filter / Fine-filter)	FMI, Cadillac, Filtec (India), AAF, Spectrum Filtration, Anfilco, APC Air Systems, Andrew Yule, Dyna, C.B Doctor, SK System, EFE, Puromatic, Camfil, Trijama, Thema dyne, Klenzaid, Aerosol
7.	Split Type Air conditioner	Blue Star, Carrier, Hitachi, Voltas, Zamil, Daikin, LG, Samsung, Aircon
8.	Air handling units	Voltas, Blue Star, Suvidha, Carrier, Caryaire, Zeco, Airflow, Edgetech, ETA Engg. pvt. Ltd., Zamil, Ethos, Flakt Group, VTS, Citizen, DRI
9.	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
10.	MS Pipes	Tata, GST, ITC, Jindal, The Indian Seamless and Metal Tubes, Maharashtra Seamless Ltd., SAIL Rourkela, Kalyani Seamless, Zenith, Zeco or Equivalent
11.	Pipe Insulation	Beardshell, Lloyds, Bakelite, Hylam, Paramount, Armacell, K-Flex, Superlon, Malanpur Entech, Polybond Insulation, FGP, UP Twigs, Rockwool India, Jayashree Insulators, ALP Aeroflex, Armaflex, Zenith, Zeco or Equivalent
12.	PVC Pipe & Fittings	Finolex, Oriplast, Bharat pipe & fittings, Supreme Industry, EPP Composites, Astral
13.	Coupling	Bibby (Wellman), Fenner, GBM
14.	Bearing	SKF, FAG, TATA
15.	GI / SS Sheets for duct	Jindal, SAIL, TATA, Bhushan, Ispat or Equivalent
16.	Vibration isolators	DUNLOP, EMERALD, GERB, GETZNER
17.	Grilles / Diffusers / Fire (Motorized) Dampers / VCD / Louvers	Ravistar, Dynacraft, Cosmos, Airflow, Caryaire, Airmaster, System Air, Ruskin Titus, Greenheck, Southern Cogen, Aquaflex, Vedha, Entech or equivalent
18.	Actuators	Siemens, Belimo, Honeywell, Johnson Control

Sl. No.	Item Description	Preferred Makes
19.	Fabricated Duct	Rolastar, Camduct, Ductmaster, Western Air Duct, ZECO, Vedha Entech, Radiant, Nutech, Spiro, Saiductfab, Ravistar, Ruskin Titus
20.	Strip Heater / Pan Humidifier	Alco Heating, Das Pass, Rapid Control
21.	3 way / 2-way Control Valve / Differential Pressure Control valve	Honeywell, Johnson Controls, Siemens, Advance, Sauter, Belimo, Danfoss, Flowcon, or Equivalent
22.	Globe / Gate / Ball / Check Valves	L&T, Audco, IVC, Intervolve, KBL, Advance, Fouress, BDK, Honeywell or Equivalent
23.	Butterfly Valves	Fouress, BDK, Intervolve, Audco, Advance, L&T, Honeywell or Equivalent
24.	Balancing Valve	Honeywell, Advance, Castle, FlowCon, Audco or Equivalent
25.	Float Valve	Leader Engineering, IVC, Levcon, Shiva Durga
26.	Automatic Air Vent	Anergy, Rapid Control or equivalent
27.	Y – Strainers / Pot Strainer	Honeywell, Emerald, Leader, Sant
28.	AHU Controller and associated instruments with interfacing	Johnson & Control, Honeywell, Siemens, Race, Schneider, Danfoss, Trane, Sauter or Equivalent
29.	Temperature / Pressure gauges	Ashcroft, Tedington, A. N. Instruments, Mass, Warea
30.	Expansion Bellow	Flexican, Flexatherm, SUR Ind., GBM Mfg., TI Flexible Tube, Madras Hydraulics, Lonestar, Anup industries, Indo Thai flexible tubes, Cori, Easy flex
31.	LT Panels (MCC / VVFD / HVAC Panels)	ABB, Siemens, Schneider, L&T, C&S, BCH
32.	Motors	ABB, Siemens, CGL, Bharat Bijlee, Kirloskar
33.	Local Push Button Station	BLEP/Flexpro/Flameproof Equipment / Pushton / L&T / ABB / SIEMENS
34.	1.1 kV PVC/XLPE Cable (Power & Control)	Universal / Polycab / Finecab / Crystal / KEI / KEC / GEMSCAB
35.	Cable Trays & supports	Advance Power Product, India Electricals Syndicate, Rabi Engg. Works, Ratan Project & Engg. Co, Tecno Fab Manufacturing, Unitech Fabricator & Engineering, Mahavir Engg, GS Engineers

18. 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 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.

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 BHEL 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
- 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.

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 interfloor 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 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.

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:

- a) Disconnect power to elevator machine
- b) Apply the main brake
- c) 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	No. of Elevators	4	1	1
2	Capacity	20 Passenger	15 Passenger	1.5 Tonnes
3	Speed	1.5 m/sec	1.5 m/sec	0.5 m/sec
4	Drive	A.C. VVVF	A.C. VVVF	A.C. VVVF
5	Location of M/c room	Machine room less	Machine room less	Machine room less
6	Travel	Approx. 21 metres	Approx. 21-metre	Approx. 21-metre
7	Serving	G+5	G+5	G+5
8	No. of stops	5	5	5
9	Power supply	415V, 3 Phase 50 Cycles AC	415V, 3 Phase 50 Cycles AC	415V, 3 Phase 50 Cycles AC
10	Auxiliary	Single Phase 220V 50 Cycles AC	Single Phase 220V 50 Cycles AC	Single Phase 220V 50 Cycles AC
11	Available car area	As per relevant IS standards	As per relevant IS standards	As per relevant IS standards
12	Available pit depth	1.8 metres	1.8 metres	1.8 metres
13	Available overhead	4.8 metres	4.8 metres	4.8 metres
14	Available Hoist way size	2450 x 2550 mm	3050 x 1850 mm	2450 x 2550 mm
15	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
16	No. of entrances	Single entrance	Single entrance	Single entrance
17	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
18	Door safety	Full Screen Infra-Red Protection	Full Screen Infra-Red Protection	Full Screen Infra-Red Protection

19	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
20	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)
21	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

22	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
23	Control specifications			
a	Door operator	Automatic with Power Operated Door	Automatic with Power Operated Door	Automatic with Power Operated Door
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

20. SEWAGE TREATMENT PLANT

Design, engineering, construction, supply, installation, testing and commissioning of 100 KLD STP based on MBR technology complete with electro-mechanical works necessary equipment, interconnecting piping network etc.

SECTION-1: - PREAMBLE

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.

BASIC DATA ON INFLUENT RAW WASTE WATER (SEWAGE): -

Following shall be the Parameters for design of Sewage Treatment Plant.

<u>TABLE-1</u>	
Parameters	Values
Daily Average Flow	100 M3 / Day
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

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.

<u>TABLE-2</u>	
<u>Parameters</u>	<u>Values</u>
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
NH4-N	5 mg/L
BOD5	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

DESIGN CRITERIA: -

- 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.
- The plant shall function in aerobic condition only. Formation of any anaerobic / septic condition in the bio-reactor shall not be allowed.
- 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.

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.

SECTION II: 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 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.
- 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

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.

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.

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.

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.

GUARANTEE

The under mentioned clauses shall govern in case of any contrary provisions given elsewhere in the document.

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.

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.

SECTION III: TECHNICAL SPECIFICATION

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:

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.

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

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

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.

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.

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)

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.
- 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.

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.

