

TECHNICAL SPECIFICATIONS

FOR

ARCHITECTURAL, CIVIL AND

MEP WORKS

PURCHASER/OWNER/ EMPLOYER/CLIENT	: MINISTRY OF MICRO, SMALL AND MEDIUM ENTERPRISES, BENGALURU
PROJECT	: TECHNOLOGY CENTRE, BENGALURU
LOCATION	: BENGALURU, KARNATAKA INDIA
CONSULTANT/CMC/ PROJECT MANAGER	: TATA CONSULTING ENGINEERS LIMITED

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TECHNICAL SPECIFICATION
ARCHITECTURAL WORKS

ARCHITECTURE WORKS

1.1 ARCHITECTURE SCOPE OF WORK

The scope includes design, detailing, procurement, supply, construction, furnishing, testing and execution in accordance with the tender documents.

Items of work include

- Painting
- Door and Windows incl Fire Doors
- Glazing & Facade works
- Stone cladding
- Flooring and finishing
- GRC Works
- Fabrication works
- Dry Partition/Glass partition
- Ceiling Finishes
- Wall Finishes
- Waterproofing and Insulation works
- Gates including automation
- Any other works shown in the drawings but not specifically mentioned above

1.2 SPECIFICATIONS FOR NON-DSR ITEMS

1.2.1 EPOXY / ESD COATING

1.2.1.1 General

Epoxy coating should be based on carefully selected solvent less Epoxy resin composition. It should be a 3 component system consisting of base, hardener and hard wearing quartz fillers. It should be self levelling composition and forms a very smooth, attractive hygienic, hard wearing and chemical resistant floor topping.

It should provides a joint less flooring making it dust free and is easy to clean because of smooth surface.

Chemical Resistant – It should have excellent chemical resistance to most chemicals

Wear Resistant – It should provide a tough floor topping to withstand foot and light vehicular traffic.

1.2.1.2 Surface Preparation

The long term durability of the applied Epoxy topping is dependent upon the adhesive bond achieved between the flooring material and substrate. It is most important therefore, that substrate surface is correctly prepared prior to application.

Substrate must be of sufficient strength to support loads applied through the topping. New concrete or cementitious substrates should have been placed for at least 28 days and have a moisture content of less than 5% before topping. Before application, the surface to

be coated should be free from loose particles, rust, oils, grease or earlier coatings and should be thoroughly dry. After surface is dry, all repair work like sealing of joints, cracks filling of cavities and crevices should be carried out. 5. The self levelling action is very localized and does not eradicate irregularities of level present in the original substrate. It is most important, therefore, that adequate surface preparation and repair is undertaken prior to application of flooring systems.

1.2.1.3 Priming

To be as per manufacturer's specifications.

1.2.1.4 Mixing

To be as per manufacturer's specifications.

1.2.1.5 Laying

Spread the mixture on the floor immediately to the required thickness by means of rollers and serrated trowels. The floor should be rolled by a spike roller to remove trapped air. The floor shall self level to uniform colour and smoothness.

1.2.1.6 Technical Information

Products Included in this System

Flowprime /Scratch Coat

Flowshield CR 1000

Finish: Gloss

Thickness: 1mm

Fire Resistance : BS476: Part 7 Surface spread of flame: Class 2 (indicative)

Slip Resistance Value : Method described in BS 7976-2 Dry 67 (Typical values for 4-S rubber slider)

Temperature Resistance : Tolerant up to 60 oC

Water Permeability : Nil-Karsten Test (Impermeable)

Vapour Permeability : 4 gms / m² / mm / 24 hours

Abrasion Resistance : Taber Abrader - 90mg loss per 1000 cycles, (1kg Load using CS17 wheels)

Compressive Strength : >60 N/mm² (BS6319)

Flexural Strength : >40 N/mm² (BS6319)

Tensile Strength : >25 N/mm² (BS6319)

Bond Strength : Greater than cohesive strength of 25N/mm² concrete. >1.5 MPa.

Toxicity : Taint free to sensitive food stuffs

1.2.2 VDF FLOORING ('TREMIX' OR EQUIVALENT)

Providing & laying in position and compaction as specified machine mixed, plain cement concrete of grade M20 using maximum 20 mm downgraded coarse aggregate using Vacuum Dewatering procedure "TREMIX or Equivalent" including all necessary dewatering, form work, casting in panels of specified size and thickness, wherever necessary, to shape and depth as specified curing, etc., complete for any specified thickness, cutting grooves, filling joints etc.

Specification to be inclusive of

- Steel form work with steel channel sections as approved by ER/PMC, mechanical vibration using needle and screed vibrators.
- Vacuum dewatering and Curing
- Cutting mechanically the dummy joints of 6mm wide and up to 0.33 times depth within 24 hours - 36 hrs after casting the slab. The dummy joints are at approx 4m x 4m grids.
- Filling the grooves for joints with approved primer and approved joint sealing compound. The joint sealant will be filed flush with PCC surface.
- The joints will be kept filled with thermocol immediately after cutting and before filling, the same shall be removed & joints cleaned thoroughly with compressed air etc as directed.
- The acceptable level difference of VDF shall be only maximum 5mm at entire length.

1.2.3 METAL FIRE DOORS

1.2.3.1 Scope

This specification covers the design, supply of materials, Manufacture and installation of factory made special type of approved make steel fire doors of 1 Hour, 2 Hrs. Fire Rating and General Purpose Doors (FD-1 Hr., FD-2 Hr. & G.D.Series) of approved makes.

1.2.3.2 General

The Contractor shall furnish all materials, labour, operations, equipment, tools & plant, scaffolding and incidentals necessary and required for the completion of all metal work in connection with steel doors, as called for in the drawings, specifications and bill of quantities which cover the major requirements only. Anything called for in the tender documents shall be considered as applicable to the items of work concerned. The supply and installation of additional fastenings, accessory features and other items not specifically mentioned, but which are necessary to make a complete functioning installation shall form a part of this contract.

All metal work shall be free from defects, impairing strength, durability and appearance and shall be of the best quality for purposes specified made with structural proprieties to withstand safety strains, stresses to which they shall normally be subjected to.

All fittings shall be of high quality and as specified and as per approval.

The Contractor shall strictly follow, at all stages of work, the stipulations contained in the Indian Standard Safety Code or its Equivalent British Standard and the provisions of the safety code and the provision of the safety rules as specified in the General Conditions of the Contract for ensuring safety of men and materials.

Any approval, instructions, permission, checking, review, etc., whatsoever by the PMC/AEC, shall not relieve the Contractor of his responsibility and obligation regarding adequacy, correctness, completeness, safety, strength, quality, workmanship, etc.

1.2.3.3 Codes and Standards

All standards, specifications, acts, and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions.

List of certain important Indian Standards, Acts and Codes applicable to this work is given below. However, the applicable standards and codes shall be as per but not limited to the list given below:

IS : 277 Galvanized steel sheet (plain and corrugated)

IS : 3614 Metallic and non-metallic fire check doors – Resistance test and Part – 2 performance criteria.

1.2.4 HOLLOW METAL FIRE DOOR (2 Hours Fire Rating) WITH HONEY COMB CORE

1.2.4.1 GENERAL

Fire door shall be 2 hour fire rated and door quality shall be approved by TAC/CBRI and tested conformed to IS : 3614 Code or its Equivalent British Standard.

Unless otherwise specified, maximum size of door in this type:

- Single shutter door : 1200 mm x 2200mm
- Double shutter door : 2000 mm x 2400 mm

For doors above 2200 mm height (Single Doors) and 2400 mm height (Double Door) the options shall be:

- A man operation door of size above 2049 mm height shall be provided with a removable panel / fixed panel on top.

The construction of above panel shall be designed similar to that of a shutter in case of flush panel to match the exteriors.

1.2.4.2 Frame

Material

Frame to be manufactured from 1.60 mm (16 gauge) galvanised steel sheets complying with latest IS 277 Code or its Equivalent British Standard coating class zinc coating mill phosphatized.

Profile

Door frame profile to be double rebated of dimensions 143 mm X 57 mm (+ / - 0.3) with bending radius of 1.4 mm.

Manufacture

Frame to be manufactured from 1.60 mm thick galvanised steel sheet to the specified profiles and dimensions. Frames manufactured at factory shall be knock down form with butt joints for bolted assembly at site.

Door frame preparations

Frames to be provided with a 3 mm thick back plates on all jambs with provision for anchor bolt fixing to wall openings. All frames to have reinforcement pads for fixing of door closer, at appropriate location as per manufacturer's details.

Frames to have factory finish-pre-punched cut outs to receive specific hardware and iron mongery.

Frames to be provided with hinge plates 3 mm thick pre-drilled to receive hinges for screw mounted fixing. All cut outs including hinge plates, strike plates to have mortar guard covers from inside to prevent cement, dust ingress into cut outs at the time of grouting.

Frames to have rubber shutter silencer on strike jambs for single shutter frames and on the head jambs for double shutter frames.

Finish

Door frames to be suitably cleaned with solvents and etch primed for receiving primer and top coats. Door frames to be primed in zinc phosphate stoving primer (35 microns DFT). Door frames to be finished in thermo setting paint (35 microns DFT) of approved colour and make as specified.

1.2.4.3 Fire Door Shutter

Material

Fire door shutter to be manufactured from 1.25 mm (18 gauge) galvanized sheets conforming to latest IS : 277 Code or its Equivalent British Standard coating class zinc coating, mill phosphatized.

Manufacture

Shutters to be press formed to 46 mm thick double skin hollow door with lock seam joints at stile edges. Shutters to have no visible screws or fasteners on either face. Internal reinforcement to be provided at top bottom and stile edges for desired fire rating.

Door Shutter Cores

Shutters to be provided with honeycomb kraft paper core to be bounded to the inner faces of the shutter.

Door shutter preparations

Shutters to be factory prepared with pre-punched cutouts and reinforcements to receive iron mongery as per final finish hardware schedule. The shutter should have an interlocking arrangement at this stile edges for flat surface on either side.

Shutters to have pre-drilled hinge plates with hinge guard covers. Shutters with locks to have concealed lock box with lock fixing brackets with pre-tapped holes.

For shutter with door closer reinforcement pads to be provided at appropriate location as per manufacturer's design.

All iron mongery preparation to have adequate reinforcement for flushes fixing at site.

Vision panel for Fire rated door

Vision panel to be provided with Borosilicate clear toughened glass of the thickness 6 mm for up to two hours fire rating. Glass to be fixed with clip on frames for square and rectangular vision panels and with spin turned rings for circular vision panels and Glazing Tape with one side adhesive. Vision Panels to be fixed with clip-on frames for square and rectangular Vision Panels with no visible screws. Unless otherwise specified standard sizes are 200 mm x 300 mm and 360 mm diameter.

Finish

Shutters to be suitably cleaned with solvents and etch primed for receiving primer and top coats. Shutters to be primed in zinc phosphate stoving primer (35 microns DFT). Shutters to be finished in thermo setting paint (35 microns DFT) of approved colour and make as specified.

1.2.4.4 Installation

Door frame fixing

The door frames should be assembled adjacent to the place of installation as the frames are not designed for transporting in an assembled condition. After assembly it is to be ensured that all threaded preparations are covered from the back of the frame using self adhesive strip to prevent penetration of mortar back-fill into screw threads. The head member of assembled frame shall be positioned against jambs ensuring correct alignment and secured using M8 x 20 long plated bolts together with nuts spring and flat washers.

The assembled frame shall be kept in position within the opening by means of bracing. In order to correctly position the frame against finished floor level or equalise on adjustable floor anchors where specified, shim shall be used under jambs. The frame shall be checked for squareness, alignment, twist etc. with carpenters bevel and plumb.

A tie rod shall be fixed to the frame during installation to ensure the correct dimensions between the frame rebated and the same may be removed after installation.

Where a 2nd fix application is required a shim detail is suggested to take up gap between frame and existing opening.

Existing masonry wall openings – Metal expansion shields

- Brace, position, level etc.
- Mark all positions of fixings on wall.
- Remove frame and drill wall to appropriate specified size.
- Fit rod anchor shells metal expansion bolts into the wall.

- Fit jamb spacer bracket into back of frame profile.
- Reposition frame back into opening and realign.
- Lightly screw CSK HD machine screws into shells, shim behind frame.
- Slowly tighten screws continually checking plumb, square etc. Finally ensure frames are not deformed as tightened.
- After fixing the frame shall be grouted with cement mortar 1:3 or Plaster of Paris or Gypsum powder as approved. Gap between frame and wall to be closed by cement pointing using cement mortar 1:3.
- Back full the frame through holes provided and insert nylon plugs.

Door shutter fixing

- Fix all the hardware to the door shutter like hinges, flush bolts, bolts, mortise locks, door closer, door stoppers, handles etc. with the appropriate screws and bolts supplied.
- The shutter is to be then fixed to the frame which is already installed. Align the shutter to match the hardware to the cutouts in the frame. Tighten the hinge screws.
- Application of Fire / Smoke UL 10 C / UL 1784 (2001) classified seal (for smoke check if specifically required)
- Clean door jamb rebate surfaces of all dust, oil etc. Affix self-adhesive Fire / Smoke seal on the door frame rebates as indicated by the manufacturer on hinge jambs, strike jambs, head member and sill.
- 2 Hours FIRE RATED DOOR – Hardware Schedule: All hardware to be in line with door schedule drawing.

1.2.5 HOLLOW METAL FIRE DOOR (1 HOUR FIRE RATING) WITH HONEY COMB CORE

1.2.5.1 General

Unless otherwise specified, maximum size of door in this type:

Single shutter door : 1200 mm x 2200 mm

Double shutter door : 2000 mm x 2200mm

For doors of size above 2200 mm height the options shall be:

A man operation door of size above 2049 mm height shall be provided with a removable panel / fixed panel on top with glazing or without glazing or without glazing as required.

The construction of above panel shall be designed similar to that of a shutter in case of flush panel to match the exteriors.

1.2.5.2 Frame

Material

Frame to be manufactured from 1.25 mm (18 gauge) galvanized steel sheets complying with latest IS 277 Code or its Equivalent British Standard coating class zinc coating mill phosphatized

Profile

Door frame profile to be single rebated of dimensions 100 mm X 57 mm (+ / - 0.3) with bending radius of 1.2 mm

Manufacture

Frame to be manufactured from 1.25 mm thick galvanised steel sheet to the specified profiles and dimensions. Frames manufactured at factory shall be knock down form with butt joints for bolted assembly at site.

Door frame preparations

Frames to be provided with a 3 mm thick back plates on all jambs with provision for anchor bolt fixing to wall openings. All frames to have reinforcement pads for fixing of door closer, at appropriate location as per manufacturer's details.

Frames to have factory finish-pre-punched cut outs to receive specific hardware and ironmongery.

Frames to be provided with hinge plates 3 mm thick pre-drilled to receive hinges for screw mounted fixing. All cut outs including hinge plates, strike plates to have mortar guard covers from inside to prevent cement, dust ingress into cut outs at the time of grouting.

Frames to have rubber shutter silencer on strike jambs for single shutter frames and on the head jambs for double shutter frames.

Finish

Door frames to be suitably cleaned with solvents and etch primed for receiving primer and top coats.

Door frames to be primed in zinc phosphate stoving primer (35 microns DFT).

Door frames to be finished in thermo setting paint (35 microns DFT) of approved colour and make as specified.

1.2.5.3 Door Shutter

Material

General purpose door shutter to be manufactured from 0.80 mm (22 gauge) galvanised sheets conforming to latest IS : 277 Code or its Equivalent British Standard coating class zinc coating, mill phosphatized.

Manufacture

Shutters to be press formed to 46 mm thick double skin hollow door with lock seam joints at stile edges. Shutters to have no visible screws or fasteners on either face.

Door shutter core

Shutters to be provided with honeycomb paper cored to be bounded to the inner faces of the shutter.

Door shutter preparations

- Shutters to be factory prepared with pre-punched cutouts and reinforcements to receive iron mongery as per final finish hardware schedule. The shutter should have an interlocking arrangement at stile edges for flat surface on either side.
- Shutters to have pre-drilled hinge plates with hinge guard covers. Shutters with locks to have concealed lock box with lock fixing brackets with pre-tapped holes.
- All iron mongery preparation to have adequate reinforcement for flush fixing at site.
- For shutter with door closer reinforcement pads to be provided at appropriate location as per manufacturer's design.

Vision panel

Vision panel to be provided with Borosilicate clear toughened glass of the thickness 6 mm for up to two hours fire rating. Glass to be fixed with clip on frames for square and rectangular vision panels and with spin turned rings for circular vision panels and Glazing Tape with one side adhesive. Vision Panels to be fixed with clip-on frames for square and rectangular Vision Panels with no visible screws. Unless otherwise specified standard sizes are 200 mm x 300 mm and 360 mm diameter.

Finish

Shutters to be suitably cleaned with solvents and etch primed for receiving primer and top coats. Shutters to be primed in zinc phosphate stoving primer (35 microns DFT). Shutters to be finished in thermo setting paint (35 microns DFT) of approved colour and make as specified.

All hardwares to be as per the detail drawing.

1.2.5.4 Installation

Door frame fixing

- The door frames should be assembled adjacent to the place of installation as the frames are not designed for transporting in an assembled condition. After assembly it is to be ensured that all threaded preparations are covered from the back of the frame using self adhesive strip to prevent penetration of mortar back-fill into screw threads. The head member of assembled frame shall be positioned against jambs ensuring correct alignment and secured using M8 x 20 long plated bolts together with nuts spring and flat washers.
- The assembled frame shall be kept in position within the opening by means of bracing. In order to correctly position the frame against finished floor level or equalise on adjustable floor anchors where specified, shim shall be used under jambs. The frame shall be checked for squareness, alignment, twist etc. with carpenters bevel and plumb.
- A tie rod shall be fixed to the frame during installation to ensure the correct dimensions between the frame rebated and the same may be removed after installation.
- Where a 2nd fix application is required a shim detail is suggested to take up gap between frame and existing opening.

Existing masonry wall openings – Metal expansion shields

- Brace, position, level etc.
- Mark all positions of fixings on wall.
- Remove frame and drill wall to appropriate specified size.
- Fit rod anchor shells metal expansion bolts into the wall.
- Fit jamb spacer bracket into back of frame profile.
- Reposition frame back into opening and realign.
- Lightly screw CSK HD machine screws into shells, shim behind frame.
- Slowly tighten screws continually checking plumb, square etc. Finally ensure frames are not deformed as tightened.
- After fixing the frame shall be grouted with cement mortar 1:3 or Plaster of Paris or Gypsum powder as approved. Gap between frame and wall to be closed by cement pointing using cement mortar 1:3.
- Back full the frame through holes provided and insert nylon plugs.

Door shutter fixing

- Fix all the hardware to the door shutter like hinges, flush bolts, bolts, mortise locks, door closer, door stoppers, handles etc. with the appropriate screws and bolts supplied.
- The shutter is to be then fixed to the frame which is already installed. Align the shutter to match the hardware to the cutouts in the frame. Tighten the hinge screws.
- Application of Fire / Smoke UL 10 C / UL 1784 (2001) classified seal (for smoke check if specifically required)
- Clean door jamb rebate surfaces of all dust, oil etc. Affix self-adhesive Fire / Smoke seal on the door frame rebates as indicated by the manufacturer on hinge jambs, strike jambs, head member and sill.

2 Hours FIRE RATED DOOR – Hardware Schedule

All hardware to be in line with door schedule drawings.

1.2.6 Polycarbonate Roofing

1.2.6.1 Scope

- Solid polycarbonate plastic glazing.
- Multiwall polycarbonate plastic glazing.
- Corrugated polycarbonate plastic glazing.
- Accessories for installation of plastic glazing.
- Skylight Glazing.

1.2.6.2 General & Codes

16 CFR 1201	Safety Standard for Architectural Glazing Materials.
ANSI Z97.1	American National Standard for Glazing Materials Used in Buildings.
ASTM D 635	Standard Test Method for Rate of Burning and/or Extent and Time of

	Burning of Self-Supporting Plastics in a Horizontal Position.
ASTM D 648	Standard Test Method for Deflection Temperature of Plastics Under Flexural Load.
ASTM D 696	Standard Test Method for Coefficient of Linear Thermal Expansion.
ASTM D 790/ASTM D 790M	Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
ASTM D 1003	Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics.
ASTM D 1044	Standard Test Method for Resistance of Transparent Plastic to Surface Abrasion.
ASTM D 1929	Standard Test Method for Ignition Properties of Plastics.
ASTM D 2843	Standard Test Method for Density of Smoke from the Burning and Decomposition of Plastics.
ASTM D 3763	Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of A Striker Impacted by A Falling Weight (40 ft-lbs).
ASTM G 53	Standard Practice for Operating Light and Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Non-Metallic Materials.
QUV 313B	Accelerated Weathering Test of Non-Metallic Materials.
ISO-9002	International Standards Organization.

1.2.6.3 POLYCARBONATE SHEETING : Typical Property Values

Property	Test Method	Unit	Value
Physical Density	ISO 1183	g/cm ³	1.2
Water absorption, 24 hours	ISO 62	mg.	10
Water absorption, saturation /23°C	ISO 62	%	0.35
Mould shrinkage	ASTM-D955	%	0.6-0.8
Poisson's ratio	ASTM-D638	-	0.38
Mechanical			
Tensile stress at yield 50 mm/min	ISO 527	MPa	60
Tensile stress at break 50 mm/min	ISO 527	MPa	70
Tensile strain at yield 50 mm/min	ISO 527	%	6
Tensile strain at break 50 mm/min	ISO 527	%	120
Tensile modulus 1 mm/min	ISO 527	MPa	2350
Flexural stress at yield 2 mm/min	ISO 178	MPa	90
Flexural modulus 2 mm/min	ISO 178	MPa	2300
Hardness H358/30 95	ISO 2039/1	MPa	95
Impact			
Charpy impact, notched	ISO 179/2C	kJ/m ²	35
Izod impact, unnotched 23°C	ISO 180/1U	kJ/m ²	NB

Izod impact, unnotched -30°C	ISO 180/1U	kJ/m ²	NB
Izod impact, notched 23°C	ISO 180/1A	kJ/m ²	65
Izod impact, notched -30°C	ISO 180/1A	kJ/m ²	10

PHYSICAL			
Specific Gravity	ASTM D792	ó	1.20
Sound Transmission, STC Rating (36" x 84")	ASTM E9070	ó	
	@ 0.118"		25
	@ 0.177"		29
	@ 0.236"		31
	@ 0.375"		34
	@ 0.500"		34
Light Transmission (Average)	ASTM D1003	%	88
Rockwell Hardness	ASTM D785	ó	M70, R118
Chemical Resistance	ANSI Z26.	1	Passes
MECHANICAL			
Tensile Strength, Ultimate	ASTM D638	psi	9,500
Tensile Modulus	ASTM D638	psi	340,000
Flexural Strength	ASTM D790	psi	13,500
Flexural Modulus	ASTM D790	psi	340,000
Flexural Endurance @ 1,800 Cycles/Min, 73°F, 50% RH	ASTM D671	psi	1,000
Compressive Strength	ASTM D695	psi	12,500
Elongation	ASTM D638	%	110
Izod Impact Strength, up to 125 mils, Notched	ASTM D256A	ft-lbs/in	12ñ16
Drop Dart Impact Strength, 1" dia.	dart GE Test	ft-lbs	
	@ 73°F		>200
	@ 0°F		>200
THERMAL			
Coefficient of Thermal Expansion	ASTM D696	in/in/°F	3.75 x 10-5
Thermal Shrinkage	GE Test	%	1
Heat Deflection Temperature	ASTM D648	°F	
	@ 264 psi		270
	@ 66 psi		280
Shading Coefficient	ASHRAE	ó	
	Clear		1.02
	Gray/Bronze		79
FLAMMABILITY			
Horizontal Burn (Flame Spread), AEB	ASTM D635	in	<1
Ignition Temperature	ASTM	°F	

	D1929		
		Flash	873
		Self	1,076

1.2.6.4 Accessories

Profile : Aluminium custom profile 60 mm wide
 Finish : 15 micron silver anodized
 Flashing : Aluminium angle 35x35x1.5 thk
 Gasket : EPDM rubber
 Fastners : Self drilling and self tapping (SDST) screws
 Washer : EPDM
 Tapes : Aluminium tape roll
 Sealant : Silicon, non stain

1.2.6.5 Preparation

- Glazing channels or recesses shall be cleaned and free of obstructions, soil, debris, and other materials.
- Seal porous glazing channels or recesses with primer-sealer compatible with substrate and polycarbonate sheet materials.
- Cut polycarbonate sheet materials to exact sizes required, with clean edges free of notches; clean contact edges with solvent compatible with polycarbonate sheet materials, as specified or approved by polycarbonate sheet manufacturer.

1.2.6.6 INSTALLATION

Install plastic glazing in accordance with polycarbonate sheet manufacturer's instructions. Do not use glazing accessories not specified or approved by polycarbonate sheet manufacturer.

1.2.6.7 CLEANING

- Immediately after completing construction activities relating to installation of polycarbonate sheet materials, remove remainder of strippable masking from surfaces of polycarbonate sheet glazing; do not expose masking to sunlight for an extended period of time.
- Immediately after removing masking, clean glazing in accordance with polycarbonate sheet manufacturer's instructions:
- Rinse surface with lukewarm water.
- Wash surface with mild soap and lukewarm water.
- Use soft cloth or sponge gently to loosen dirt and grime; scrubbing glazing surfaces, or using squeegee on glazing surfaces, is not permitted.
- Repeat rinse as above, and wipe surface dry with soft cloth until surfaces are spotless and dry.

1.2.6.8 PROTECTION OF INSTALLED PRODUCTS

- Immediately after cleaning, cover polycarbonate sheet glazing surfaces with polyethylene sheeting, or other covering material approved by polycarbonate

sheet manufacturer; secure covering in place by taping to framing members - do not tape covering to polycarbonate sheet materials.

- Protect installed glazing from damage to function or finish by subsequent construction activities.
- Repair minor damage to finishes in accordance with polycarbonate sheet manufacturer's recommendations.
- Replace glazing having damage to function, and glazing having damage to finishes

1.2.7 GRC [GLASS REINFORCED CONCRETE] WORKS

1.2.7.1 Scope

The specifications refer to GRC [Glass Reinforced Concrete] works in the building.

1.2.7.2 Specialist Contractor

The work specified in this section is to be undertaken by a Manufacturer who is a Member of the National Precast Concrete Association Australia, GRC Industry Group with experience in the GRC industry, which includes the production of architectural panels (or other products for which this specification is being used). With his tender, the contractor shall submit to the construction manager written evidence indicating his capability of producing panels of a reliable and consistent quality.

1.2.7.3 Standards and Codes

AS 3972	Portland and blended cements.
BS 1	Portland Cement.
BS 3892	Pulverised Fuel Ash for use in Concrete.
BS 476	Test Methods and Criteria for the Fire
Part 8	Resistance of Elements of Building Construction.
	GRC Industry Group of National Precast Concrete Association Australia,
	A Recommended Practice – Design, Manufacture and Installation of Glass Reinforced Concrete (GRC)
AS 3582.1	Supplementary cementitious materials for use with portland and blended cement - Fly ash.
AS 1130	Code of practice for use of fly ash in concrete.
AS/NZS 1170.1	Structural design actions – Permanent, imposed and other actions.
AS/NZS 1170.2	Structural design actions – Wind actions.
AS 1170.4	Minimum design loads on structures (known as the SAA Loading Code) – Earthquake loads.
AS 1379	Specification and supply of concrete.
AS 3610	Formwork for concrete.
AS 1478.1	Chemical admixtures for concrete, mortar and grout – Admixtures for concrete.
BS 1014	Pigments for Portland Cements and Portland Cement Products

BS EN 1169	Precast Concrete Products – General Rules for factory production control of glass fibre reinforced cement.
BS EN 1170	Precast Concrete Products – Test Methods Parts 1-8 for glass-fibre reinforced cement.

1.2.7.4 MATERIALS

General & Codes

Materials used for making the GRC unit shall generally comply with relevant British and Australian Standards and Codes. Any reference to a British Standard shall mean that current at the time of going to tender.

Where materials are not fully covered by this specification or alternative materials are offered, the Contractor shall forward to the Construction Manager prior to commencing the work, details of those he proposes to use together with supporting evidence indicating that the finished product will be capable of meeting the performance requirements of this specification.

Alkali-Resistant Glassfibre

Glass fibre shall be an alkali-resistant, continuous filament fibre developed and formulated specifically to have high strength retention in Ordinary Portland Cement environments. The glass fibre shall have a minimum ZrO₂ content of 16% by weight, in accordance with internationally-recognised standards, and shall have a minimum strength retention (determined by Strand In Cement (SIC) testing) of 300 MPa (Test Method: GRCA SO 104/0184).

The producer shall provide certification from the glassfibre manufacturer to show that the glass fibre conforms to these requirements, has a history of successful use in similar matrices, and is manufactured under an internationally-recognised Quality Management system.

Suitable alkali-resistant glassfibres are “Cem-FIL“, manufactured by Saint-Gobain/Vetrotex and “NEG ARG Fibre” manufactured by Nippon Electric Glass.

Cement

The cement shall be Ordinary Portland Cement, supplied by a manufacturer of assessed capability to AS 3972– 1997 and BS 12 or its derivatives, and should be supported by suitable certification. Cement shall be obtained from one source throughout manufacture. Cement shall be correctly stored and kept dry to avoid deterioration.