SECTION IV: LIST OF APPROVED MAKES

Pumps	
Equipment / Material /Component	Manufacturers Name
Centrifugal Pumps	Kirloskar / Grundfos / Xylem / Ebara
Centrifugal	Grundfos / Xylem / Ebara
Screw Pumps	Roto / Positive / Tushaco / Rotomac
Submersible Pumps	Grundfos / Xylem / KSB / Ebara
Dosing Pumps	Asia LMI / Emec Italy / Toshcon
Dewatering Pumps	Grundfos / Xylem / KSB / Ebara
Sludge Pumps	Kirloskar / Tushaco

Piping	
Equipment / Material /Component	Manufacturers Name
GI / MS Pipes	Jindal / Prakash Surya

GI Pipes Fittings	Unik / UNCO / R Brand
HDPE Pipes	Reliance / Duraline / Supreme / Jain
PVC Sch 40 & 80 Water Supply Pipes & fittings	Supreme / Astral / Finolex / Ashirwad
CI / Cast Steel / Bronze Gate construction of Butterfly / Globe / Butterfly / NRV	IVC / Venus / Audco / Advance / SKS / AIP / Kirloskar / Sant
Strainer	CIM / Audco / Advance / AIP

Mechanical Equipment	
Equipment / Material /Component	Manufacturers Name
Blowers	Everest / Usha / Kay / Beta
Diffused Aeration	EDI / Thermax / Geo Miller / Micro / ITT System / Envirotech / Norton / Rehau / MM Aqua
Tube Settler media / Media for Bio	MM Aqua / Thermax / Geo Miller / Cooldeck
Reactor	
U V Sterilizer	Creative / Alfa
Filter Press	Sachin Filtech / Pharmatech
Membrane Module	GE / Siemens / Huber
Mechanical Step Screen	Jash / Wastech / Ecologix

Instrumentation	
Equipment / Material /Component	Manufacturers Name
Pressure Indicator	Manometer India/ H Guru Instruments/ General Instruments/AN Instruments/ Forbes Marshall / Bells / Emerald / Jepson / Waree Instruments
Level Sensor & Indicator	Toshniwal Bros./ABB/ Bells Controls / Forbes Marshal / Pune Techtrol / Level tech / Elegant / Cirrus

Flow Instrument System	Resemount (I) Pvt. Ltd/ABB/ E&H/ Forbes Marshall / SB Electromech /Waree Instruments/ Level tech Systems
Gas Meter	Fluid Components/ MKS Instruments/ Kurtz Instruments /Forbes Marshall/ABB
pH meters	A-LMI/ Rosemont / Toshniwal /E&H/ Forbes Marshal / Ultra line
Analyser- Conductivity	Fobes Marshall /. A- LMI / Rosemont / Forbes Marshall / Kent
Bulk Water Meter	Aquamet / Kaycee / Kent
Electro-magnetic type Flow Meter	Forbes Marshall / ABB
DO Sensor	Forbes Marshall / Hach / Electronet

Instrumentation	
Equipment / Material /Component	Manufacturers Name
MCB / RCCB / RCBO / DB	L&T / Hager / ABB / Legrand / Schneider
Industrial outlet	L&T / Hager / ABB / Legrand / Schneider
Electrical Control Panel	Advance / Adlect / Ambit / Trico lite / Milestone / Vidyut control / RST / Dynamic
Switchgear & Accessories	ABB / Schnieder / L&T / Siemens
MCCB (Microprocessor)	ABB (T max) / L & T (D sine) / Schneider (Compact NXS / NS) / Siemens (3VL) / Legrand (DPX)
Switch Fuse Unit with HRC Fuses	L & T / ABB / Schnieder / Siemens / GE
Contactors / Relays	L & T / Siemens / ABB / Schneider
Ammeters / Voltmeters and metering equipment's	L & T / Siemens / Automatic Electric / Neptune / Enercon
Selector Switches	Kaycee / Salzar / L&T
LED lights	L&T / Vaishno / Siemens
PVC Insulated Copper Conductor Wires	Finolex / Polycab / Skystone / RR

PVC / XLPE Insulated 11 KV / 1.1 KV Cables	Finolex / Polycab / sky tone / RR
Lugs	Dowell's / 3D / C.C.I. / 3 M / Comet / Hex
Cable Glands	Siemens / Comet / Grippwel
MS Conduits and Accessories	B.E.C. / AKG / MK
Fluorescent Tube Fitting	PHILIPS / WIPRO / Bajaj
Ceiling Fans / Exhaust Fans / Air Circulators	Crompton / Bajaj / Usha

21. ELECTRIC OVERHEAD TRAVELLING (EOT) CRANE

21.1 GENERAL

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.

21.2 SCOPE

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

- Electrical cables for power supply from distribution control panel in shed to DSL up to 10m length as per GAD of shed.
- 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.
- Supply and fixing of shrouded type DSL along the entire length of shed as indicated in GAD of sheds.
- 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.
- Portable radio remote control along with accessories and items required controlling all motions of crane including synchronous operation of two cranes.
- 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.
- 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
 - ✓ 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.

21.3 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
 - ✓ 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.
- 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.
 - ✓ Receiver of radio remote control should meet features like power interruption protection, relay's contacted failure detection circuit, shock resistance mounting.

21.4 BROAD TECHNICAL PARAMETERS

Bidder shall ensure that crane dimensions like span, gantry height and crane clearances are compatible and suitable to GAD of shed. Crane should meet broad technical parameters detailed hereunder.

S. No	Location	Ground floor	First Floor
1	Capacity (T) (M/A)	25/5	10/2
2	Span (m)	22	22
3	LT travel (m)	390 (Min)	390 (Min)
4	CT travel (m)	20 (Min)	20 (Min)
5	TOR in (m)	13.8	32.5
6	Height of Lift (m)	12	12
7	Hoist Speed (m/min)	3/3	3/3
8	CT speed (m/min)	20	20

9	LT Speed (m/min)	50	50
10	No. of cranes (Qty-Nos.)	4	4

21.4.1 EOT CRANE 25T

- Double Girder, Capacity MH 25T and AH 5T, Span ≈ 22 m.
- Class of Duty M6, for indoor operation.
- VVVF drive, step less speed for all motions.
- Speed in m/minute: MH-3, AH-3, LT-50 and CT-20.
- Crane controls by RRC (Radio Remote Control).
- Lift of MH hook above floor level (FL) & drop of hook below FL 10.5 m & nil
- Lift of AH hook above floor level (FL) & drop of hook below FL 10.5 m and 1
- Type of MH hook: C type, Type of AH hook: C type
- Head room (crane height from gantry rail level) 2200 mm maximum
- Overhang (crane end projection from rail canter) 200 mm maximum
- Centre distance between hooks MH & AH ≈ 1 m

21.4.2 EOT CRANE 10T

- Double Girder, Capacity MH 10T and AH 3T, Span ≈ 22 m.
- Class of Duty M6, for indoor operation.
- VVVF drive, step less speed for all motions.
- Speed in m/minute: MH 3, AH 3, LT 45 and CT 20
- Crane controls from moving pendant RRC.
- Lift of MH hook above floor level (FL) & drop of hook below FL 10.5 m and nil.
- Lift of AH hook above floor level (FL) and drop of hook below FL 10.5 m and 1m.
- Type of MH hook: C type, Type of AH hook: C type
- Head room (crane height from gantry rail level) 2000 mm maximum.
- Overhang (crane end projection from rail centre) 200 mm maximum.
- Centre distance between hooks MH & AH ≈ 800 m

22 WATER SUPPLY FACILITIES

22.1 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.

Treated effluent from STP meeting required norms shall be used for flushing in washrooms and general horticulture purpose.

22.2 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 cooling towers & car testing facility & remaining major water consumption in the plant is once through type.

Table Showing Break - Up of Recirculation and Fresh Makeup Water Requirement

Sl. no.	Description	Existing BEML with 400 car per Annum (cum)	Proposed BEML with 1200 car per Annum (cum)	Makeup water per day (cum)	Makeup water (cum) per hour	Remarks
	A	B	C	D	E	F
1	Water consumption FOR CAR body & bottom plate water testing.	335.00	1005 (Re-circulation)	40.2	3.35	Process loss considered is 3% to 5%. 4 % circulation is considered
2	RO reject water for makeup RO water at 2D is	-	-	12.06	1.01	1D & 2D are the RO feed water

3	Cooling water recirculation	-	750 (Re-circulation)	7.5	0.63	Makeup water considered is 1%
4	Water requirement Considering No. of People around 1000	45.00	225.00 (Once through)	225.00	18.75	Water requirement for 5000 people
5	Water requirement considering Kitchen 3 Nos. for working complete day for breakfast, lunch, snacks & dinner	70.00	350.00 (Once through)	350.00	29.17	Water requirement for 5000 people
	Total			634.76 Say-635	52.90	55 cu.m say i.e. 12hours working per day or 6 hours each shift
	Number of days storage (Days)			3		
	Volume of the storage considering 10 %			2095		

	additional volume (Cu.M)					
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22.3 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 2095 Cum will cater for 3 days storage requirement. It is considered that the water is made available at the storage reservoir in the plant.

22.4 Proposed facilities

To cater to the water requirements of the plant, the following facilities are envisaged which are explained below.