Sand

Sands should be washed and dried to remove soluble matter, and to permit control of the water/cement ratio. Sand added to the mix shall not exceed 50% by weight of the total mix and sand/cement ratio shall not exceed 1:2. Sand shall be only high silica and conform to the following specification:

Silica content	>	967%
Water content	<	2%
Soluble salts	<	1%
Grain size	<	1.2 mm
	<	10% passing a 150 micron sieve

Sands other than silica sands may be used subject to approval of the architect and engineer, but the producer must be able to show proof of their suitability.

Admixtures

The manufacturer shall ensure that any admixtures used do not have any harmful effects on the product, and are used in accordance with the manufacturers' recommendations. The use of superplasticisers may be encouraged to keep water content of the composite to a minimum without loss of suitable working characteristics, especially the ease of attaining full compaction.

Any admixtures used, shall comply with AS 1478.

Pigments

Any pigments used shall conform to BS 1014. These shall be:

- Harmless to the GRC's set and strength.
- Stable at high temperature.
- UV-resistant and alkali-resistant.

The client should recognise that some colour variation may occur, and must agree an acceptable range of variation with the producer.

Water

Water shall be free from deleterious matter that may interfere with the colour, setting, or strength of the concrete.

Mix Design

The mix shall have been determined by the manufacturer, and written confirmation of the mix design shall be submitted so the proportions shall be chosen to achieve the quality-control requirements specified herein.

Mould-Release Agent

The mould-release agent shall be selected by the manufacturer and approved by the architect or engineer. This should be compatible with the surface finish required for the product. Any residue shall be removed from the finished product so that this does not interfere with any joint sealants or applied finishes which may be used.

Formwork

The design, material and manufacture of the forms shall be consistent with the type and quality of the surface finish required from the panel, and with the tolerances specified. The forms shall be constructed such that the finished products conform to the profiles and dimensions indicated by the contract documents.

Support Steelwork and Fixings

- The Manufacturer will be responsible for the design, manufacture and installation of all support framing, cleats and fixings inserted into and affixed to the GRC panels, or provided for the support of the GRC panels. Fixing zones are described on the drawings, together with primary structural concrete and steelwork provided by others for use by the contractor if required.

- Fixings shall be concealed and cast into panels unless otherwise specified. They shall be of non-corrosive material and located at suitable spacings to ensure support of panels without creating undue stresses to the panels under thermal movements and/or moisture movement.
- The recommendations of the Recommended Practice – Design, Manufacture and Installation of GRC – NPCAA Publication, August 1999 (herein after called NPCAA Recommended Practice) shall be incorporated in the design of fixings.
- Steel materials and workmanship shall comply with the relevant codes, and all steel will be free from rust, loose scale, pitting and other defects.
- Fabricated steel components shall be true to line and free from twists, bends and open joints.
- All ungalvanised materials shall be thoroughly cleaned prior to fabrication, by grit blasting to Class 2 in accordance with AS 1627 Part 4 and painted with Red Oxide Zinc Chromate in two coats to a minimum dry film thickness of 80 microns.
- Fixing cleats to existing steelwork, where indicated on the GRC cladding shop drawings, shall be site-welded unless otherwise arranged with the construction manager.
- Any damage to protective coatings on steelwork, supplied as part of this contract works, shall be repaired.

1.2.7.5 WORKMANSHIP

Weighing and Batching

Dry ingredients shall be batched by weight using calibrated weighing equipment capable of an accuracy of $\pm 2\%$ of the stated batch weight. Liquids should be weighed, volume-batched or automatically dispensed. The producer must demonstrate that the method employed will give an accuracy of $\pm 2\%$.

Mixing

The cement slurry should be mixed in a high-speed shear mixer, or other high-speed mixer which can achieve a good and even dispersion of all slurry ingredients.

Application

- Application shall be by spraying, using purpose-built equipment which allows the simultaneous deposition and uniform mixing of the glassfibre and cement matrix.
- The glassfibre and cement slurry shall be metered to the spray head at rates to achieve the desired mix proportion and glass content. These shall be checked for each spray pump at least once per day and prior to commencing spray production after each stoppage. The test shall be conducted in accordance with the method described in BS EN 1170-3. Distribution of fibre in the mix shall be controlled by the operator in such a way as to be as uniform as possible.
- Cleanliness of equipment and working areas shall be maintained at all times.

Shape and Finish

- The panels are to be formed of GRC in moulds to achieve the profiles indicated by the architectural drawings.
- The manufacturer shall provide a means for producing a replacement panel at any time during the building contract. Moulds shall be adequately cured to eliminate shrinkage and distortion and shall be properly braced.
- The exposed face of the GRC panels surfaces shall be free of blowholes, cracks, undulation or similar imperfections.

Manufacture

- The panels shall be manufactured by a spray technique as detailed in the NPCAA Recommended Practice or as otherwise agreed between the manufacturer and architect/engineer to an approved method.
- Spray applicators shall be experienced personnel whose proficiency meets industry standards.
- If an architectural face mix is being used, this will first be sprayed into the mould. The thickness shall generally be the minimum possible to achieve the desired finish, which will normally make it at least 20% thicker than the largest sand or aggregate being used and normally 4 mm minimum and 12 mm maximum thickness. An acrylic polymer should be used in the face mix to reduce any risk of this unreinforced layer cracking.
- If no face mix is being used, a mist coat consisting of the basic mortar composition without fibre may, if necessary, be sprayed onto the moulds to prevent fibres from being visible on the finished surface of the product. The mist coat is intended to be just thick enough to cover mould details and surfaces so that fibres are not visible on the surface, but not so thick that crazing of this unreinforced layer may occur.
- The normal target thickness of a mist coat for non-polymer GRC is 1 mm, though the use of acrylic polymer in the mix may allow the thickness to be increased up to a maximum of 3 mm. However, it should be noted that for design purposes the thickness of the mist coat should not be considered as contributing to the strength of the GRC panel.
- Spray-up of GRC backing material shall proceed before any mist coat or face mix has set.
- The method of spraying the main body of material shall achieve the greatest possible uniformity of thickness and fibre distribution.
- Consolidation shall be by rolling and such other techniques as are necessary to achieve complete encapsulation of fibres and full compaction.
- Control of thickness shall be achieved by using a pingauge or other acceptable method. Minimum thickness of panels is recommended as 8 mm (hand-spray) and 6 mm (auto-spray).
- All hand-forming of intricate details, incorporation of formers of infill materials and over-spraying shall be carried out before the material has achieved its initial set so as to ensure complete bonding.

- Inserts shall be properly embedded into thickened, homogeneous areas of GRC. Waste material such as over-spray is not acceptable to encapsulate inserts or for bonding pads.
- Any rigid embedded items bonded to the GRC shall not create undesirable restraint to volume changes.

Shop Drawings

- Prior to commencing manufacturing work, the manufacturer shall submit for approval detailed shop drawings showing the following information:
- layout (sectional plan and elevation) of complete wall panelling;
- full-size section of typical panel and support members;
- method of assembly and supports and fixings to the existing structure and provision to withstand imposed stresses;
- method of installation, caulking, flashing and provision for vertical and horizontal expansion;
- junction and trim to adjoining surfaces; and
- fittings and accessories,
- The submission of shop drawings shall be supported by engineering design computations to show that cladding and supports comply with the design criteria specified.

Tolerances

The GRC elements shall be manufactured and installed to the tolerances stated in the NPCAA Recommended Practice (Section 10).

Demoulding and Curing

- Once the initial set has taken place, GRC elements should be covered with polythene for their protection and to prevent them from drying out fully. They must not be moved again until they are ready for demoulding.
- The GRC elements must not be demoulded until they have gained sufficient strength to be removed from the mould and transported within the factory, without being overstressed.
- If the GRC elements are too large to be demoulded by hand, special demoulding sockets or loops should be embedded in the panel during manufacture, and demoulding should be assisted with a lifting frame. This procedure should be agreed with the engineer.
- During demoulding, the panels shall be uniformly supported in a manner which avoids undue stresses in the panels.
- If polymers are used in the mix to avoid wet curing, the panels should be stored under cover for a minimum of 7 days at a temperature of between 5°C and 35°C.
- If polymers are not used in the mix, curing shall be continued after demoulding under conditions which shall provide free water on the surfaces of the panels at a temperature not exceeding 50°C for a period of not less than 7 days (including the initial cure in the mould).

Identification of Elements

All panels shall be identified individually to indicate the panel type and date of manufacture.

At the time of preparation of shop drawings the manufacturer shall indicate his required order of delivery.

Handling, Transportation and Installation

The products shall be handled, transported and installed using methods which ensure that no damage or marking of architectural surfaces occurs and so that the panels are not subject to undue stress.

The safety and protection of GRC units shall be ensured throughout the whole of the contract works.

Site access and, if necessary, storage space shall be provided by the main contractor.

The main contractor shall also provide true, level and clean support surfaces and shall provide for the accurate placement and alignment of connection hardware on the structure.

Test Requirements

The specified glass fibre content shall be 5% by total wet weight of materials.

The GRC from which the panels are made shall have the following properties on completion of curing:

- Characteristic Modulus of Rupture (MOR) 18 MPa at 28 days.
- Characteristic Limit of Proportionality (LOP) 7 MPa at 28 days.

The value of MOR and LOP design stresses to be used should be determined by the design engineer for specific service requirements.

The minimum dry density shall exceed 1800 kg/m³.

Tests

The following tests shall be carried out on coupons cut from the test boards in accordance with BS EN 1170 Parts 2, 4, and 5. If acrylic polymer is used in the mix, presoaking immediately prior to testing shall not be required for Modulus of Rupture or Limit of Proportionality.

- Glass Content – BS EN 1170 Part 2
- Modulus of Rupture – BS EN 1170 Part 5 (and simplified method in Part 4)
- Limit of Proportionality. – BS EN 1170 Part 5

Test boards shall be produced alongside each day's production (at least one per day for each production team). The recommended size of these sample boards is 600 x 600 mm. The test boards shall be produced with the same quality, thickness and curing as the actual panels.

Those test boards which are not required for testing should be kept for the duration of the contract, or for a period to be agreed between the manufacturer and engineer.

Frequency of Testing

The frequency of testing shall be agreed between the architect, engineer and manufacturer.

The recommendation of BS EN 1169 is as follows:

- Glass content – tested in accordance with BS EN 1170 Part 2. Once per week for each spray team. (This is in addition to the calibration test referred to in section 3.3).
- Modulus of Rupture and Limit of Proportionality – tested in accordance with BS EN 1170 Part 5. Should be tested by the manufacturer or by a qualified laboratory as the mix design is being set-up and thereafter at least twice per year, or when the mix design is changed.
- A simplified bending strength test to determine the Modulus of Rupture (MOR) should be conducted by the manufacturer more frequently. The frequency of testing recommended by BS EN 1169 is for each 10 tonnes of GRC produced, or at least once per week.
- Water Absorption and Dry Density – tested in accordance with BS EN 1170 Part 6. As the mix design is being set-up, and then for each 10 tonnes of GRC produced, or at least once per week.

Compliance

Compliance with glass content and the characteristic strength for both LOP and MOR shall be assumed if the following conditions are met:

- Glass Content : The glass content shall not vary from the specific amount by more than $\pm 20\%$.
- Modulus of Rupture and Limit of Proportionality : The characteristic MOR and LOP is defined as the value which 95 per cent of all the mean strengths of the individual test-boards shall exceed.
- Compliance with the characteristic MOR and LOP requirements shall be assumed if no single test-board mean shall be less than 85 per cent of the characteristic MOR and LOP, and the average of 4 consecutive test board results shall exceed 21 MPa (MOR), and 8 MPa (LOP).
- If any single test-board fails to meet any of the compliance requirements, the GRC at risk shall be that produced between the previous complying test board and the next complying test board.
- Where failure to comply arises from consideration of consecutive groups of four test-boards, the GRC at risk shall be that represented by the first and fourth testboards, together with all intervening material.
- Note: If different values for MOR and LOP are required for specific service requirements, these should be determined by the design engineer for the specific service requirements. The selection of unnecessarily high strength requirements may result in cost penalties.
- Dry Density : The dry density of the GRC shall exceed 1800 kg/m³.
- Non-Compliance : In the event of non-compliance, the action to be taken should be agreed between the manufacturer and the client. Due regard should be paid to the technical consequences of the non-compliance and the economic consequences of adopting remedial measures or replacing the rejected products. Account should also be taken of the safety factors incorporated in the design and also the thickness of the GRC produced, compared with the design thickness. Re-testing may be considered appropriate if it is considered that the storage

conditions of the product may result in improved properties because of extended curing, or if the sampling, testing or calculation may have been at fault.

- The material at risk may be reduced by the testing of additional test boards from the same, previous, or next manufacturing periods. Testing may also be performed on GRC samples cut from the actual GRC elements at risk.

Weatherproofing

- Responsibility for the weatherproofing of the whole installation of GRC panels rests with the GRC manufacturer.
- The joint details shown on the drawings represent the appearance required and their minimum standard of weatherproofing acceptable.
- Joints shall be weather-sealed with closed-cell polyethylene compressible backing rods and caulked with 2-part polysulphide sealant or other approved sealant in selected colours, installed completely in accordance with the sealant manufacturer's recommendations with regard to joint dimension, priming, substrates, mixing, curing, masking, cleaning and the like.
- The GRC manufacturer shall submit details of the proposed sealant and the application recommendations for approval by the construction manager prior to commencement of the contract works.
- Joints located and indicated on the drawings are those required for sealing the GRC cladding against adjacent materials and those required for architectural purposes for division of the panels into the design modules. Should the GRC manufacturer or contractor propose to subdivide the cladding into smaller panels for ease of casting, handling and erection, additional joints may be introduced in the design, provided the location proposed is discreet. The GRC manufacturer shall submit proposed locations and designs of additional panel joints with their tender submission.

1.2.7.6 Other Issues

Responsibility

The GRC manufacture shall be solely responsible for the design and performance of the GRC panels and their supports. Information provided on the drawings or this specification shall not affect this responsibility.

Guarantees

The Manufacturer shall warrant the GRC panels installed, or to be installed, against any and every defect or failure which may occur during the period of practical completion for the works arising out of any fault of the GRC cladding system, workmanship, fabrication, fixing or quality of materials used.

Design Criteria

- Glassfibre-reinforced wall cladding shall comply with the following:
- FINISH : Class 1 to the formwork code, smooth face suitable for high paint finish.
- DESIGN LOADS : Cladding and framing shall be designed in accordance with AS1170.

- **DEFLECTIONS OF MAIN FRAME STEEL MEMBERS:** The attention of the contractor is drawn to the allowance made for differential deflections between the structure at level 2 and the ground. The anticipated allowance is 30 mm. The detailing of the GRC cladding should take this into account

1.2.8 PARTITION WORKS

1.2.8.1 Scope

This specification covers the general requirements for fabrication and erection of wooden / aluminum / gypsum board partitions and other related works forming a part of this job, which may be required to be carried out though not specifically mentioned above. The work under this specification shall consist of furnishing of all tools, labour, materials and everything necessary for carrying out the work.