22.5 Raw water treatment plant

Incoming fresh water / raw water will be stored in the RCC reservoir. The fresh water / raw water drawn from the plant storage reservoir will be filtered in multi grade pressure sand filters and this water will be used as make-up for the various recirculation systems & once through system. chlorination is done for supplying water to canteen & RO units for drinking water.

As consumption of water for various purposes in the plant is not constant & varies in wide range, for pumping purposes hydro pneumatic pump along with air bottle with diaphragm, VFD motor (for all pumps) are envisaged. Here no recirculation system & over-head tank are envisaged for the pumps. This hydro pneumatic pumping system makes pumps trouble free operation & power saving & prevent frequent on & off of recirculation control valve. (As control valve is not there in this case).

Pump will operate based on the line pressure. On demand, flow of water will occur & pr. reduces, at pre-set pressure, pumps will start & supply water. One pump for supplying process water & drinking water to the plant continuously, other two pumps will normally not be working continuously, however operates during pressure filter cleaning operation (i.e., during high water demand for pressure filters cleaning purpose) for short duration of time (20 to 30 minutes, approx.). Therefore, normally two pumps will be stand-by for most of the time.

Refer Drg. no.: MEC-/I0047-01-04-D1-ZZ-12-DR-N-03001, PFD of water system.

22.6 Firefighting facilities

Refer separate writeup for Firefighting facilities.

22.7 Cooling Water Recirculation systems

The requirement of water in the chillers & compressed Air Station is only for indirect cooling of the compressors. Cooling water will be pumped to the chillers & compressors and will be cooled in the Cooling towers before reuse. Only process water makeup is envisaged.

For Cooling tower & re-circulation cooling water details refer AC & Ventilation chapter.

22.8 Water distribution

MS / CS / DI/ 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)

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.

22.9 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
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 specification of Butterfly valves
21.	BS	BS EN: 593	Industrial valves: metallic butterfly valves for general purposes
22.	ANSI	ANSI/AW WA 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.)
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.
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	<u>Fusion welding of steel.</u>
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.
57.	ASME	ASME Sec 9	ASME boiler & pressure vessel code.
58.	BIS	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.

23 COMPRESSED AIR FACILITIES

23.1 General

To cater the plant air & instrument air requirement of the proposed Rolling stock commuter Rail and Metro Cars Manufacturing plant air 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.

In order to meet the air demand for testing of the pipelines & braking system of car, high pressure air compressors are proposed. These compressors will be decentralized & are installed in the respective works shops, inspection & testing bay.

Proposed equipment's

To meet the high pressure compressed air requirement following are envisaged.

SL. No.	Equipment Description	No of units
4.	Lubricated screw compressor of capacity 100 CFM with delivery pressure of 12 kg/cm ² (g). mounted on 500 liters horizontal air receiver.	5-Nos. (5W+0S)
5.	Refrigerant air dryer of matching capacity	5-Nos. (5W+0S)

Refer Drg. no.: MEC-/I0047-01-04-D1-ZZ-15-DR-N-03002, PFD of air compressor facility enclosed with report.

23.2 Description Of Equipment

1. Air Compressor.

All air compressor will be air-cooled, single/multistage, oil free, fixed speed, rotary screw type: each capable of delivering continuously rate volume of airflow at rated delivery pressure these shall be supplied with all accessories etc. for smooth and trouble-free operation.

Screw compressors will generally be confirmed to API 619.

Each compressor unit will be complete in all respect with electric motor drive mounted on common skid, coupling, replaceable coupling guard, etc. Driving motor capacity will have 10% margin over the required shaft power including all shaft driven auxiliaries at maximum capacity of compressor.

The working of compressor (load & unload) will be controlled based on the system pressure.

Each type of compressors will be identical in design, construction and performance and all the components will be inter changeable. Compressor will be designed for continuous duty and parallel operation. All the compressor parts/sub-assemblies will be duly accessible for maintenance. Unbalanced forces and moments of the rotating parts will be minimum to ensure least vibration and noise.

The thickness of screw compressor casing will be sufficient to withstand maximum pressure and temperature.

The rotor will be made of forged steel suitable for operating parameters and suitable lubrication system for moving parts will be provided.

Compressors will have built-in micro-processor panel controlling the operation of the compressors automatically. Necessary instrumentation and control will be as per manufacturer's standard & system requirement.

Each compressor unit will be provided with suction filter.

Each compressor will be provided with oil tank, oil filter, oil cooler, oil separator, oil pump & after cooler, moisture separator with auto condensate trap, air flow & air pressure control system, acoustic hood, heat exchangers, base frame, casing cooling system, lubrication system, solenoid valves, pressure / temp/ flow switches, NRV, safety valves, integral pipings, etc. Oil separator will be complete with necessary fittings & mounting like safety valve, etc. The design / fabrication of the intercooler / after cooler will conform to IS: 4503-1991 or equivalent foreign standards. In case of 100 CFM compressors entire compressor unit will be mounted on the horizontal air receiver.

Suitable acoustic enclosure will be provided to keep the noise level within 85 dB (A) at source. The acoustic hood frame work will be made of rolled steel section.

Direct drive will be employed between compressor & motor

2. 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
- ✓ 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.
- ✓ Air cooled 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.

3. Air Receivers

Air receiver will be vertical type & horizontal type i(n case of 100 CFM compressor) 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 (devit 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.

4. 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.

5. Pre filter

Each stream will be provided with one no. of pre filter. These filters will be surface filter renewable / replaceable type with the following parameters:

1. Material of construction:
 - a) Body: Carbon steel
 - b) Filtering element: Sintered bronze / borosilicate fiber type.
2. Capacity: 3200 cum/hr. (FAD). & 100 CFM
3. Pressure: Air compressor delivery pressure (Max)
4. Particle size: 1 micron
5. Diff. Pr. gauge: Yes

6. 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 fiber / equivalent
2. Capacity: 3200 cum/hr. (FAD) & 100 CFM.

3. Pressure: Air compressor delivery pressure (Max)
4. Dust / oil Particle size: 0.01 microns
5. 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

7. **Compressed air distribution:**

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.

8. **Reference codes & standards**

Sl. No.	Design standard	Standard	Description
1.	API	API: 619	Rotary – Type displacement compressors for petroleum m chemical & gas industry services
2.	API	API: 618	Reciprocating Compressors for Petroleum, Chemical, and Gas Industry Services.
3.	BIS	IS: 2825	Code for unfired pressure vessels

4.	ASME	ASME Sec 8	Rules for Construction of Pressure Vessels.
5.	BIS	IS:7938	Air receiver for compressed air installations
6.	ISO	ISO: 8573.1	Air Quality standards
7.	ISO	ISO: 12500	Filters for compressed air
8.	ISO	ISO: 7183:2007	Compressed-air dryers
9.	IS	IS: 8183	Bonded mineral wool specification.
10.	ANSI	ANSI B 31.1	Power piping code
11.	ANSI	ANSI B 31.3	Process piping code
12.	BIS	IS: 1239 (Part-I)	Steel tubes, tubulars and other wrought steel fittings - Specification
13.	BIS	IS: 1239 (Part-II)	Steel tubes, tubulars and other wrought steel fittings - Specification
14.	BIS	IS: 3589	Electrically welded steel pipes for water, and sewerage (168.3 to 2540 2000).
15.	BIS	IS: 5504	Spiral welded pipes
16.	ASTM	ASTM A 106 Gr. B	ERW & Seamless CS pipe specification
17.	ASTM	ASTM A 53	MS pipe specification
18.	ANSI	ANSI B 36.1	Welded & seamless wrought steel pipe dimensions
19.	ANSI	ANSI B 36.19	Stainless Steel pipes dimensions
20.	ANSI	ANSI B 16.9	Butt welding pipe fittings dimensional standard.
21.	ANSI	ANSI B 16.11	Forged steel fittings: Socket welded & threaded
22.	BIS	IS: 6392	Steel pipe flanges.

23.	ANSI	ANSI B 16.5	CS pipe flanges & flanged fittings
	BIS	IS:13095	Butterfly valves for general purpose.
24.	IPSS	IPSS-1-06-012	Steel industry OPSS specification of Butterfly valves
25.	BS	BS EN: 593	Industrial valves: metallic butterfly valves for general purposes
26.	ANSI	ANSI/AW WA C504	Rubber seated butterfly valves
27.	BIS	IS: 5312	Swing check type reflux (non-return) valves for water works purposes — specification
28.	BS	BS: 5153	Specification for cast iron check valves for general purposes
29.	BIS	IS: 778	Copper alloy gate, globe and check valves for waterworks purposes
30.	BIS	IS: 3042	Specification for single faced sluice gates (200 to 1200 mm size.)
31.	BIS	IS: 13349	Cast iron single faced thimble mounted sluice gates - Specification
32.	BIS	IS: 14846	Sluice valve for water works purposes (50 to 1 200 mm size) — specification
33.	BIS	IS: 14845	Resilient seated cast iron air relief valves for water works purposes — specification
34.	ISO	ISO:17192	Metal ball valves for petroleum, petrochemical and allied industries
35	BIS	IS: 1703	Water fittings — copper alloy float valves (horizontal plunger type) — specification
36	BIS	IS: 2906	Indian standard specification for sluice valves for water works purposes (35-1200mm size).
37	BIS	IS: 5312	Swing check type reflux (non-return) valves for water works purposes — specification
38	BS	BS: 5155	CI & carbon steel butterfly valve for general purpose

39	BS	BS: 5158	CI & carbon steel plug valve for general purpose
40	API	API: 602	Steel gate, globe & check valves for sizes pns 4 (ND100) and smaller for the petroleum and natural gas industries.
41	BS	BS: 5352	Steel wedge gate, globe and check valves 50 mm and smaller for the petroleum, petrochemical and allied industries.
42	API	API: 600	Gate valves for petroleum & natural gas.
43	BS	BS: 1414	Specification for steel wedge gate valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries.
44	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
45	BS	BS: 1868	Specification for steel check valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries.
46	API	API: 599	Metal plug valves - Flanged, threaded, and welding ends
47	API	API 598	Valve inspection & testing.
48	BIS	IS: 2002	Steel plate for pressure vessel for intermediate and high temperature service including boilers.
49	BIS	IS:2062	Hot rolled medium and high tensile structural steel – Specification.
50	BIS	IS: 7307	Fusion welding of steel.
51	BIS	IS: 7310	Approval Tests for Welders Working to Approved Welding Procedures.
52	API	API: 1104	Welding of Pipelines and Related Facilities.
53	ASTM	ASTM Sec. 5	Non-Destructive examination.

54	ASME	ASME Sec 9	ASME boiler & pressure vessel code.
55	BIS	IS: 1447	Code of practice for painting of ferrous metals in buildings.
56	BIS	IS: 5	Colours for Ready Mixed Paints and Enamels.
57	-	-	Central Pollution Control Board standards.

24 EPSS: EMERGENCY DIESEL GENERATOR SETS.

24.1 General

BEML Limited intends to construct green field project for construction of Rolling Stock Manufacturing Plant at Bhopal, Madhya Pradesh for Commuter Rail and Metro Cars.

This chapter enumerates the details of emergency DG sets planned for supplying the power during grid power outage in the proposed Manufacturing Plant.

The dimensions shown in the layout of DG sets and Chimney for exhaust here under are just for reference and understanding purpose. The EPC vendor would be required to design, construct, supply, install and commission the facility as per rating and numbers of DG sets envisaged and in accordance with applicable code and statutory requirements.

The total emergency load estimated for the proposed manufacturing plant is 3000 KVA (2400 KW). Emergency load is estimated about 50 % of the total electrical load demand of the plant.

To cater the above emergency / critical load, 11 KVA, 3 Nos x 750 KVA capacity HSD fired (2 W+1 S), Diesel Generator sets are envisaged along with associated accessories & panels. Emergency DG sets & accessories will be installed out door near to MRSS. All 3 DG sets will be working.

24.2 Site Conditions.

DG set foundation shall be designed to the site conditions specified under respective chapter.

24.3 Standards And Regulations

DG set & accessories shall meet the requirements laid down in relevant ISO 8528 & ISO 3046., BS, IEC and other reputed national / international 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.

Emergency power supply of all other units including chiller plant & Pump Houses are planned from Centralized DG system near to MRSS building.

3Nos. 750 kVA, 11kV, DG sets has been considered and the same is located near to MRSS. Containerised type DG set has been considered with a provision for Day tank to feed the DG set. An area of approx.70 Sq. m has been considered for the facility.

24.4 Technical Details of Diesel Generator Set.

Diesel engine shall be of four strokes, 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 stipulated.

Refer Drg. no.: MEC-/I0047-01-40-D1-ZZ-14-DR-N-03003, layout & sections of DG sets for emergency power enclosed with report.

24.5 TECHNICAL PARTICULARS OF DG SETS

Sl. No.	Description	Unit	Value
1.	Number of DG sets	Nos.	3 (2 Working + 1 standby)
2.	Rated power at the alternator terminals	KVA	750
3.	Power rating classification	KVA	Prime power with varying load required during power outage.
4.	Fuel	-	High Speed Diesel
5.	DG sets Cooling system	-	Radiator-cooled.
6.	Engine speed	rpm	1500 rpm
7.	Lubrication system	-	Forced lubrication
8.	DG sets Starting system	-	Battery start.
9.	Frequency	Hz	50 Hz
10.	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.

24.6 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

charger shall be mounted on the engine / base frame. Differential pressure gauge or mechanical clogging indicator to be provided across suction filter.

24.7 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.

24.8 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 start-ups, 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.

24.9 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.
- 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 Deg C. Also, hot mineral wool insulation shall be wrapped with chicken mesh and 22 SWG aluminium cladding.

23.10 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.

23.11 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.
- 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.

23.12 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.

23.13 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.

23.14 CONTROLS & INSTRUMENTATION

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 set/s & accessories shall be provided with all instruments necessary to check the DG sets system parameters & check its performance continuously.

23.15 BRIEF TECHNICAL DETAILS OF ELECTRICAL EQUIPMENT

1. Generator

The main parameters of generator would be as follows: -

- i) Power factor - 0.8 (lagging)
- ii) Rated voltage - 11 kV+ 10%, 3 phases, 50Hz, +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.

2. 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.

3. Terminal Box

Suitable Alternator Terminal Box duly painted shall be provided towards power output side as well as towards neutral side.

4. 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 meter in equipment as well as synchronization arrangement and a separate control cum 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.

HT/LT cables: 11 kV (UE) cables shall be heavy duty, XLPE insulated, PVC sheathed multi core, aluminium conductor.

5. steel wire/strip armoured type.

Power Cables for kV system shall be heavy duty, 1.1 kV grade, XLPE insulated PVC sheathed aluminium conductor, armoured / unarmoured 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.

6. 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. illumination inside DG enclosure is proposed using LED type lighting fixtures. Wherever applicable, weather proof outdoor type fixtures, flame proof fittings, flame proof junction boxes, switches etc., are envisaged.

25 Illumination

Illumination inside DG enclosure is proposed using LED type lighting fixtures. Wherever applicable, weather proof outdoor type fixtures, flame proof fittings, flame proof junction boxes, switches etc., are envisaged.

25.1 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 design, testing and installation of under-ground/above-ground 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.
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.

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

- a) 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
- b) 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.
- c) 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.
- d) 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 portable water.
- e) Rain water harvesting, reuse of treated water and conservation of potable water.
- f) Energy efficient and eco-friendly illumination like usage of LED, efficient air condition system with controls.
- g) Solar panels are proposed over shop building to harness solar energy in a bid to utilise renewable energy
- h) Building orientation to take advantage of solar access, shading and natural lighting and effects of micro climate on building.
- i) Environmentally friendly building materials for construction like fly ash-based cement, low VOC paints, bamboo based/ engineered wood instead of virgin wood.
- j) 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.

26. FURNITURE SPECIFICATION

26.1 L- Shape workstation (L1800/1500 x D600 x H750mm) + Metal Pedestal Unit: as per below specs. (warranty- 5 years) For Executives in Grade 4-5.

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 zinc /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.

26.2 L- Shape workstation (L1500/1500 x D600 x H750mm) + Metal Pedestal Unit: - as per below specs. (warranty- 5 years) For Executives in Grade 1-3 and supervisory personnel

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 zinc /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.

26.3 Linear workstation (L1200 x D600 x H750mm) + Metal Pedestal Unit: - as per below specs. (warranty- 5 years) For Workmen/Technicians

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 zinc /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 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.