1.2.8.2 Applicable Codes and Standards

Work shall be carried out as per latest edition of Indian Standards and Code of Practices. List given here shall not be considered as conclusive and is for reference and guidance only. Any discrepancies/ conflict noticed shall be brought to the notice of Architect/Engineer in charge for direction / approval. However, as a general rule more stringent specification shall take precedence.

IS: 287	Permissible moisture content for timber used for different purposes.
IS: 303	Plywood for general purpose
IS: 710	Marine plywood
IS: 733	Wrought aluminum and aluminum alloys, bars, rods and sections for general engineering purposes.
IS: 848	Synthetic resin adhesive for plywood
IS: 1200	Method of measurement of building and civil engineering works.
IS: 1328	Veneered decorative plywood
IS: 1868	Anodic coating on aluminum and its alloys.
IS: 1948	Aluminum doors, windows and ventilators
IS: 1949	Aluminum windows for industrial buildings
IS: 2095	Gypsum plaster boards
IS: 2191	Plywood face panels
IS: 2542	Method of test for gypsum plaster
IS: 2835	Flat transparent sheet glass
IS: 3144	Methods of test for mineral wool thermal insulation materials
IS: 3513	Resin treated compressed wood laminates
IS: 3677	Unbonded rock and slag wool for thermal insulation
IS: 4021	Timber door, window and ventilator frames
IS: 5509	Fire retardant plywood
IS: 5523	Methods of testing anodic coatings on aluminum
IS: 5437	Figured rolled and wired glass
IS: 8183	Bonded mineral wool
IS: 13871	Powder Coatings
BS: 2972	Methods of test for inorganic thermal insulating materials

1.2.8.3 Aluminium Partitions

Materials

- Aluminium alloy used in the manufacture of extruded sections for the fabrication of doors, windows, ventilators shall conform to designation 63400 WP of IS:733.
- Transparent sheet glass shall conform to the requirements of IS: 2835. Wired and figured glass shall be as per IS: 5437.
- Builder's hardware of fittings & fixtures shall be of the best quality from approved manufacturers.

Workmanship

- All aluminium partitions shall be of the type as specified in the respective items of work and of sizes as indicated in the drawings.
- All aluminium units shall be supplied with anodized/powder coated finish. The minimum anodic film thickness shall be 0.015 mm.
- Aluminium partitions shall be as described in the item of work and/or bid drawings which indicate generally the arrangement along with the overall size of the various components and weight per running meter of the extruded sections to be adopted.
- IS:1948 and IS:1949 are referred to incorporate the sizes, shapes, thicknesses and weight per running meter of extruded sections for the various components of the units. However, new sizes, shapes, thicknesses with modifications to suit snap-fit glazing clips etc. are continuously being added by various leading manufacturers of extruded sections, which are available in the market. As such, the sections of the various components of the unit proposed by the CONTRACTOR, will be reviewed by the ENGINEER and will be accepted only if they are equal to or marginally more than that specified in the codes/ item of works.
- The framework of the partitions with mullions and transoms shall be with anodized/powder coated aluminium extruded sections of dimensions as per the item of work. Anodized/powder coated Aluminium extruded sections shall be infilled with timber of class 3 (silver oak or any other equivalent) as per IS:4021. Panels of double/single glazing/plywood shall be fixed as per details indicated in the drawing. Partitions shall be fixed rigidly between the floor and the structural columns/beams including provision of necessary shims for wedging etc. Finished work shall be of rigid construction, erected truly plumb to the lines and levels, at locations as per the construction drawings.
- Specific provisions as stipulated for steel doors, windows, ventilators shall also be applicable for this item work. Glazing beads shall be of the snap-fit type suitable for the thickness of glazing proposed as indicated in the item of work. A layer of clear transparent lacquer shall be applied on aluminium sections to protect them from damage during installation. This lacquer coating shall be removed after the installation is completed.

TECHNICAL SPECIFICATION

CIVIL WORKS

CIVIL WORKS

2.1 RUBBLE SOLING WORK

2.1.1 Scope

This specification covers general requirements for materials to be used for carrying out rubble soling including requirements in regard to the quality & placement of rubble soling. This also covers the compaction of surfaces for level & profile thereof.

2.1.2 General

Area receiving soling will be excavated and trimmed to the required levels, profile, gradient, if any, and the same shall be rolled / compacted thoroughly, as approved by the ENGINEER.

2.1.3 Material Specification

Stone for soling work shall be black stone of good quality of specified size with minimum size variation. It shall be free from impurities and foreign matter.

2.1.4 Workmanship & Construction

- 2.5.1** The Soling shall not be constructed on a wet surface.
- 2.5.2** Unless otherwise specified, the width of the soling stone shall be 230 mm and the finished soling course thickness shall be 230 mm.
- 2.5.3** As the laying of rubble advances the soling shall be hand packed by wedging and packing with 80 mm metal in the joints of the soling and driving them by hammers in place so as to fill the voids as completely as possible. This operation of hand packing shall closely follow the rubble laying. The soling shall be laid and hand packed true to grade and section and these shall be often checked by boning rods, template boards, fish line, etc. The grades, sections, etc. of soling shall correspond to those of the surfacing coming thereon. The soling thus laid shall be finished by knocking out projecting stones and filling depressions by chips to reach up to the grade and camber
- 2.5.4** The quality of the 80 mm metal shall be same as that specified for the soling stone and the longest dimension shall not be more than 100 mm and the shortest dimension not less than 50 mm.

2.1.5 Payment

Measurements shall be made for the finished work in square metres of the actual plan area covered with the soling stone. The rate shall include the cost of all materials, labour, plant and equipment required in all the operations and including soling stone and gravel.

2.2 WATERPROOFING OF UG WATER TANK

The RCC base slab & wall surface is cleaned by removing dust, dirt etc. by mechanical means. Ensure that all bolt holes and sleeves, pipe inserts have been plugged properly by using Polymer Modified Mortar (PMM). Holes are drilled for fixing of PVC nozzles at 1 mt c/c at construction joints and the same are sealed by using PMM. Further, cracks are to be opened out by making V groove and filling the same using PMM.

Thereafter Injection grouting shall be done with providing and injecting non-shrink cementations grout of flowable consistency, grouting the same under pressure in pre-drilled holes by grouting pump. 24 hours after grouting is completed, cut the nipples and seal it with Polymer Modified Mortar.

A layer of about 1 inch IPS in 1:2:4 is provided on the base floor with vata at wall & floor junctions providing proper slope towards the drain point.

On the side walls provide double coat 20 mm thick plaster in CM 1:3 with approved waterproofing admixture followed by curing for 7 days. All mortar mix to be necessarily mixed with approved waterproofing compound.

2.3 STEEL CHEQUERED PLATES

SCOPE: This specification covers general requirements for materials to be used for steel chequered plates, having raised figures at regular intervals on one surface of the plate.

SUPPLY OF MATERIAL: General requirements relating to the supply of chequered plates shall conform to IS 8910.

MATERIAL: Unless specified otherwise the steel (base material) for chequered plates shall conform to the requirements of Grade E 250A of IS 2062.

2.4 COLD FORMED SECTIONS

Providing, supplying ,designing, detailing, fabricating and fixing erecting GI cold formed sections (GSM 120 Min), having minimum thickness of 2mm confirming to the physical specifications of ASTM A-607 (Grade 50) having minimum yield strength of 345 N/mm² of any shape (angle, channel, zee, channel with lips, zee with lips)including fabrication drawings (approved by Engineer) for all heights & levels including transportation of the same to site, provision of necessary erection bolts, fixing bolts, nuts, washers, cleats, and all necessary operations like straightening, cutting, drilling as specified, welding,

cleaning, grinding and removing the welding burr etc. complete and as directed by Engineer In Charge.

2.5 SITE GRADING

2.5.1 Scope:-

The work covered shall consist of providing for and executing the site grading works as shown in the relevant drawings and in accordance with the specifications.

2.5.2 TECHNICAL REQUIREMENTS

SETTING OUT & LEVELLING

The Contractor shall be responsible for accurate and proper setting out of the work with regard to lines and levels of reference, and with regard to the correctness of dimensions, alignments and levels of the work in conformity with the drawings. The Contractor shall at his own cost, provide all necessary instruments, labour material and equipment for this purpose should any error be discovered, at any time, during the progress of work or thereafter, in the dimensions, alignment or level of part or all of work, the Contractor shall at his own expense rectify the errors to the satisfaction of the Owner/Consultant. Any checking of line or level by the Owner/Consultant shall in no way relieve the Contractor of his responsibilities.

The Contractor shall, prior to start of work, construct one or more permanent bench marks at a central location from which all levels for the earth work shall be set. Permanent bench marks shall be accurately referenced to the Owner's plant datum. All labour and materials for setting levels shall be at Contractor's cost. Permanent bench marks shall be made of masonry pillars with a neatly plastered top and levelled as per the directions of Owner/Consultant. The bench marks shall be well connected with a triangular grid system or other bench marks and the entire arrangement approved by the Owner/Consultant.

CLEARING AND STRIPPING

The area where earth work is to be carried out shall be cleared and stripped completely of all bushes, roots, trees, shrubs and other vegetation, organic matter and other objectionable materials. All these should be completely uprooted and not merely scraped at the surface. Trees upto 50 cms girth shall be removed from the site and those above 50 cm girth shall be handed over to the Owner.

Excess materials including trees, roots etc. shall be removed to the disposal areas as directed by the Owner/Consultant outside the refinery premises.

EARTHWORK IN FILLING

Description and Testing of Fill Material

a) The fill material shall be granular, well graded compactable and possess good drainage characteristics. It shall be free of vegetation, organic matter and other impurities. Acceptable classes (as per IS:1498) are GW, GP, GM, SW or a mix of these. Following limits of grain size distribution are recommended :

1. Maximum size : 100 mm
2. Retained on 20mm sieve : ☐30%
3. Passing No. 100 sieve : ☐45%
4. Passing No. 200 sieve : ☐10%

b) The Contractor shall, at his own cost, conduct tests, to ensure the suitability of the proposed fill material. He shall submit the test results to the Owner/Consultant and obtain approval of the same before commencing the site grading operations, and, if required shall make arrangements for the Owner/Consultant to witness sample preparation and conducting of the tests.

c) The Contractor shall also carry out on the proposed fill material compaction tests to determine the optimum moisture content and maximum dry density as per IS2720-Part 7:1980 and water content test as per IS 2720- Part 2:1973 to determine the natural moisture content.

d) The Contractor shall repeat the tests described in 3.3.1.b and 3.3.1.c above, as often as directed by the Owner/Consultant but at least once for every 5000 m³ of fill. He shall establish an adequately equipped field laboratory for this purpose. Test results shall be carefully recorded and tagged such that when field control of moisture during the filling and compaction operation is carried out, based on them, easy and accurate identification of the test result corresponding to each stretch of fill is possible.

Filling and Compaction

a) The fill shall be constructed in layers, each layer being compacted to the required density before the next layer is laid. The compacted thickness shall be 200 mm for each layer.

b) Compaction shall be carried out using steel wheeled or rubber tyred rollers as appropriate. The Contractor shall determine the number of passes of the roller required to achieve the required density by first conducting trials over a test stretch. Vibrating roller shall be used if it allows faster compaction. The number of passes shall be reviewed and adjusted in consultation with the Consultant/Owner, as required during the course of the work.

c) All lumps and clods in the fill material shall be broken before rolling. The top surface of each layer shall be roughened before placing the subsequent layer to ensure proper keying in between layers.

d) Prior to rolling, the moisture content of the material shall be brought to within $\pm 2\%$ of the optimum moisture content as obtained from the tests in 3.3.1.c by addition or removal of water, accompanied by thorough mixing to ensure a uniform moisture content. Each layer shall be compacted to at least 95% of the maximum dry density as obtained from the Standard Proctor Test.

e) Each layer shall be tested by the Sand replacement method to ensure that the specified density has been achieved. At least one such test shall be carried out for every 2500 sq. m of graded area of every layer.

If the testing indicates that any part of the fill does not meet the requirements, that part shall be reworked by the Contractor at his own cost till the specified density is achieved.

f) The Contractor shall submit daily laboratory and observations report. This shall provide details of location of sample, time of collection, time it was placed in oven, the moisture content and density test results.

MICROGRADING

Micrograding shall be carried out by Contractor over graded areas to bring the finished grade level to level indicated, including provision of required slopes and finishes. Rolling to be done along with watering using road roller to achieve proper compaction and level.

2.6 AAC BLOCKS

Scope

This specification covers the construction of load bearing and non-load bearing walls with autoclaved cellular (aerated) concrete blocks conforming to IS : 2185 (Part 3) - 1984

Mortar For Masonry

The blocks shall be embedded with a mortar, the strength of which is relatively lower than that of the mix used for making blocks in order to avoid the formation of cracks. A 1:6 cement - sand mortar may be used. (Refer IS 6041-1985 Para 3, 3.9.2)

Wetting of Blocks

These blocks need not be wetted before or during the laying in the walls; in case the climatic condition so required, the top and the sides of the blocks may be slightly moistened. (Refer IS 6041-1985 Para 6, 6.1)

Coping Beam

Horizontal coping at 0.9 to 1.2 mtr height & Vertical coping in centre if wall length is more than 3 mtr, with 2nos 8mm reinforcement, M20 concrete. (Refer IS 6041- 1985 Para 4, 4.6.5.1 & 2)

Storage

The blocks shall be stored in such a way as to avoid any contact with moisture on the site. (Refer IS 6041-1985 Para 5, 5.1)

Mortar Thickness

Keep it limited to 10 to 12 mm in cement sand mortar (Refer IS 6041-1985 Para 7, 7.1) & 3 to 4 mm in ready mix mortar.