26.4 AGM/DGM Workstation - as per below given sizes & Metal Pedestal unit.

Main Table (750 mm high & 750mm wide): 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 (750mm high & 500mm wide) :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 (750mm high & 400mm wide) :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)

Length - M.T.1650 mm, S.T.1000 mm, B.C.1500mm

26.5 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)

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. Understructure :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 (Environmental Friendly) thickness 25 mm. ,cover with Melamine. The height of Modesty panel should be 600mm. Each table should have 3 drawer pedestal 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. Wiremanagement : 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.

Cabin Table of size: Main Table- 2100 x 900 mm; Side table- 1200 x 600 mm; Back console 2100 x 550 mm; 740-760 H mm

26.6 CGM/Executive Director desk

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 banding. Understructure : 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 pedestal 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. Wiremanagement : 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.

26.7 ED Cabin Table of size: Main Table- 3000 x 900 mm; Side table- 1250 x 600 mm; Back console 3300 x 550 mm; 740-760 H mm

26.8 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. Understructure : 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 pedestal 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. 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).

SA Cabin Table of size: Main Table- 1650 x 750 mm; Side table- 1000 x 500 mm; Back console 1650 x 400 mm; 740-760 H mm

26.9 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.Understructure :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 (Environmental Friendly) thickness 25 mm. ,cover with Melamine. The height of Modesty panel should be 600mm. Each table should have 3 drawer pedestal 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. Wiremanagement : 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.

CMD Cabin Table of size: Main Table (3300 X 900) Side Table (1250 X 600) 740-760Hmm , Back storage of size: 3900+3300 mm X 550mm 740-760Hmm

26.10 Director desk

DIRECTOR & 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 -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. Understructure : 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 (Environmental Friendly) thickness 25 mm. ,cover with Melamine. The height of Modesty panel should be 600mm. Each table should have 3 drawer pedestal 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.

26.11 Director Cabin Table of size: 3300mm x900mm Front Table, 1250mm x 600mm Side Table & 2700mm (900+1800) x 600mm Back Storage with all table Height as 740-760mm

26.12 PS Tables

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 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.

PA Cabin Table of size: Front Table 2100 x 900mm; Side Table 1200 x 600mm; Back storage of size: 2550 x 550mm; Height 740-760 mm PA Cabin Table of size: Front Table 1950 x 900mm; Side Table 1200 x 600mm; Back storage of size: 3000 x 550mm; Height 740-760 mm

26.13 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)

2800mm L x 1200 mm W (08/10 PAX) Conference Room - 1 no. access flap + Box + Switch Mounting Plate of size 450mm L 5250mm L x 1350 mm W (14/16 PAX) Conference Room - 2 No. access flap + Box + Switch Mounting Plate of size 450mm L 1000mm DIA (MT Room- 4 PAX)

26.14 Auditorium / 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 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)

Size: 10800mm x 600mm LINEAR SHAPE

26.15 Storage (warranty- 5 years)

Providing and fixing Medium Height Storages of Size 750mm W x 450mm D x 1200mm H, 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

Storage of size: 750W x450D 1200Hmm

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 Minifix & Dowels. All the hardware and Hinges are from Hettich/Ebco. Storage has Brushed SS finish handles and lock . Prelam storage unit of 600mm ht and 450mm depth (SQMT) RO . Units in standard width of 600mm / 750mm / 900mm.

26.16 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 (Basic cost of Granite Rate Rs. 180/- per sft).

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.

26.17 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 clad as per approval, complete with drawer units, shutter and all hardware complete. Size : 3600 mm l X 750 mm W X 1050 mm H (Base rate rs. 450 / sqft.)

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 clad as per approval, complete with drawer units, shutter and all hardware complete.

Size : 2400 mm l X 750 mm W X 1050 mm H (Base rate rs. 450 / sqft.)

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 corion cladding complete with drawer unit, shutter and all hardware complete. Size : 1800 mm long

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. Size : 1800 mm long.

26.17 CHAIRS (WARRANTY-8 YEARS)

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 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.

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.

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 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.

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,molded plywood and upholstered with leatherite in front and back. Overall dimension: 750 mmD X

750 mmW X 1180mm H. Seat Dimension: 520mmW X 480mmD X 520mm H. The backrest is made from molded plywood and leatherite in front and back. The armrest are 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.

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, molded plywood and upholstered with leatherite in front and back. Overall dimension: 750 mmD X 750 mmW X 1020mm H. Seat Dimension: 520mmW X 480mmD X 520mm H. The backrest is made from molded plywood and leatherite in front and back. The armrest are 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.

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 Armpad 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 leatherite in front and back. Overall dimension: 750 mmD X 750 mmW X 1180mm H. Seat Dimension: 520mmW X 480mmD X 520mm H. The backrest is made from molded plywood and leatherite in front and back. The armrest are 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.

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 Support, finish in all Black Color 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. Understructure shall be made of hollow Stainless Steel.

Providing & placing Chairs as per approved design. Understructure and Back are made of wood, Seat shall be having Fabric Upholstery. Size: (W)460*(D)525*(H)920mm.

26.18 SOFAS

Reception/Waiting: Supplying and Placing Leatherite 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 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 \pm 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 : 88.0cm (W), 92.0cm (D), 82.0cm(H), 45.0cm(SH).

Basic Rate of Leatherite/Fabric: Rs.600

Guest Room: Supplying and Placing Leatherite 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 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 \pm 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 : 88.0cm (W), 92.0cm (D), 82.0cm(H), 45.0cm(SH).

Basic Rate of Leatherite/Fabric: Rs.600

ED Cabin: Supplying and Placing Leather sofa. SIZE:- 920mm (W) x 920mm (D) x 890mm (H). Seat height 470mm. THREAD : Nylon

Material Handling Data Sheet (MSDS) for Glue

Standard of Plywood used: IS 303 Commercial Plywood

Thickness 12mm

Basic Rate of Leather: Rs.2500

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 \pm 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).

Basic Rate of Leatherite/Fabric: Rs.600

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).

Basic Rate of Leatherette/Fabric: Rs.600

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 27.5Weft 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.

Basic Rate of Fabric: Rs.600

Providing & installing Three Seater Sofa .-

18.1 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 additional top layer 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. Basic Rate of Leatherite/Fabric: Rs.600

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)

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

Basic Rate of Leather: Rs.2500

P/I 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 / leatherite 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.

Basic Rate of Fabric: Rs.600

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-incharge. Refer image attached. (Base Rate of stone rs.450/sft.)

LXWXH – 1200X600X450 mm

LXWXH – 1800X600X450 mm

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. (Base Rate of stone rs.450/sft.)

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

Supply of Study Table; Size 1200L x 550W x 750H mm Made of 19mm particle board, finished in laminate as per approval.

Laminate color to be matched with the bed color.

Supply of Queen Size Bed & bedside tables (78x60 inches)

Supply of Queen size Mattress (78x60x10 inches)

Supply of Modular Wardrobe cum Dressing Table as per provided drawing.

Size: 3000L x 600W x 2400H; Made of 19mm Particle Board, finished in laminate as per approval of BEML.

Providing & placing Guest Room 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.

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 Rehau edge banding of matching shade.

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 qty of same is to assessed and to be included in price break-up.

SPECIFICATION FOR ELECTRO MECHANICAL (MOTORIZED) BED

SL NO	DESCRIPTION	BID PARAMETERS	GOLDEN PARAMETER
1	BRAND	GODREJ INTERIO/PARAMOUNT BEDS/JANAK HEALTHCARE/HILL-ROM	YES
2	TYPE OF ICU BED ACTUATOR	ELECTRO MECHANICAL MOTORIZED	YES
3	TYPE OF MECHANISM FOR FUNCTIONING OR CONTROLLING ANGULAR MOTION OF BED PART	ELECTRO MECHANICAL(MOTORIZED)/SUPER SMOOTH CRANK SCREW MECHANISM/ HYDRAULIC MECHANISM(MOTORIZED)	NO