Plaster

Plaster thickness required Internal:10 to 12mm, External:15 to 17mm (Refer IS 6041-1985 Para 12)

2.7 LIST OF APPROVED MAKES FOR CIVIL AND ARCHITECTURAL WORKS

2.7.1 Scope

- a) All materials and products shall conform to the relevant standards and shall be of approved make and design. A list of manufacturers/ vendors is given in Clause 2.3.2 herein below for guidance. The Engineer shall give the approval of a manufacturer/ vendor/ only after review of the sample/ specimen. In case the same is not available in the market or in case of change in trade name, equivalent makes/ re-designated manufacturer then an equivalent approved make shall be used with the approval of Employer/ Engineer. The complete system and installation shall also be in conformity with applicable Codes & Standards and Tender specifications.
- b) Only “First” class quality materials shall be used.
- c) Employer reserves the right to choose any of the approved make / vendors as per this list.
- d) In case of products not indicated in this list, BIS marked products shall be preferred.
- e) Specification of manufacturer’s item shall be checked against tender item / specifications before selecting any product or brand name. In case of any discrepancy, tender item/ specifications shall prevail, and any such brand of item shall not be used which is not conforming to tender specifications even if it is listed in this list.
- f) For use of material from a BIS listed/ certified manufacturer, the contractor shall furnish a copy of the valid BIS certificate to Employer before procuring the material.
- g) In case non-availability of any item/ material among approved manufacturers/ brands at a particular site/ region, alternate manufacturers/ brands conforming to BIS/ BS etc. shall be used subject to approval by Employer.
- h) In case of non-availability of any manufacturer among approved manufacturers at a particular site/ region, alternate manufacturer’s name shall be proposed along-with required credentials for Employer’s approval.
- i) In case of any item/ product neither covered in this list nor having A BIS specifications, the contractor shall submit the proposed item/ product along-with technical details/ specifications (as per bid), test certificates etc. And other credentials of the manufacturer for Employer’s approval.

2.7.2 List of Approved Makes For Products And Materials For Civil And Architectural Works

NOTE:

- All materials and products shall conform to the relevant standards and shall be of approved make and design. A list of manufacturers/ vendors is given separately herein below for guidance. The Engineer shall give the approval of a manufacturer/ vendor/ only after review of the sample/ specimen. In case the same is not available in the market or in case of change in trade name, equivalent makes/ re-designated manufacturer then an equivalent approved make shall be used with the approval of Employer/ Engineer. The complete system and installation shall also be in conformity with applicable Codes & Standards and Tender specifications.
- Only “First” class quality materials shall be used.
- Employer reserves the right to choose any of the approved make / vendors as per this list.
- In case of products not indicated in this list, BIS marked products shall be preferred.
- Specification of manufacturer’s item shall be checked against tender item / specifications before selecting any product or brand name. In case of any discrepancy, tender item/ specifications shall prevail, and any such brand of item shall not be used which is not conforming to tender specifications even if it is listed in this list.
- For use of material from a BIS listed/ certified manufacturer, the contractor shall furnish a copy of the BIS certificate to Employer before procuring the material.
- In case non-availability of any item/ material among approved manufacturers/ brands at a particular site/ region, alternate manufacturers/ brands conforming to BIS/ BS etc. shall be used subject to approval by Employer.
- In case of non-availability of any manufacturer among approved manufacturers at a particular site/ region, alternate manufacturer’s name shall be proposed along-with required credentials for Employer’s approval.
- In case of any item/ product neither covered in this list nor having A BIS specifications, the contractor shall submit the proposed item/ product along-with technical details/ specifications (as per bid), test certificates etc. And other credentials of the manufacturer for Employers approval.

LIST OF APPROVED MAKES FOR PRODUCTS AND MATERIALS FOR CIVIL AND FINISHING WORKS ARE INDICATED IN THE TABLE BELOW. HOWEVER, ANY OTHER MAKE WHICH IS EQUIVALENT AND MEETING THE TENDER SPECIFICATIONS ARE ALSO ACCEPTABLE WITH PRIOR APPROVAL OF THE ENGINEER

SR. NO.	DETAILS OF MATERIALS	MANUFACTURER'S NAME
1.	CEMENT	ACC / ULTRATECH / JK / C K BIRLA / AMBUJA / BINANI / JSW / SANGHI / INDIA CEMENT.
2.	WHITE CEMENT	JK / BIRLA WHITE / TRAVANCORE CEMENT
3.	READY MIX CONCRETE	ULTRATECH / ACC / RMCRIPL / JK CEMENT / UNITECH / GRASIM / LAFARGE / GODREJ & Boyce / Madras Cement / RMC Readymix (I) /
4.	REINFORCEMENT BARS	SAIL/ TISCON/ RINL/ IISCO/ JSW
5.	STRUCTURAL STEEL	SAIL/ TISCON/ RINL/ IISCO/ JSW / CHORUS
6.	TUBULAR STRUCTURAL STEEL	TATA STRUCTURA
7.	ANTI TERMITE TREATMENT	CHLOROPYRIPHOSPHOROUS CHEMICAL PECOPP DE-NOCIL, CYNAMIDE
8.	BLOCK BOARD / FLUSH DOORS	DURA-BOARD / KIT PLY / MERINO PLY ISI MARKED / KUTTY, INDIA PLYWOOD, MYSORE PLYWOOD,
		ALL MANUFACTURERS LISTED BY BIS UNDER IS:2202 (HAVING OPERATIVE AND VALID LICENSE) AT BIS WEB SITE HTTP://WWW.BIS.ORG.IN/
9.	PLYWOOD	ALL MANUFACTURERS LISTED BY BIS UNDER IS:303 (HAVING OPERATIVE AND VALID LICENSE) AT BIS WEB SITE HTTP://WWW.BIS.ORG.IN/
10.	WATERPROOF PLY	GREEN PLY, GARNET, CENTURY
11.	COMMERCIAL PLY	GARNET, CENTURY, DONEAR, GREEN PLY

SR. NO.	DETAILS OF MATERIALS	MANUFACTURER'S NAME
12.	LAMINATES	ALL MANUFACTURERS LISTED BY BIS UNDER IS:2406 (HAVING OPERATIVE AND VALID LICENSE) AT BIS WEB SITE HTTP://WWW.BIS.ORG.IN/
		RAMMICA INDUSTRIES; THE BOMBAY BURMAH TRADING CORPN.; GREENLAM, CENTURY, MERINO
13.	MDF BOARDS	NUCHEM LTD; MANGALAM TIMBER PRODUCTS LTD; WESTERN BIO SYSTEM LTD; BAJAJ ECO-TEC PRODUCTS LIMITED
14.	VENEER	DURO, GREEN, DONEAR, CENTURY
15.	PARTICLE BOARD (PLAIN / VENEERED / PRE-LAMINATED)	ALL MANUFACTURERS LISTED BY BIS UNDER IS:3087 (HAVING OPERATIVE AND VALID LICENSE) AT BIS WEB SITE HTTP://WWW.BIS.ORG.IN/
16.	PRE-LAMINATED PARTICLE BOARD	NOVOPAN/ MERINO/ ANCHORLAM/ BHUTAN BOARD
17.	WOODWORK POLISHING	ASIAN PAINTS; SHALIMAR PAINTS
18.	TERRAZZO TILES	NITCO; HINDUSTAN; NEC; BHARAT; NIMCO; GK BANSAL;
19.	VITRIFIED TILES	NAVEEN, MARBO GRANIT, GRANAMITE, BOSS, NITCO, ASIAN, RAK, EURO, SOMANY, BELL CERAMIC, KAJARIA, REGENCY, ORIENT, JOHNSON; PELICAN, VARMORA, PILKINGTON
20.	GLAZED TILES	ORIENT, KAJARIA, NITCO, SOMANY, BELL, JOHNSON, ASIAN, RAK, EURO, PARSHURAM POTTERY, PILKINGTON
21.	CERAMIC TILES	REGENCY, KAJARIA, ORIENT, BELL, SOMANY, JOHNSON, SPARTEK, NAVEEN, BELL,

SR. NO.	DETAILS OF MATERIALS	MANUFACTURER'S NAME
		VARMORA, PILKINGTON
22.	ACID / ALKALI RESISTANT TILES	REGENCY, ENDURA, KOTHARI, CHORAMANDALAM, RUSTILE, ARCOY, PERFECT ACID WARES/ MAHAKOSHAL POTTERIES/ CHAMPION CERAMICS, GOODEARTH MINERALS
23.	PVC TILES/ ROLLS	ALL MANUFACTURERS LISTED (HAVING OPERATIVE AND VALID LICENSE) BY BIS AT BIS WEB SITE HTTP://WWW.BIS.ORG.IN/ EXCELEN BY ARMSTRONG; MARBLEX BY BHOR INDUSTRIES SHYAM VINYL
24.	PVC TILES/ ROLLS (ANTI-STATIC)	SOLIDGL BY ARMSTRONG; ANSTAT BY PREMIER POLYFILMS LTD
25.	RUBBER TILE FLOORING	ECOFLEX SURFACES PVT. LTD., RUDI SPORTS SURFACES, THE FLOORSMITHS
26.	STAINLESS STEEL SECTIONS	JINDAL/ SAIL/ GOLDEN
27.	ALUMINIUM SECTIONS	HINDALCO/ JINDAL/ MAHAVIR/ LNDAL / AJIT INDIA / ALUMILITE
28.	PRESSED STEEL DOORS AND WINDOWS	SKS STEEL IND., DHIMAN STEEL SUPER STEEL WINDOWS, RDG ENGINEERING, ANAND INDUSTRIES, RAYMUS ENGINEERING, NICOMAC, WINDOORS, SHAKTIMET, NCL SECOLOR, GODREJ, SENTINAL, MULTIWIN
29.	ALUMINIUM DOORS AND WINDOWS	JINDAL; HINDALCO, AJIT INDIA, ALUMILITE
30.	FIRE PROOF DOORS	SHAKTIMET, SHIRKE POLYNORM, VIPER BY NAVAIR INTERNATIONAL, RADIANT BY RDG ENGG., GANDHI AUTOMATION,

SR. NO.	DETAILS OF MATERIALS	MANUFACTURER'S NAME
		PROMAT, GODREJ, ADHUNIK, SIGNUM
31.	INDUSTRIAL DOORS / GATES (FOLDING, SLIDING, SWING DOORS)	GANDHI AUTOMATION; NICOMAC; AVIANS;
32.	ROLLING SHUTTERS (MANUAL / GEAR OPERATED / MOTORIZED)	TECHNO SYSTEMS DOOR SOLUTIONS; AEGIS; SHAKTIMET; GANDHI AUTOMATION; DORPLUS; SWASTIK ROLLING SHUTTERS; BENGAL ROLLING SHUTTERS;
33.	DOOR HARDWARE	INGERSOL RAND, GEZE, DORMA, GUARDIAN, DORSET, MAGNUM, UNION, KITCH
34.	MORTICE LOCKS WITH HANDLES	GODREJ & BOYCE; EVERITE AGENCIES; GOLDEN INDUSTRIES
35.	MISC. DOOR HARDWARE / FITTINGS (HINGES, TOWER BOLTS, LATCHES, STOPPERS ETC.	ALL MANUFACTURERS LISTED BY BIS UNDER IS:3087 (HAVING OPERATIVE AND VALID LICENSE) BY BIS AT BIS WEB SITE HTTP://WWW.BIS.ORG.IN/ EVERITE; EBCO; ECIE; HARDWYN
36.	NUTS BOLTS/ SCREWS	KUNDAN/ PUJA/ ATUL
37.	ANODISED ALUMINIUM FITTINGS	CROWN/ ALANS/ CLASSIC/ BHARAT/ ARGENT
38.	MILD STEEL BUTT HINGES/ PIANO HINGES	JOLLY/ GARG/ AMIT/ASI SUPREME
39.	HYDRAULIC DOOR CLOSERS (OVERHEAD AND FLOOR MOUNTED)	ALL MANUFACTURERS LISTED BY BIS UNDER IS:3087 (HAVING OPERATIVE AND VALID LICENSE) AT BIS WEBSITE HTTP://WWW.BIS.ORG.IN DOORKING
40.	CLEAR FLOAT GLASS	AS GLASS/ SAINT GOBAIN/ MODIGUARD
41.	GLASS (TOUGHENED)	SAINT GOBAIN/ MODI FLOAT/ ASAHI FLOAT

SR. NO.	DETAILS OF MATERIALS	MANUFACTURER'S NAME
42.	POLYCARBONATE SHEET	DANPALON/ ALCOX/ POLYGAL
43.	HDPE WATER SUPPLY PIPES	DURALINE/ ORIPLAST/ HALLMARK/ PIONEER / SUPREME
44.	FIRE RETARDANT PAINT	JOTUN, HILTI, AKZONOBEL, ASIAN PPG, CHEMBOND COATINGS; HITAKSHI SAFETY SOLUTIONS; AKZO NOBEL
45.	PLASTIC / ACRYLIC EMULSION PAINT (INTERNAL & EXTERNAL), DISTEMPER	ICI; BERGER; ASIAN PAINTS; SHALIMAR; KANSAI NEROLAC; JOTUN; ACROPAINTS; GODAVARI PAINTS; N E PAINT UDYOG; SURFA COATS
46.	SYNTHETIC ENAMEL PAINT FOR BUILDING WORKS	ICI; BERGER; ASIAN PAINTS; SHALIMAR; KANSAI NEROLAC; JOTUN; ACROPAINTS; GODAVARI PAINTS; N E PAINT UDYOG; SURFA COATS
47.	WATER-PROOF CEMENT PAINT	KILLIC NIXON (SNOWCEM); GODAVATI PAINTS (SUPREMECEM); ACRO PAINTS (ACROCEM); SNOW EHTE INDUSRIAL CORP (SUPERCHEM); RAJDOOT PAINTS (XTRACHEM 76 SUPERIOR CEMENT PAINT)
48.	DECORATIVE TEXTURED PAINT	LUXTURE SURFACE COATINGS PVT LTD (LUXTURE); BAKELITE HYLAM LTD (HERITAGE); NCL ALLTEK & SECCOLOT LTD (ALLTEK); ACRO PAINTS LTD (ACROTEXTURES); UNITILE; SPECTRUM PAINTS; SURFA COATS
49.	ANTI CORROSIVE BITUMASTIC PAINT	ASIAN PAINTS / BERGER / J&N
50.	PRECOATED PROFILES GI / GALVALUME / ZINCALUME SHEETS	LLYOD INSULATION INTERARCH BUILDING PRODUCTS MULTICOLOR STEEL PVT LTD HARDCASTLE & WAUD MFG CO.

SR. NO.	DETAILS OF MATERIALS	MANUFACTURER'S NAME
		LTD JAPAN METAL BUILDING SYSTEM PVT LTD TATA BLUESCOPE STEEL LTD SHREE PRE-COATED STEEL LTD CRIL
51.	CGI SHEETS	ISPAT INDUSTRIES / SAIL / TATA STEEL /
52.	ALUMINIUM SHEETS	HINDALCO; JINDAL ALUMINIUM LTD
53.	FIBRE GLASS SHEET	SIMBA FRP PVT LTD
54.	POLYCARBONATE SHEET	DANPALON, ALCOX, POLYGAL, V. A. CORPORATION, JOY FAB, YADAV ENGINEERING
55.	EPOXY COATINGS	FOSROC (NITOFLOOR SL 2000 / 1000); SIKA; BUILDTECH PRODUCTS PVT LTD; CICO TECHNOLOGIES; ASIAN PPG; BASF; SUNANDA SPECIALITY CHEMICALS; CHRYSO; KOTHARI CORROSION CONTROLLERS; AKZO NOBEL; BOSTIK; APURVA INDIA LTD.; CHEMBOND COATINGS.
56.	FLOOR HARDENERS	CICO; SAMCOCK CHEMICALS; PEE ESS PROCESSOR & TRADERS; IRONOTE; BASF; CHRYSO; BASF; SUNANDA SPECIALITY CHEMICALS; FOSROC; BOSTIK; POLYFLEX COATINGS AND LININGS
57.	WATER PROOFING COMPOUNDS	BASF; SIKA; CICO; SUNANDA SPECIALITY CHEMICALS; FAIRMATE; PIDILITE; CHRYSO; XYPEX; IMPERMO; PENETRON; ALCHIMICA; BOSTIK; MC BOUCHIME; SURFA COATS; LIKPROOF; KRYPTON BUILDMAT;
58.	CONCRETE ADMIXTURES	BASF; SIKA; COCO; SUNANDA

SR. NO.	DETAILS OF MATERIALS	MANUFACTURER'S NAME
		SPECIALITY CHEMICALS; FAIRMATE; PIDILITE; CHRYSO; XYPEX; IMPERMO; PENETRON; ALCHIMICA; BOSTIK; MC BOUCHIME; ACC
59.	POLYSULPHIDE / POLYURETHANE / SILICON / SEALANTS	CHOWKSEY CHEMICALS CICO TECHNOLOGIES FOSROC; BASF; SIKA; PIDILITE; CHEMETALL-RAI; CHRYSO; BOSTIK;
60.	BITUMEN SEALANT	STP
61.	CONSTRUCTION CHEMICALS	BASF; SIKA; COCO; SUNANDA SPECIALITY CHEMICALS; FAIRMATE; PIDILITE; CHRYSO; XYPEX; IMPERMO; PENETRON; ALCHIMICA; BOSTIK; MC BOUCHIME; ACC.
62.	ELECTRO-FORGED GRATING	GREATWELD GRATINGS PVT LTD INDIA GRATINGS PVT LTD
63.	FALSE / RAISED FLOORING	UNITED INSULATION LLOYD INSULATIONS MULTIFLOORS A R BROTHERS BESTLOCKS SYSTEM & CONCEPTS DG FLOOR UNIFLOOR
64.	GYPSUM BOARD	SAINT-GOBAIN GYPROC INDIA LTD LAFARGE DRYTECH
65.	UNDER-DECK INSULATIONS	BEKELITE HYLAM LTD LLOYD INSULATION UP TWIGA FIBRE GLASS LTD ROCKWOOL INDIA LTD
66.	OVER-DECK INSULATIONS	LLOYD INSULATION UP TWIGA FIBRE GLASS LTD

SR. NO.	DETAILS OF MATERIALS	MANUFACTURER'S NAME
		ROCKWOOL INDIA LTD BEST PLASTRONICS
67.	PVC WATER STOPS	OMAI PLASTICS, BASECON PASK, ASIAN ENGG PRODUCTS, CAPRIHANS INDIA LTD, R.C ENTERPRISES, FIXOPAN, WATERSEAL INDIA LIMITED.
68.	EXPANSION JOINT BOARDS	SHALITEX, STP LTD, LLLOYD INSULATION, SUPREME INDUSTIES
69.	WATER BARS	HYDROTITE, BASF, HYDROSWELL
70.	GROUT	BASF, FOSROC, SUNANDA SPECIALITY COATINGS, BOSTIK, SIKA,
71.	PVC COVER BLOCKS	ISHITA ENTERPRISES
72.	APP MEMBRANE	LLOYD INSULATIONS BUILDTECH PRODUCTS PVT LTD CICO; SIKA; SHALIMAR TAR PRODUCTS; IWL INDIA LTD, PURE LEATHERS PVT LTD
73.	EPDM GASKETS	ANAND/ ROOP/ BOHRA/ HANU
74.	PARQUET FLOOR	NEMO/ PRIMA/ PERGO
75.	MINERAL FIBRE BOARD CEILING	LLOYD/ NITTOBO/ ARMSTRONG
76.	GYPSUM BOARD	SAINT GOBAIN, LAFARGE
77.	WEATHER SILICON MAKE AND GRADE	DOW CORNING/ MOMENTIVE (GE)
78.	ADHESIVES	BAL, LATICRETE, KERAKOLL, PIDILITE
79.	FIRE SMOKE SEAL	HILTI, CFS, SPWB JOINTS SPRAY
80.	AAC BLOCKS	BILT INDUSTRIES PVT. LTD., AEROCON, SIPOREX INDIA LIMITED, XTRALITE
81.	ACOUSTIC INSULATION	U.P. TWIGA LTD. LLOYD, SAINT

SR. NO.	DETAILS OF MATERIALS	MANUFACTURER'S NAME
		GOBAIN, ECOPHONE
82.	ANCHOR FASTENERS/ BOLTS	HILTI, FISCHER, HALFEN
83.	TENSILE FABRIC SYSTEM	FERRARI, MEHLER, MAKMAX
84.	MASKING TAPES	3M, SUN CONTROL/ WONDER POLYMER
85.	INTERLOCKING CONCRETE BLOCKS	VYARA TILES PVT. LTD.. SUPER DECORATIVE FLOORINGS PVT. LTD., SAI ENTERPRISES,HINDUSTAN TILES, NIMCO PREFAB,R.K. TILES.

TECHNICAL SPECIFICATION

PLUMBING WORKS

PLUMBING WORKS

3.1 SCOPE

- 3.1.1** This specification covers the general requirements of providing and laying water mains and water supply piping, providing and fixing sanitary fixtures and piping and providing and laying drainage lines.
- 3.1.2** The Work shall be carried out in accordance with the drawings and designs as would be issued to the Contractor by the Engineer duly signed and stamped by him. The Contractor shall not take cognizance of any drawings, designs, specifications, etc. not bearing Engineer's signature and stamp. Similarly the Contractor shall not take cognizance of instructions given by any other Authority except the instructions given by the Engineer in writing.
- 3.1.3** The Work shall be executed and measured as per metric dimensions given in the Schedule of Quantities, drawings, etc.
- 3.1.4** The Contractor shall acquaint himself fully with the partial provisions for supports that may be available in the structure and utilise them to the extent possible. In any case the Contractor shall provide all the supports regardless of provisions that have been already made. Nothing extra shall be payable for situations where bed plates (for supports) are not available or are not useful.
- 3.1.5** The Contractor shall incorporate seismic considerations of anchoring and isolation in the design of the systems as per the requirements of the different equipment.
- 3.1.6** Shop coats of paint that may be damaged during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with paint to match the finish over the adjoining shop painted surface.
- 3.1.7** In addition to the sectional testing carried out during the construction, the Contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakage and shall replace all defective materials in the system. Any consequential damage done to the building, furniture and fixtures on account of Contractor's carelessness, like open or burst pipes or failure of fittings during testing and commissioning shall be made good by the Contractor at no additional cost.

3.2 SCAFFOLDING

- 3.2.1** Only steel tube scaffolding of approved design shall be used for all works. The scaffold structure shall comply with the requirements of IS: 4014 and IS: 3696. An independent tied scaffold (double scaffold), which has two lines of standards, shall be provided with the inner line kept at least one board clear of the finished face with extended transoms, or hop up baskets to carry an inside board. Diagonal braces shall not prevent the material being moved along the scaffold run. The

scaffolding shall be suitably packed at the ends to prevent damage to the finished work.

3.3 PROTECTION

- 3.3.1** Protection against damage: Care shall be taken to avoid damage from any cause at all stages. Packing pieces used for protection shall not disfigure or otherwise permanently mark the Works.
- 3.3.2** Surface protection shall be afforded by careful handling and the avoidance of the use of hooks, crowbars, or other implements that are likely to damage the works.
- 3.3.3** During installation of piping, open end of pipe shall be protected with temporary cover to prevent dust or other materials entering it.
- 3.3.4** Protection during construction: Decorative surfaces shall be carefully protected during construction by providing a temporary cover.
- 3.3.5** Protection of finished work: At all stages of the Contract it is essential that all works are properly protected.
- 3.3.6** Suitable packing shall be used to ensure that scaffolding does not damage erected stone, marble, granite or other finished works.
- 3.3.7** Any disfigurement, discolouration or imperfection whatsoever due to any reason shall not be accepted and the Contractor shall either remedy the same or redo the work at no extra cost. The decision of the Engineer as to whether any work either in whole or in part is acceptable or not shall be final and binding on the Contractor.

3.4 GUARANTEE

- 3.4.1** The Contractor shall guarantee and undertake to maintain and rectify the various components of the Plumbing work installed by him for successful performance for a period as indicated elsewhere in the tender/ contract document. The Contractor shall indemnify the Engineer for a similar period against any damage to property and injury to persons on account of any defective work or maintenance carried out by the Contractor. All sanitary wares shall be guaranteed for a period of 5 years.
- 3.4.2** All CP fittings shall be guaranteed for a minimum period of 5 years.

3.5 APPLICABLE CODES, STANDARDS AND PUBLICATIONS –

- 3.5.1** All equipment, supply, erection, testing and commissioning shall comply with the requirements of Indian Standards and code of practices given below as amended till date. All equipment and material being supplied by the Contractor shall meet the requirements of IS and other Codes/ Publications as given below.

SP: 6 (1)	Structural steel sections.
IS: 325 :1996	Three phase induction motors.
IS: 554 :1999	Dimensions for pipe threads where pressure tight joints are required on the threads

IS:694 :2010	PVC insulated cables for working voltages up to and including 1100 V.
IS: 779 :1994	Specification for water meters (domestic type).
IS: 800 :2007	Code of Practice for general construction in steel.
IS: 1068 :1993	Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium.
IS: 1172 :1993	Code of Basic requirements for water supply drainage and sanitation.
IS: 1367 (Part 1):2002	Technical supply conditions for threaded steel fasteners: General Requirements.
IS: 1367 (Part 2):2002	Technical supply conditions for threaded steel fasteners: Tolerances for fasteners – Bolts, screws, studs and nuts – Product Grades A, B and C.
IS: 1554 (Part 1):1988	PVC insulated (heavy duty) electric cables: For working voltages up to and including 1100 V.
IS: 1554 (Part 2):1988	PVC insulated (heavy duty) electric cables: For working voltages from 3.3 kV up to and including 11 kV.
IS: 1726 :1991	Specification for cast iron man hole covers and frames.
IS: 1742 :1983	Code of practice for building drainage.
IS: 2064 :1993	Selection, installation and maintenance of sanitary appliances - Code of practice.
IS: 2065 :1983	Code of practice for water supply in buildings.
IS: 2373 :1981	Specification for water meters (bulk type).
IS: 2379 :1990	Colour code for identification of pipelines.
IS: 2527 :1984	Code of practice for fixing rain water gutters and down pipes for roof drainage.
IS: 2629 :1985	Recommended practice for hot dip galvanizing on iron and steel.
IS: 4985:2000	Unplasticised PVC pipes for potable water supplies - specification.
IS: 5329 : 1983	Code of practice for sanitary pipe work above ground for buildings.
IS: 5455 : 1969	Cast iron steps for manholes.
IS: 6159:1998	Recommended practice for design and fabrication of material prior to galvanising.
IS: 7558:1974	Code of practice for domestic hot water installations.
IS: 8321	Glossary of terms applicable to plumbing work.
IS: 9668:1990	Maintenance of water supplies and fire fighting.
IS: 9842:1994	Preformed fibrous pipe insulation.
IS: 11149:1984	Rubber Gaskets.
IS: 12251	Code of practice for drainage of building basements.
BS: 5572	Code of practice for sanitary pipe work.
BS: 6700 :2006	Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages.

BS: 8301	Code of practice for building drainage.
BSEN274	Sanitary tap ware, waste fittings for basins, bidets and baths. General technical specifications.
IS: 458 :2003	Specification for precast concrete pipes(with and without reinforcement).
IS:651 :2007	Salt glazed stoneware pipes and fittings.
IS: 1239 (Part 1) :2004	Steel tubes, tubulars and other wrought steel fittings: Steel tubes.
IS: 1536:2001	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
IS: 1538 :1993	Cast iron fittings for pressure pipes for water, gas and sewage.
IS: 1729:2002	Sand cast iron spigot and socket soil, waste and ventilating pipes, fitting sand accessories.
IS: 1879:2010	Malleable cast iron pipe fittings.
IS: 1978 :1982	Line pipe.
IS: 1979 :1985	High test line pipe.
IS: 2501 :1995	Copper tubes for general engineering purposes.
IS: 2643 (Part 1):2005	Dimensions for pipe threads for fastening purposes: Basic profile and dimensions.
IS: 2643 (Part 2) 2005	Dimensions for pipe threads for fastening purposes: Tolerances.
IS: 2643 (Part 3)2005	Dimensions for pipe threads for fastening purposes: Limits of sizes.
IS: 3468 :1991	Pipe nuts.
IS: 3589 :2001	Seamless or electrically welded steel pipes for water, gas and sewage (168.3 mm to 2032 mm outside diameter).
IS:3989 :1984	Centrifugally cast (spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS: 4346 :1982	Specifications for washers for use with fittings for water services.
IS: 4711	Methods for sampling steel pipes, tube sand fittings.
IS: 6392	Steel pipe flanges.
IS: 6418	Cast iron and malleable cast iron flanges for general engineering purposes.
IS: 7181	Specification for horizontally cast iron double flanged pipes for water, gas and sewage.
IS: 778	Specification for copper alloy gate, globe and check valves for water works purposes.
IS: 780	Specification for sluice valves for water works purposes (50 mm to 300 mm size).
IS: 1703 2000	Specification copper alloy float valves (horizontal plunger type) for water supply fittings.
IS: 2906 2000	Specification for sluice valves for water works purposes (350 mm to 1200 mm size).