		ELECTRO MECHANICAL(MOTORIZED)/SUPER SMOOTH CRANK SCREW MECHANISM/HYDRAULIC MECHANISM(MOTORIZED)/COUNTER WEIGHT MECHANISM	
4	TYPE OF MECHANISM FOR FUNCTIONING OR CONTROLLING HEIGHT OF BED		NO
5	MAXIMUM REVERSE TRENDLENBURG ANGLE IN DEGREE (TOLERANCE +_ 2 DEGREE)	15/20	NO
6	MAXIMUM TRENDLENBURG ANGLE IN DEGREE (TOLERANCE + 2 DEGREE)	15/20	NO
7	MAXIMUM ADJUSTABLE KNEE REST ANGLE IN DEGREE	0-40	NO
8	MAXIMUM ADJUSTABLE BACK REST ANGLE IN DEGREE	0-70	NO
9	MATERIAL FOR IV ROD WITH CHROMIUM PLATED	SS	YES
10	MATERIAL FOR WHEELS	SS/POLYESTER	NO
11	MATERIAL FOR BED TOP SECTION	SS/MS/ABS PLASTIC	NO
12	CLEARANCE BETWEEN BED BASE FRAME AND FLOOR SURFACE IN MM	150	YES
13	TYPE OF SIDE PANEL	SWING UP DOWN TYPE/DETACHABLE TYPE	NO
14	NUMBER OF SIDE PANEL	2/4	NO
15	NUMBER OF HOOKS PROVIDED IN IV ROD	2/4	NO
16	DEGREE ANGLE AND HEIGHT INDICATOR SHALL BE PROVIDED AR BOTH FOOT AND HEAD SIDE	SHOULD BE PRESENT	YES
17	POWER OF MOTOR IN HP	05 /0.8 / OR HIGHER	NO
18	ICU MATTRESS	IT SHOULD BE X RAY TRANSLUCENT	YES
19	MATTRESS	SHOULD BE PROVIDED	YES
20	MATTRESS SHOULD BE MADE OF HIGH RESILIENT AND BIO DENSITY FOAM	SHOULD BE PROVIDED	YES
21	MATTRESS SHOULD BE TRANSLUCENT TO ALLOW RADIOGRAPHY USING PORTABLE X RAY	SHOULD BE PROVIDED	YES
22	MATTRESS SHOULD BE MADE OF CUBE CUT DESIGN AND INDEPENDENT CUBE TO PROMOTE AIR FLOW TO REDUCE MOISTURE	SHOULD BE PROVIDED	YES
23	MATERIAL FOR ICU BED MATTRESS	PU FOAM	YES
24	THERAPEUTIC WEIGHT LIMIT FOR MATTRESS IN KG	150/175	NO
25	POWER SUPPLY	230 V SINGLE PHASE 50 HZ	YES
26	MATERIAL FOR FRAME OF BED	MS	YES

27	MATERIAL FOR SIDE RAILING: SIDE SAFETY GUARD	MS/ABS PLASTIC	NO
28	MATERIAL FOR HEAD AND FOOT PANEL: BOARD	MS/ABS PLASTIC	NO
29	LENGTH OF BED IN MM	2100-2200	NO
30	WIDTH OF BED IN MM	950-1000/1000-1050	NO
31	ELECTRIC SHOCK PROTECTION LEVEL CLASS B: CLASS 1	SHOULD BE PROVIDED	YES
32	SAFE WORKING LOAD CAPACITY OF THE ICU BED IN KG	200/250	NO
33	CONFIRMITY TO STANDARD FOR SAFETY AND ELECTROMAGNETIC COMPATIBILITY	IEC-60601-1-2:2001 STANDARD OR IS- 13450	YES
34	BED SHOULD HAVE RADIO TRANSLUCENT TOP (X RAY TRANSLUCENT)	SHOULD BE PROVIDED	YES
35	WARRANTY	3 YEARS OF MORE	NO
36	CERTIFICATION OF PRODUCT	EUROPEAN CE	YES

27. TECHNICAL SPECIFICATION OF GOLIATH CRANE

1. INTRODUCTION

The Gantry crane with lifting beam / girder of suitable dimension and capacity is required to be supplied installed tested and commissioned. The facility is meant for loading of finished and tested coaches on lorry for dispatch. This crane shall be reliable, trouble free and maintainable. The facility is to be installed in dispatch area year marked for metro coaches in between the two traversers. The combined track consisting of Standard gauge and broad gauge shall be laid of length 420meters between the two traversers.

The technical requirements of crane are indicated in the table below.

2. TECHNICAL REQUIREMENTS FOR 60 T GANTRY CRANE

2.1. General:

Sr. No.	Item	Parameter
1.	Type of Crane	Double girder Gantry crane (Goliath Type)
2.	Duty Class of Crane	Class M6 as per latest IS: 3177
3.	Type of Service	out-door
4.	Hoisting Capacity a. Main Hoist (MH)	60 T
5.	Atmospheric Condition	Normal atmosphere

6.	Weight Details a) Crane Weight b) Crab Weight	(To be furnished by supplier) (To be furnished by supplier)
	Operating Speed (at rated load)	
7.	Long Travel Motion (L.T.)	5 & 0.5 m/min
8.	Cross Travel Motion (C.T.)	5 & 0.5 m/min
9.	Hoisting Speed (MH)	3 m/min Hoist motion shall also be provided with two slow speeds i.e. 10%, 50% of normal speed using VVVF (Variable Voltage Variable Frequency) controlled drives
	Crane Performance and Structural Details	
10.	Span	8m
11.	Bay Length	60m
12.	Required lifting height (above floor)	10m
13.		

17.	Cross Travel approach for Hoist from L.T. rail (C1)	1000 mm
18.	Cross Travel approach for Hoist from L.T. rail (other side) (C2)	1200 mm
19.	Longitudinal Approach for hoists from wall (L1)	1000mm
20.	Longitudinal Approach for hoists from wall (other side) (L2)	1000mm
21.	Distance between rail brackets	8m (max)
22.	Operation of gantry crane	Through push button pendent operating from floor & Hand-Held Radio Remote Control.

3. CODES AND STANDARDS

The crane shall comply with all currently applicable statues, regulation and safety codes relating to the design, construction and operation of cranes in the locality where the crane will be installed. No part of these specifications shall be construed to relieve the vendor of his responsibility to supply a functionally adequate crane. The crane supplied shall comply with the latest applicable Indian / International standards. Other national standards are acceptable if they are established to be equal or superior to the referred standards.

In the event of any conflict between codes, standards referred below and this specification, the requirements of this specification shall govern.

Some applicable codes are listed below;

Table 2

i.	IS : 3177 (2020)	Code of Practice for Design of E.O.T. and Gantry Cranes other than steel works Crane
ii.	IS : 807 (2014)	Code of Practice for Design, Manufacture, Erection & Testing (Structural portion) of Cranes and Hoists.
iii.	IS : 2266 (2002)	Steel Wires for Ropes for General Engineering Purposes. Hoisting rope
iv.	IS : 325 (1996)	Three Phase Induction Motors
v.	IS : 15560	Point hooks with shank up to 160 Tonne
vi.	ISO : 12488	Cranes-Tolerance for wheels and travel and traversing tracks
vii.	IS : 800 (2007)	General Construction in Steel – Code of Practice
viii.	IS 3938	Specification Electric Wire Rope Hoists [MED 14: Cranes, Lifting Chains and Related Equipment]
ix.	IS : 4460 (1995)	Gears – Spur and Helical Gears – Calculation of Load Capacity
x.	IS : 3443 (1980)	Crane Rail Section
xi.	IS : 4029	Guide for Testing Three Phase Induction Motors
xii.	IS : 694 (2010) or IS 7098 (part1)	Electric Cables. (PVC or XLPE)
xiii.	ASME Section V & IX	For non-destructive testing and welding

xiv.	IS : 961 (1975)	Structural Steel (High Tensile)
xv.	IS : 816 (1969)	Code of Practice for use of Metal Arc Welding for General Construction in Mild steel
xvi.	IS : 823 (1964)	Code of Practice for use of Metal Arc Welding of Mild steel
xvii.	IS/IEC: 60034-1(2004)	Rotating electrical Machines

MATERIAL OF CONSTRUCTION

All materials used shall be of industrially proven and sound quality. It shall conform to latest relevant standards as given below;

Table 3

i.	Steel Plates	IS-2062 Gr- E250 and quality BR
ii.	High Tensile Bolts	BS-970 (EN-24) or IS equivalent,
iii.	Hooks and Clevises	20Mn2 & IPSS or IS-1875 Class 3A
iv.	Steel Pinions / gears	BS-970 (EN-24 / En 19) or IS equivalent
v.	Steel Shafts and Axles	BS-970 (EN-8 or 9) or IS equivalent
vi.	Pins and Screws	BS-970 (EN-8) or IS equivalent
vii.	Steel Castings	IS-1030 (Gr-II)
viii.	Steel Forgings	IS-2004, Class III
ix.	Hoisting rope	IS-2266
x.	Runway track for L.T. & C. T	IS-2062 Gr- E250 and quality BR (<i>hardness of shall not be less than 200HB</i>)
xi.	Wheels	BS-970 (En-9) forged
xii.	Seamless pipe	ASTM A- 53 / 106 Grade B
xiii.	Rope drum	ASTM 106Gr-B

Purchaser may ask for additional tests, if necessary, to confirm the quality of material at vendor's cost. Manufacturer can, however, use alternative material which is superior for the intended service. But in all cases, they are required to obtain prior concurrence of the purchaser after furnishing chemical and physical properties of the offered material, and any other information that may be asked by the purchaser.