IS: 3950 :1979	Specification for surface boxes for sluice valves.
IS: 5312 (Part 1)2004	Specification for swing check type reflux (non return) valves: Single door pattern.
IS: 5312 (Part 2):2004	Specification for swing check type reflux (non return) valves: Multidoor pattern.
IS: 13095 :1991	Butterfly valves for general purposes.
IS: 771 (Parts 1 to 3)1978-1985	Specification for glazed fire clay sanitary appliances.
IS: 774 2004	Specification for flushing cistern for water closets and urinals (other than plastic cistern).
IS: 781 1984	Specification for cast copper alloy screw down bib taps and stop valves for water services.
IS: 1700	Specification for drinking fountains.
IS: 2326 1987	Specification for automatic flushing cisterns for urinals (other than plastic cisterns).
IS: 2548 (Part 1)1996	Specification for plastic seats and covers for water closets: Thermoset seats and covers.
IS: 2548(Part 2) 1996	Specification for plastic seats and covers for water closets: Thermoplastic seats and covers.
IS: 2556 (Part 1)2004	Specification for vitreous sanitary appliances (vitreous china): General requirements.
IS: 2556 (Part 2)2004	Specification for vitreous sanitary appliances (vitreous china): Specific requirements of wash down water closets.
IS: 2556 (Part 3)2004	Specification for vitreous sanitary appliances (vitreous china): Specific requirements of squatting pans.
IS: 2556 (Part 4)2004	Specification for vitreous sanitary appliances (vitreous china): Specific requirements of wash basins.
IS: 2556 (Part 6. Sec 2)1995	Specification for vitreous sanitary appliances (vitreous china): Specific requirements of urinals, Section 2 Half stall urinals.
IS: 2556 (Part 6, Sec 4)1995	Specification for vitreous sanitary appliances (vitreous china): Specific requirements of urinals, Section 4 Partition slabs.
IS: 2556 (Part 6, Sec 5)1995	Specification for vitreous sanitary appliances (vitreous china): Specific requirements of urinals, Section 5 waste fittings.
IS: 2556 (Part 6, Sec 6)1995	Specification for vitreous sanitary appliances (vitreous china): Specific requirements of urinals, Section 6 Water spreaders for half stall urinals.
IS: 2556 (Part 7)2004	Specification for vitreous sanitary appliances (vitreous china): Specific requirements of half round channels.
IS: 2556 (Part 8)2004	Specification for vitreous sanitary appliances (vitreous china): Specific requirements of siphonic wash down water closets.
IS: 2556 (Part	Specification for vitreous sanitary appliances (vitreous

11)2004	china): Specific requirements for shower rose.
IS: 2556 (Part 12)2004	Specification for vitreous sanitary appliances (vitreous china): Specific requirements of floor traps.
IS: 2556 (Part 15):2004	Specification for vitreous sanitary appliances (vitreous china): Specific requirements of universal water closets.
IS: 2717 :1979	Glossary of terms relating to vitreous enamel ware and ceramic metal systems.
IS: 2963 :1979	Specifications for copper alloy waste fittings for wash basins and sinks.
IS: 3311 :1979	Specification for waste plug and its accessories for sinks and wash basins.
IS: 5961 :1970	Specification for cast iron gratings for drainage purposes.
IS: 6249 :1999	Specification for flush valves and fittings for marine use.
IS: 6411:1985	Specification for gel coated glass fibre reinforced polyester resin bath tubs.
IS: 8931:1993	Specification for copper alloy fancy single taps, combination tap assembly and stop valves for water services.
IS: 9758 :1981	Specification for flush valves and fitting for water closets and urinals.

3.6 QUALITY ASSURANCE AND QUALITY CONTROL

- 3.6.1** The Work shall conform to high standards of design and workmanship, shall be structurally sound and aesthetically pleasing. Quality standards prescribed shall form the backbone for the Quality Assurance and Quality Control system.
- 3.6.2** At the site level the Contractor shall arrange the materials, their stacking/ storage in an appropriate manner to ensure quality. Contractor shall provide equipment and manpower to test continuously the quality of materials, assemblies, etc. as directed by the Engineer. The test shall be conducted continuously and the result of tests maintained. In addition the Contractor shall keep appropriate tools and equipment for checking alignments, levels, slopes and evenness of surface.
- 3.6.3** The Engineer shall be free to carry out tests as may be considered necessary by him at his sole discretion, from time to time, in addition to those specified in this document. The Contractor shall provide the samples and labour for collecting the samples. Nothing extra shall be payable to the Contractor for samples or for the collection of the samples.
- 3.6.4** The test shall be conducted at the site laboratory that may be established by Engineer or at any other Standard Laboratory selected by Engineer.
- 3.6.5** The Contractor shall transport the samples to the laboratory for which nothing extra shall be payable. In the event of Contractor failing to arrange transportation of the samples in proper time Engineer shall have them transported and recover at two times the actual cost from the Contractor's bills.
- 3.6.6** Testing charges shall be borne by the Contractor.

- 3.6.7** Testing may be witnessed by the Contractor or his authorised representative. Whether witnessed by the Contractor or not, the test results shall be binding on the Contractor.

3.7 SANITARY AND OTHER APPLIANCES

3.7.1 SCOPE OF WORK

- a) Without restricting to the generality of the foregoing, sanitary and other appliances shall inter-alia include the following: All Sanitary appliances and fittings shall be as per Green Rating for Integrated Habitat Assessment (GRIHA) Rating 2015.
- b) Sanitary appliances and fixtures for toilets.
- c) Chromium plated brass fittings.
- d) Accessories e.g. towel rods, toilet paper holders, towel rails, coat hooks, etc.
- e) Drinking water dispenser , etc
- f) Whether specifically indicated or not the Contractor shall provide for all appliances and fixtures, all fixing devices, nuts, washers, teflon tape, sealant, cement, brackets, supports, paints, connectors, Chromium Plated (CP) riser pipes, adopters, bolts, screws, hangers, etc., as required.
- g) All exposed pipes within toilets and near appliances/ fixtures shall be of CP brass or copper unless otherwise specified.

3.7.2 GENERAL REQUIREMENTS

- a) All materials shall be new and of quality conforming to specifications and subject to the approval of the Engineer. Wherever particular makes are mentioned, the choice of selection shall remain with the Engineer.
- b) All appliances, fixtures and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Schedule of Quantities, specifications, and drawings. Accessories shall include proper fixing arrangement, brackets, nuts, bolts, washers, screws and required connection pieces.
- c) Fixing screws shall be half round head CP brass screws, with CP brass washers unless otherwise specified.
- d) Porcelain sanitary ware shall be glazed vitreous china of first quality free from warps, cracks and glazing defects conforming to IS: 2556. The choice of the colour of the Sanitary ware shall be that of the Engineer and nothing extra shall be payable to the Contractor for fixing of Sanitary ware of any colour.
- e) Sinks for Kitchen shall be of stainless steel or as specified in the Schedule of Quantities.
- f) CP fittings shall be cast brass CP of the best quality approved by the Engineer.
- g) If Supply of sanitary appliances, fixtures are fittings are in Employer's scope, Contractor shall ensure that no damages occur to the same during

shifting, transportation, installation and successful handing over. If any damage occurs, the same shall be replaced by the Contractor at his own cost.

- h) All appliances, fittings and fixtures shall be fixed in a neat workmanlike manner true to level and to heights shown on the drawings and in accordance with the manufacturer's recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling, plaster, paint, insulation or terrace shall be made good by the Contractor at his own cost.
- i) All materials shall be rust proofed; materials in direct or indirect contact shall be compatible to prevent electrolytic or chemical (bimetallic) corrosion.
- j) Sanitary appliances, subject to the type of appliance and specific requirements, shall be fixed in accordance with the relevant standards and the following:
- k) Contractor shall, during the entire period of installation and afterwards protect the appliances by providing suitable cover or any other protection in order to absolutely prevent any damage to the appliances until satisfactory handing over. (The original protective wrapping shall be left in position for as long as possible).
- l) The appliance shall be placed in correct position or marked out in order that pipe work can be fixed or partially fixed first.
- m) The appliance shall be fixed in a manner such that it will facilitate subsequent removal, if necessary.
- n) All appliances shall be securely fixed. Manufacturers' brackets and fixing methods shall be used wherever possible. Compatible rust proofed fixings shall be used. Fixing shall be done in a manner that minimizes noise transmission.
- o) Appliances shall not be bedded (e.g. WC pans and pedestal units) in thick strong mortar that could crack the unit (e.g. a ceramic unit).
- p) Pipe connections shall be made with de-mountable unions. Pipe work shall not be fixed in a manner that it supports or partially supports an appliance.
- q) Appliances shall be fixed so that water falls to the outlet (e.g. baths).
- r) All appliances shall be secured as per the recommendations of manufacturer.
- s) Appliances shall be fixed true to level firmly fixed to anchor or supports provided by the manufacturer and additional anchors or supports where necessary.
- t) Sizes of Sanitary fixtures given in the Specifications or in the Schedule of Quantities are for identification with reference to the catalogues of makes considered. Dimensions of similar models of other makes may vary within +10% and the same shall be provided and no claim for extra payment shall be entertained nor shall any payment be deducted on this account.

3.7.3 URINAL PARTITIONS

- a) Urinal partitions shall be Granite /white glazed vitreous china of size specified in the Schedule of Quantities.
- b) Porcelain partitions shall be fixed at proper heights with CP brass bolts, anchor fasteners and MS clips as recommended by the manufacturer and directed by the Engineer.

3.7.4 WASH BASIN

- a) Wash basins shall be white glazed vitreous china of size, shape and type specified in the Schedule of Quantities.
- b) Each basin shall be provided with painted MS angle or CI brackets and clips and the basin securely fixed to wall. Placing of basins over the brackets without secure fixing shall not be accepted. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make, brand and colour as approved by the Engineer.
- c) Each basin shall be provided with 32 mm dia. CP waste with overflow, pop-up waste or rubber plug, CP angle valve, CP riser pipe with connectors/ adaptors and CP brass chain as specified in the Schedule of Quantities, 32 mm dia. CP brass bottle trap with CP pipe to wall flange.
- d) Wash basin shall be provided with hot and cold water mixing fitting or as specified in the Schedule of Quantities.
- e) Basins shall be fixed at proper heights as shown on drawings. If height is not specified, the rim level shall be 790 mm from finished floor level or as directed by the Engineer.

3.7.5 SINKS

- a) Sinks shall be stainless steel or any other material as specified in the Schedule of Quantities.
- b) Each sink shall be provided with painted MS or CI brackets and clips and securely fixed. Counter top sinks shall be fixed with suitable painted angle iron brackets or clips as recommended by the manufacturer. Each sink shall be provided with 40 mm dia. CP waste, CP angle valve, CP riser pipe with connectors/ adaptors and rubber plug with CP brass chain as given in the Schedule of Quantities. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make, brand and colour as approved by the Engineer.
- c) Supply fittings for sinks shall be deck mounted CP swivel faucets with or without hot and cold water mixing fittings as specified in the Schedule of Quantities. These shall be measured and paid for separately.

3.7.6 SHOWER SET

Shower set shall comprise of two CP brass concealed stop cocks, four/ five way auto-diverter, adjustable type overhead shower, all with CP wall flanges of approved quality all as specified in the Schedule of Quantities. Bath spout, shower

head/ rose, hand showers and pop up wastes shall also be provided wherever specified.

Wall flange shall be kept clear off the finished wall. Wall flanges embedded in the finishing shall not be accepted.

3.7.7 DRINKING WATER FOUNTAIN

It shall have built-in RO Filtration and UV System. Drinking water fountain shall be wall mounting type made of stainless steel or any other material as given in the Schedule of Quantities. The drinking water fountain shall be with anti-squirt bubble less, self closing valve type with automatic volume regulator. The drinking water fountain shall be provided with an anti-splash back and integral strainer with 32 mm or 40 mm cast brass trap.

3.7.8 MEASUREMENT AND RATES

Sanitary fixtures (Porcelain ware and CP fittings) shall be measured by numbers. Rate for providing and fixing of sanitary fixtures, accessories, shall include all items, and operations stated in the respective specifications and Schedule of Quantities and nothing extra is payable.

Rates for all items under specification Clauses above shall be inclusive of cutting holes and chases and making good the same, CP brass screws, nuts, bolts and any other fixing arrangements required and recommended by manufacturers, testing and commissioning etc. complete.

3.8 SOIL, WASTE, VENT AND RAINWATER PIPES

3.8.1 SCOPE OF WORK

- a) Soil, waste, vent and rain water disposal scope shall include Supply, Installation, testing, commissioning and successful handing over to Employer as per the drawings, specifications and Schedule of Quantities.
- b) All soil, waste and storm water disposal for the portion above ground level to the public sewers shall be by gravity, whereas from the basement it shall be by pumping. Without restricting to the generality of the foregoing, the soil, waste, vent and rain water pipes system shall inter-alia include the following:
 - c) Vertical and horizontal soil, waste, vent and rainwater pipes and fittings, joints, supports, paints and connections to fixtures.
 - d) Connection of all pipes to sewer lines as shown on the drawings at ground level.
 - e) Floor and urinal traps, clean out plugs, inlet fittings and rainwater (roof) outlets.
 - f) Testing of all pipes and fittings in the workshop.
 - g) Testing, commissioning and handing over of all pipes lines after installation.

3.8.2 GENERAL REQUIREMENTS

- a) Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
- b) Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
- c) Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for fixing pipes on RCC ceilings and RCC/ masonry walls.
- d) Access doors for fittings and clean outs shall be so located that they are easily accessible for repair and maintenance.
- e) Long bends shall be used on all main pipelines as far as possible. Use of elbows shall be restricted for short connections.
- f) Wherever piping is going across the separation/ expansion joints of buildings, piping shall be provided with flexible connectors on both sides of such joints or on single side depending on whether any wall is to be crossed or not.

3.8.3 UPVC PIPE WORK

UPVC SWR(Soil Waster and Rain water) pipe work shall be provided for above ground soil, waste, vent and rain water pipe work as shown in drawings. UPVC SWR pipes and fittings shall confirm to IS: 13592 and IS: 14735 respectively. Pipes shall be of Type - B, pressure rating 6 kg/cm². The pipes shall be supplied in nominal lengths of 2, 3, 4 or 6 metres, tolerance on specified lengths shall be +10 mm and -0 mm. Any physical test requirements shall be as per IS: 13592 - 1992.

3.8.4 Handling

Because of their light weight, there may be a tendency for the UPVC pipes to be thrown often during installation. Reasonable care should be taken in handling and storage to prevent damage to the pipes. The pipes shall be stored as per manufacturer's recommendation. The Contractor shall be fully responsible in this case. In no case, pipes should be dragged on the ground. Pipes should be given adequate supports at all times.

3.8.5 Pipe Work Installation

- a) UPVC pipes shall be laid under the flooring or hanging below slab or fixed on walls either buried or exposed as the case may be, as shown in the drawings. The minimum thickness of fittings shall be of 3.2 mm. the fittings shall be of injection mould type with solvent cement joint (for exposed piping) or rubber ring joint (for concealed piping). The pipes and

fittings shall be capable of withstanding sun's rays. UPVC pipes laid below slab or suspended from ceiling shall be supported by GI angle brackets/ supports as detailed in the drawings.

- b) All vertical pipes shall be fixed by GI clamps truly horizontal. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a vent cowl (terminal guard).
- c) Horizontal pipes running along ceiling shall be fixed on structural members by adjustable clamps of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully rest on them.
- d) Contractor shall provide all sleeves, openings, hangers and anchor fasteners during the construction. Sleeves shall be one size higher than pipe or there should be at least 12 mm gap all around between pipes and sleeves. Wherever pipe passes through fire rated wall, the gap shall be filled with fire rated sealant as directed by Engineer. For non-fire rated wall, gap shall be filled with wool and silicon sealant (20 mm depth). Contractor shall provide all necessary information to the building work Contractor for making such provisions in the structure as necessary. All damages shall be made good by the Contractor at his own cost to restore the surface.
- e) Door type fittings shall be used in vertical piping installations. Door position of fittings shall be on top of fitting. Easy removal of access door should be possible. The access door shall be air and water tight. Single - yee shall be used for horizontal branch connection. Double - yee fittings shall be used in vertical piping branch connection only.