Lifting girder of commensurate length and capacity to be supplied along with goliath crane.

28. INDUSTRIAL GASES

• Introduction

BEML has proposed Rolling stock commuter Rail and Metro Cars Manufacturing plant (green field) at Bhopal, Madhya Pradesh. Industrial gases like Acetylene, Oxygen, Argon, AOM gas & ACM gas are required in the plant. The said industrial gases are required for the following purposes:

- Acetylene & Oxygen gas are 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:

• Requirement Of the Industrial Gases:

The requirement of said industrial gases is indicated below:

TABLE SHOWING REQUIREMENT OF INDUSTRIAL GASES

Number of Days-320

<u>Description</u>	<u>Unit</u>	<u>Total Quantity Required (per annum)</u>	<u>Per day consumption (320 working days)</u>	<u>Consumption in each shift (Considering 2 shifts)</u>	<u>Consumption per hour, with each shift of 8 hours</u>	<u>No. of cylinders required for 3-days (47 L cylinder holds 7 m3 of gas @150 bar)</u>	
<u>Dissolved Acetylene Gas (DAGas)</u>	<u>Cu.M</u>	<u>36471.00</u>	<u>113.97</u>	<u>56.99</u>	<u>7.12</u>	<u>48.8</u>	<u>50</u>
<u>Compressed Oxygen Gas</u>	<u>Cu.M</u>	<u>70995.00</u>	<u>221.86</u>	<u>110.93</u>	<u>13.87</u>	<u>95.1</u>	<u>95</u>
<u>Argon Gas</u>	<u>Cu.M</u>	<u>69048.00</u>	<u>215.78</u>	<u>107.89</u>	<u>13.49</u>	<u>92.5</u>	<u>95</u>
<u>98%Argon+ 2%Oxygen (AOM Gas)</u>	<u>Cu.M</u>	<u>189627.0</u>	<u>592.58</u>	<u>296.29</u>	<u>37.04</u>	<u>254.0</u>	<u>255</u>

<u>80%Argon+</u> <u>20%Co2 (ACM</u> <u>Gas)</u>	<u>Cu.M</u>	<u>122544.0</u>	<u>382.95</u>	<u>191.48</u>	<u>23.93</u>	<u>164.1</u>	<u>165</u>
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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.

Refer Drg. no.: MEC-/I0047-01-04-D1-ZZ-16-DR-N-03004, PFD of industrial gas, enclosed with report.

- **Source of gas**

In the proposed plant, gas generation is not envisaged, however gas is supplied from outside in the portable 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.

- **Proposed facilities**

Various industrial Gas requirements viz. Acetylene, 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 central / common 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.

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 metres. 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 / user’s 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 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.

b. 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 needs 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.

c. Gas bank and Gas Management system

The central 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. In the flammable gas bank, all flammable and toxic gases like Acetylene will be kept. The two types of banks will be in the common gas bank & no wall between various gases proposed. Only acetylene gas bank will be kept 6 m away from oxygen gas bank.

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
35.	ANSI	ANSI B 31.1	Power piping code
36.	ANSI	ANSI B 31.3	Process piping code
37.	BIS	IS: 1239 (Part-I)	Steel tubes, tubulars and other wrought steel fittings - Specification
38.	BIS	IS: 1239 (Part-II)	Steel tubes, tubulars and other wrought steel fittings - Specification
39.	BIS	IS: 3589	Electrically welded steel pipes for water, and sewerage (168.3 to 2540 2000).
40.	BIS	IS: 5504	Spiral welded pipes
41.	ASTM	ASTM A 106 Gr. B	ERW & Seamless CS pipe specification
42.	ASTM	ASTM A 312	Standard specification for austenitic stainless-steel pipe intended for high-temperature and corrosive service
43.	ASTM	ASTM A269	Standard specification for seamless and welded austenitic stainless-steel tubing used in general corrosion-resisting and low- or high-temperature service
44.	ASTM	ASTM B75	Copper Tubes
45.	ASME	ASME G93	Oxy cleaning
46.	ASTM	ASTM A 53	MS pipe specification
47.	ANSI	ANSI B 36.1	Welded & seamless wrought steel pipe dimensions
48.	ANSI	ANSI B 36.19	Stainless Steel pipes dimensions
49.	ANSI	ANSI B 16.9	Butt welding pipe fittings dimensional standard.
50.	ANSI	ANSI B 16.11	Forged steel fittings: Socket welded & threaded
51.	BIS	IS: 6392	Steel pipe flanges.
52.	ANSI	ANSI B 16.5	CS pipe flanges & flanged fittings
53.	ISO	ISO:17192	Metal ball valves for petroleum, petrochemical and allied industries

54.	API	API: 602	Steel gate, globe & check valves for sizes pns 4 (ND100) and smaller for the petroleum and natural gas industries.
55.	BS	BS: 5352	Steel wedge gate, globe and check valves 50 mm and smaller for the petroleum, petrochemical and allied industries.
56.	API	API: 600	Gate valves for petroleum & natural gas.
57.	BS	BS: 1414	Specification for steel wedge gate valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries
58.	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
59.	BS	BS: 1868	Specification for steel check valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries.
60.	API	API: 599	Metal plug valves - Flanged, threaded, and welding ends
61.	API	API 598	Valve inspection & testing.
	BIS	IS: 2002	Steel plate for pressure vessel for intermediate and high temperature service including boilers.
62.	BIS	IS:2062	Hot rolled medium and high tensile structural steel – Specification.
63.	BIS	IS: 7310	Approval Tests for Welders Working to Approved Welding Procedures.
64.	API	API: 1104	Welding of Pipelines and Related Facilities.
65.	ASTM	ASTM Sec. 5	Non-Destructive examination.
66.	ASME	ASME Sec 9	ASME boiler & pressure vessel code.
67.	BIS	IS: 1447	Code of practice for painting of ferrous metals in buildings.
68.	BIS	IS: 5	Colours for Ready Mixed Paints and Enamels.
69.	BIS	IS-2379: 1990(R2006), (R2007-05)	Colour Code for identification of pipeline.

70.	Indian std.	-	Central Pollution Control Board standards.
71.	Indian std.	Gas Cylinder Rules	Gas cylinder rules
72.	Indian std.	-	Petroleum & Natural Gas Regulatory Board.
73.	BS and International Std.	BS-EN 50073:1999 And IEC60079-292 Ed1.0: Explosive atmospheres	Gas Detectors and Detector Panels selection, positioning, installation, commissioning, testing and maintenance.

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 portable 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.

APPROVED MAKES

S.N	ITEMS	MAKE
1.	Cement	ACC, JK, Ultra Tech.
2.	Chlorpyriphos	DE-NOCIL, Cyanamide, Bayer India Ltd, Bhagiradha Chemicals Ltd.
3.	Structural Steel	SAIL, TATA, RINL, JSW, JSPL
5.	Reinforcement steel	TISCO, SAIL, RINL, JSW
6.	M.S. Pipe, Tubes, Bar, Flats, angle, Tee Sections	SAIL, TATA, TISCO, JINDAL
7.	Concrete admixture	Fosroc, MC-Bauchemie, BASF, Sika; Choksey Chemical
8.	Ready Mix cement concrete	ACC Concrete, UltraTech concrete, L&T concrete or equivalent
9.	Polysulphide sealant	Pidilite, Chemetall-Rai, Thio flex 600 FOSROC, CHOKSEY CHEMICAL; DOW CORNING
10.	Bitumen Impregnated Board	Shalitex, Sika or approved equivalent
11.	Polyethylene back up rod	Supreme Ind. Ltd. or approved equivalent
12.	PVC water stops	Fixopan, Sintex or equivalent
13.	White Cement	Birla, J. K
14.	Water proofing compound	Fosroc, MC-Bauchemie, BASF, Sika, CICO Technologies Limited
15.	White washing lime	Dehradun (Source) or equivalent
16.	Paints	Asian Paints, Nerolac, AkzoNobel, Berger
17.	Fire Retardant paint	Viper or approved equivalent
18.	Epoxy	Fosroc, BASF, SIKKA, MC-Beauchemin
19.	Waterproof Ply	Green, Century, Duro, Marino
20.	AAC Blocks.	BILT, JK, KJS
21.	APP Polymeric Polyethylene Felt-	BITUMAT, Techno Nicol, or equivalent
22.	Expanded Polystyrene (Thermocole)	Beardshell, BASF or approved equivalent
23.	Extruded Polystyrene	Iso board ND, BASF or approved equivalent
24.	Commercial Quality White Glazed Ceramic Tiles	Kajaria, Somany, Jhonson
25.	PVC strips	Fixopan, Fair Polymers or approved equivalent
26.	Welding rod	ADVANI or approved equivalent
27.	Micro Concrete	PIDILITE, FOSROC, SIKKA, BUILTECH
28.	R.C.C. pipes	Indian Hume Pipe, Pragati, Paradise, Vikas pipes
29.	Water proofing cement paint	Super Snowcem paint, J.K, Birla, Acrocem
30.	Chemical Grout	Endure Bal-grout, Leticrete, Fosroc, star coating
31.	Dash Fasteners	Fischer, Hilti or equivalent
32.	Granite Stone	as per approved sample
33.	Metal Deck	Pennar, TATA
34.	Hydraulic door closers	DORMA, HAFLE, or equivalent
35.	Aluminium Sections	Hindalco, Jindal/approved equivalent
36.	Glazing	Modi glass, AIS glass, Saint Gobain
37.	Silicon sealants	Dow corning
38.	Wall putty	Birla putty, JK putty, Asian putty
39.	Spider fittings	Dorma, Nexus, Hafle

40	Floor springs	Dorma, Hafle
41	LOW VOC paints	Asian Paints, Nerolac paints, Alco noble (ICI)
42	Aluminium Powder coating	AkzoNobel, Jotun.
43	Structural Sealant	Wacker, Dow Corning, GE

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. No	Name of materials	Approved Make
Civil works		
1	Cement (PPC/OPC)	ACC/ Ultra Tech/ RAMCO / Dalmia / Chettinad Cements
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 drain Pipe, CPVC 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/ ICICH 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/ Prominance/ Rehau/Torfenster/ Alupast / NCL Veka LTD
22	Admixture	Fosroc/ Sika.
23	Water Proofing Compound	Tapcrete/ Cico/ Accoproof/ Impermo/ Fosroc.
24	Adhesive	Pidilite/ Dunlop/ Sika/ Fosroc/ Endura/ Laticrete
25	Epoxy Mortar	Fosroc/ Sika/ Pidilite/ MYK
26	Structural & Weather Silicon	Dow Corning/Wacker.
27	Epoxy/PU Flooring & other specialised floorings.	Berger/ Fosroc/ Pidilite/Sika/MYK/ Ardex Endura/ STP.
28	Flush Door shutters	Duro/ Kitply (Swastik)/ Century/ Durian/ Greenply/ Merino/ Green Panel/ A1 teak/ / JENA
29	Fire rated door	Signum Fire Protection/ Shakti Metdoor/ NAVAIR/ Sukri/ Promat/ Godrej/
30	Acoustic Door	Ica Acoustics/ Oceanz Acoustics/ Acoustical Solution Inc.
31	Flush Door Shutters (Decorative/ Non-Decorative).	Swastic/ Corbett/ Century/ Green/ Archid/Jena
32	Glass FRP Door Shutters	Polyline/ Duroplast/ Cactus.
33	Hydraulic Door Closer/ Floor Spring	Hardwyn/ Godrej/ Dorma
34	S.S. Staircase Railing	Connect Architectural Products Pvt.Ltd/ Jindal Stainless Steel Ltd./ Icich Industries, Essar

35	Door Coordinator	UL Listed/ Monarch/ Dorma.
36	Anodised Aluminum Hardware (Heavy Duty)	Hardima/Everite/ Sigma (ISI Marked).
37	Tempered / Clear / Float / Toughened Glass	Pilkinton/Saint Gobain/ Asahi.
38	Door Locks	Godrej/Europa/Ozone/Dorset
39	Rolling Shutter Motor	CAME/AUTOZON/ GEAPL
40	Floor spring & Door closure	Godrej/ Dorma/Dorset/ Kich
41	Water proofing chemical	DrFixit /SIKA/ ARDEX/BERGER /FOSROC
42	Tile Adhesive	Lacticrete/ Ardex Endure/ Pidilite/ Sika/ Asian Paints/ Fosroc.
43	Acoustic Treatment: Wall Panelling	Armstrong / Anutone / Himalaya / Credenze
44	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
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 Sheeting / 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
19	PUF sandwich Panel	AlFa/Karthik/ Lloyd/Kirby/ Metecno/ TATA Bluescope
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/ Single Phase Preventer /Timer	ABB/ Schneider/L&T/Legrand
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 (Mossaic/Myrise)/ Crabtree (Picadly)/ Schneider (Zencello)
13	Indication lamps / push buttons / selector switch	L&T/Siemens/Schneider/AE/Kaycee/Tecknic/BC H/ 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	Duraline /Rex Polyextrusion / Plato / Tijaria / Tirupati Plastomatics / AJAPLAS
22	Terminals	Connectwell/ 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/Elstomer.
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)
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	Wet Mix Macadam (WMM)	Local Supply (as per MORTH grade)
2	Granular Sub base (GSB)	Local Supply (as per MORTH grade)
3	Aggregates (40mm, 20mm, 10mm)	Local Supply (as per MORTH grade)
4	Concrete Kerb Stones / Edging Blocks	KK Manhole / Local precast vendor
5	Paver Blocks (M40 or M50 Grade)	KK / UltraTech / Local ISI vendors
6	Road Marking Paint	Asian Paints / Berger / Shalimar/ Dulux/ Nerolac
7	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/ Firesheild/ 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 / multi-function 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
3	UPVC, PVC pipes with fittings	Supreme/ Finolex/ Astral/Aashirvad
4	All types of Valves	Zoloto/Apollo/Leader/Audco /Kirloskar
5	Solenoid valves	Dwyer/Taylor/Audco
6	Cast iron pipes and fittings	NECO/ RIF/ BIC/ KAPILANSH,
7	Injection Grouting	Fosroc/ Sika/ MYK/Pidilite.
8	Grab bars for Disabled	Dorma/ D-line/ Cera/ Jaquar/ Hindware
9	Water dispenser	Crossfields/Aqua clan/ Conway/ Voltas/Thermax/
10	Water storage tank	Sintex/Aquatech/Vectus/Plasto/Supreme
11	Hydro-pneumatic pump	Grundfos/ Kirloskar/ KSB/ Mather Platt
12	Sewage pump and other pumps	Grundfos/ Kirloskar/ KSB/ Lubi
13	Galvanised Iron pipes	Jindal/ Techno flex
14	Wall Mixer, Kitchen sink,	Hindware/ Parryware/ Jaquar/Cera
15	Electromagnetic flow meter	Reputed make with NABL calibration
16	RCC Hume Pipes (NP2/NP3 Class)	Spun Pipe/KK/ISI-approved vendor
17	Precast RCC Drain Covers	KK / Local Precast ISI vendor
18	Stoneware Pipes (if used in gravity drains)	Supreme / Prince / Local ISI
19	Sump / Catchpit Precast Chambers	KK Manhole / Local Precast

20	Drainage Inspection Chamber Covers	Neco/ Skf/Rif/Rpmf/ Bic/ Kapilansh/ Nfl
21	Manhole Steps (FRP coated or MS)	Neco/ Skf/Rif/Rpmf/ Bic/ Kapilansh/ Nfl
22	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
12	Melamine Polish	Asian Paints/Berger/ICI

Note: Contractor shall obtain prior approval of BEML before procurement of the Materials from the manufacturers listed above for the work. If any of the above Brands of Materials are not available, Engineer-in-charge shall allow use of other brand material duly approved by OIC/EIC provided they confirm to the requirement of IS as per Technical Specification/Quality Plan.

For category of materials not mentioned above approved list, contractor shall use reputed and BIS certified brands. Before using prior approval for the brands for such materials shall be obtained from OIC/EIC, BEML

BEML reserves the right to reject or accept any of the make given above without assigning any reasons and contractor is bound to supply other brands in the list.