3.8.6 Jointing

- a) UPVC pipes and fittings shall be joined as per the manufacturer's instructions/ recommendations. UPVC pipes and fittings shall be joined with Solvent Cement and jointing shall be carried out as follows:
- b) Cut the spigot end of the pipe square.
- c) All burrs from the internal and external surfaces should be removed.
- d) The spigot should be marked with a pencil line at a distance equivalent to the socket depth. Clean the surface within the marked area.
- e) Apply uniform coat of approved solvent cement on the external surface to the pipe and a lighter coat on the internal surface of the fitting.
- f) Insert the pipe end into the socket of the fitting and push it in upto the mark.
- g) The pipe work should be assembled in a manner such that it does not entail making of joints in restricted area.
- h) UPVC Pipe Work Testing
- i) UPVC pipes and fittings assembled shall be tested in accordance with IS 13592 - 1992. The openings of the pipes shall be sealed for the section to be tested. The water column of 2 m shall be maintained for a maximum of

15 minutes. Contractor with his team shall examine carefully all the joints for leakage.

- j) The Contractor shall test all vent pipes by a smoke testing machine. Smoke shall be pumped into the stack after plugging all inlets and connections and filling water in all trap seals. The test shall be conducted under a pressure of 25 mm of water and shall be maintained for 15 minutes. The stack shall then be observed for leakages and all defective pipes and fittings removed or repaired as directed by the Engineer.
- k) A test register shall be maintained and all entries signed and dated by Contractor and Engineer. A proforma of the proposed test register shall be submitted to the Engineer for approval.
- l) All pipes in wall chase or meant to be encased or buried shall be hydro tested before the chase is plastered or the pipe encased or buried.
- m) All systems shall be tested in sections as required to expedite the work for other trades and meet construction schedules and final test on completion.

3.8.7 WASTE PIPE FROM APPLIANCES

Waste pipe from appliances e.g. washbasins, baths, sinks and urinals, etc. shall be of UPVC confirming IS: 4985 as given in the Schedule of Quantities.

The internal diameter sizes of outlet branch waste pipes for different fittings shall be as follows:

Wash Basin	40 dia.
Urinals	50 dia.
Sink	50 dia.
Nahani Trap	75 dia., 50 mm seal.
Multi Floor Trap	75 or 100 dia. as required, with 50 mm or 75 mm seal.
Wash troughs	50 dia.
Canteen wash areas	50 dia.

All pipes shall be fixed in gradient towards the outfalls of drains. Pipes inside a toilet room shall be in chase unless otherwise shown on drawings. Where required pipes may be run at ceiling level in suitable gradient and supported on structural clamps as directed by the Engineer. Spacing for the clamps shall be 3,000 mm for vertical runs and 2,400 mm for horizontal runs.

Pipes shall be UPVC tubes conforming to IS: 4985 and quality certificates shall be furnished. Pipes shall be provided with all required fittings conforming to IS: 4985 e.g. tees, couplings, bends, elbows, unions, reducers, nipples, plugs, etc. All UPVC waste pipes shall be terminated at the point of connection with the appliance with an outlet of suitable diameter. Pipes shall be painted as specified under Clause (c).

3.9 DRAINAGE ACCESSORIES

3.9.1 Floor Trap/ Urinal Trap Grating

Floor/ urinal traps grating shall be of stainless steel square/ round of size 125 mm x 125 mm square/ round as approved by Employer and shown in the drawing. Floor trap assembly shall be provided with round stainless steel strainer basket as a cockroach trap. Entire assembly shall be complete with ring, frame, outer cup, inner cup, grating, screws, etc. of an approved make.

3.9.2 Floor Cleanout

Floor cleanout cover shall be of stainless steel square/ round of size 125 mm x 125 mm square/ round as approved by Employer and shown in the drawing. Floor cleanout assembly shall be complete with ring, outer frame, cover, screws, etc. of an approved make.

3.9.3 Ceiling Cleanout

Ceiling cleanout cover shall be in nickle bronze/ PVC plug type/ GI flanged type of round shape matching pipe size as approved by Employer and shown in the drawing. Ceiling cleanout assembly shall be threaded with key hole for opening/ flanged type suitable for pipe. Threaded cover shall be used upto 100 mm size and above shall be GI flanged type with GI nuts and bolts. PVC cover shall be used for PVC drainage piping only, whereas nickle bronze and GI flanged type cover shall be used for HDPE/ CI/ CI LA pipe work.

3.9.4 RAINWATER PIPES

All rainwater pipes shall be of UPVC/ HDPE as shown in drawing and specified in specification. UPVC piping shall conform to IS: 4985 and 6 kg/cm² minimum pressure rating or as specified in the Schedule of Quantities.

3.9.5 RAIN WATER OUTLET

- a) Rain water outlet shall be preferably scupper type drain with cast iron body and cast aluminium grating with stainless steel screws. Suitable adapter/ connector shall be used to match the pipe. Wherever shafts are not available near rain water outlet, dome type rain water outlet shall be installed.
- b) Rain water outlet shall be tested for water leaking, prior to waterproofing treatment. Extreme care shall be taken, while sealing gap between rain water outlet and wall/ slab.

3.10 MEASUREMENT AND RATES

3.10.1 General

- a) Rates for all items shall be inclusive of all work and items called for in the specifications given above and the Schedule of Quantities as applicable for the work under floors, in shafts or at ceiling level at all heights and depths.

- b) All rates are inclusive of cutting holes and chases in RCC and masonry work and making good the same.
- c) All rates are inclusive of shop testing, pre-testing at site and final testing of the installations, materials and commissioning.

3.10.2 Pipes

- a) The unit of measurement shall be linear metre to the nearest centimetre.
- b) All CI/ UPVC/ HDPE soil, waste, vent, anti-siphonage and rain water pipes shall be measured net, correct to a centimetre, including all fittings along their length after fixing. The length shall be taken along centre line of the pipes and fittings. No allowance shall be made for the portions of pipe lengths entering the sockets of the adjacent pipes or fittings. The above shall apply to all cases i.e. whether pipes are fixed on wall face or pillars or embedded in masonry or pipes running at ceiling level. The quoted rate shall include lead jointing.
- c) All CI/ UPVC/ HDPE pipes shall be measured in running metre correct to a centimetre for the finished work which shall include fittings e.g. bends, tees, elbows, reducers, crosses, sockets, nipples, nuts, unions, etc. The length shall be taken along centre line of the pipes and fittings. All pipes and fittings shall be classified according to their diameter, method of jointing and fixing substance, quality and finish. The diameters shall be nominal diameter of internal bore. In case of fittings of unequal bore, the largest bore shall be considered.

3.10.3 Pipe Encasing/ supports

- a) Cement concrete around pipes shall be measured along the centre of the pipe line measured per linear metre and include any masonry supports, shuttering and centering, curing, cutting, etc. complete as described in the relevant specifications.
- b) GI Supports
- c) GI Supports rate for pipe work shall be included in the quoted BOQ/ SOQ rate and shall include GI channels/ angles (structural steel members), GI bolts, GI nuts, GI washers, brass screws, SS fasteners, GI threaded rod, GI clamps, GI hangers, primer coating, painting, etc. Length of supports embedded in the cement concrete blocks of 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 20 mm nominal size) formed in the masonry walls shall not be paid extra. Also nothing shall be paid extra for the cement concrete block and making good the masonry wall, anchor fasteners, etc. complete.

3.10.4 Traps

Unit of measurement shall be the number of pieces. All urinal traps, trap gratings, hoppers, clean out plugs shall be measured by number and shall include all items

described in the relevant specifications and Schedule of Quantities. Cockroach traps shall not be measured separately and are deemed to be included in the rate for Traps.

3.10.5 Painting

Painting of pipes shall be measured per running metre for each diameter of pipe and shall be inclusive of all fittings and clamps. No deduction shall be made for fittings.

3.10.6 Excavation for Soil Pipes

No extra payment shall be admissible for excavation, dewatering, back filling, consolidation and disposal of surplus earth for soil and waste pipes.

3.10.7 Rain Water Outlet

Rain water outlet shall be measured by numbers for different sizes.

Leaf and gravel grates along with the perforated ring shall be measured in kilograms.

3.11 WATER SUPPLY SYSTEM

3.11.1 SCOPE OF WORK

- a) The scope shall include supply, installation, testing, commissioning and satisfactory handing over of the complete water supply system to Employer as per drawings, specifications and Schedule of Quantities. The water supply system shall include the following:
- b) Distribution system from main supply or overhead tank to all fixtures and appliances for cold and hot water.
- c) Insulation for hot water pipes.
- d) Pipe painting.
- e) Control valves, masonry chambers and other appurtenances.
- f) Connections to all plumbing fixtures, tanks, appliances.
- g) Inserts, nozzles for Reinforced Concrete tanks.
- h) The term water supply is used as indicative of all water supply work required and necessary for the building including such external work as may be necessary to make the system functional.

3.11.2 GENERAL REQUIREMENTS

If necessary and if approved by the Engineer, where unavoidable, bends may be formed by means of a hydraulic pipe bending machine for pipes up to 20 mm dia. No bending shall be done for pipes of 25 mm dia. and above. After bending zinc rich paint shall be applied wherever the zinc coating is damaged.

Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs. Valves shall be located at a height not exceeding 1.6 m above their operating floor/ platform level. Where such a provision is not possible and the valve is to be frequently operated a MS chain shall be provided for its operation.

3.11.3 GI PIPES, FITTINGS AND VALVES

- a) All pipes inside the buildings and where specified, outside the building shall be MS galvanised steel tubes conforming to IS: 1239 of Class specified. When Class is not specified they shall be Heavy Class. All embedded/ concealed pipes shall be of heavy duty.
- b) Fittings shall be of malleable cast iron galvanised, of approved make. Each fitting shall have manufacturer's trade mark stamped on it. Fittings for GI pipes shall include couplings, bends, tees, reducers, nipples, unions, bushes, etc. Fittings, etc. shall conform to IS: 1879.
- c) Pipes and fittings shall be jointed with screwed joints using Teflon tape suitable for water pipes. Care shall be taken to remove burr from the end of the pipe after cutting by a round file. All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. Necessary vents and drains shall be provided at all high and low points respectively. GI pipes inside toilets shall be fixed in wall chases well above the floor. No pipes shall be run inside a sunken floor as far as possible. Pipes may be run under the ceiling or floors and other areas as shown on drawings. All pipe joints after testing of the line shall be seal welded and the weld plus the adjoining portion shall be given two coats of zinc rich primer.

3.11.4 Clamps

GI pipes in shafts and other locations shall be supported by GI clamps of design approved by the Engineer. Pipes in wall chases shall be anchored by iron hooks. Pipes at ceiling level shall be supported on structural clamps fabricated from MS structural sections. Pipes in shafts shall be supported on slotted angles/ channels as specified/ as directed.

3.11.5 Unions

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

3.11.6 Flanges

Flanged connections shall be provided on pipes as required for maintenance/ ease in dismantling or where shown on the drawings, all equipment connections as necessary and required or as directed by the Engineer. Connections shall be made by the correct number and size of the GI nuts/ bolts as per relevant IS Standards and made with 3mm thick insertion rubber washer/ gasket. Where hot water or steam connections are made insertion gasket shall be of suitable high temperature grade and quality approved by the Engineer. Bolt hole dia. for flanges shall conform to match the specification for CI sluice valve as per IS: 780. Gaskets shall conform to IS: 11149.

3.11.7 Trenches

All GI pipes below ground shall be laid in trenches with a minimum cover of 600 mm. The width and depth of the trenches shall be as follows except at places where welding/ jointing, etc. needs larger width of trench. Additional width/ depth shall be provided as necessary for welding/ jointing, etc. at no additional cost:

3.11.8 Diameter of pipe (mm)	3.11.9 Width of trench (mm)	3.11.10 Depth of trench (mm)
3.11.11 15 to 50	3.11.12 300	3.11.13 750mm
3.11.14 65 to 100	3.11.15 450	3.11.16 1000mm

3.11.17 Sand Filling

GI pipes in trenches shall be protected with fine sand 150mm all around before filling in the trenches.

3.11.18 Painting

All pipes above ground shall be painted with one coat of red lead and two coats of synthetic enamel paint of approved shade and quality to give an even shade, or as specified by the Engineer.

3.11.19 Hot water pipes in chase:

All hot water pipes fixed in wall chase shall be properly insulated by elastomeric tape as per manufacturer's recommendation.

3.11.20 Pipe Protection

Where specified, pipes below floor or below ground shall be protected against corrosion by the application of two or more coats of solvent based rubberised asphaltic primer to give a uniform coat covered with two layers of 2 mm thick bituminous based anti-corrosive tape. The application of primer and anti-corrosive tape shall be done as specified by the manufacturer.

3.11.21 Reverse Osmosis Unit

Supplying & fixing potable Reverse Osmosis Unit (RO Unit) includes with ultra filtration & ultra violet treatment, shall have purified water flow rate of 15 litres/ hour, and 7 litres water storage capacity suitable for all kind of raw water. RO unit shall be suitable for minimum 90 % of TDS reduction & minimum 25 % water recovery. RO unit shall consist of all accessories, valves, fittings etc required for complete satisfactory installations as required by client / engineer-in-charge.

3.11.22 Drinking Water Cooler Unit

Supplying & fixing two tap stainless steel storage type drinking water cooler, which includes ultra filtration shall have 100 litres storage capacity and 100 litres/hour water cooling capacity. Water cooler unit shall have adjustable cold water thermostat, overload compressor protection and mechanically expanded compressor. Water cooler unit shall consist of all accessories, valves, fittings etc required for complete satisfactory installations as required by client / engineer-in-charge.

3.12 VALVES & FITTINGS

3.12.1 Gunmetal Valves

Valves 50 mm dia. and below shall be heavy gunmetal full way valves or globe valves conforming to Class I of IS: 778. Valves shall be tested at manufacturer's works and the same stamped on it. All valves shall be approved by the Engineer-in-Charge before they are allowed to be used in the Work.

3.12.2 Sluice Valves

Unless otherwise specified all valves 80 mm dia. and above shall be CI double flanged sluice valves with non rising spindle. Sluice valves shall be provided with wheel when they are in exposed positions and with a cap top when they are located underground. Contractor shall provide suitable operating keys for sluice valves with cap tops. Sluice valves shall be of approved makes conforming to IS: 780 of Class as specified

3.12.3 Butterfly Valves

- a) Where specified, Valves 65mm dia. and above shall be cast iron butterfly valve to be used for isolation and/ or flow regulation as directed by the Engineer. The valves shall be tight shutoff/ regulatory type with resilient seat suitable for flow in either direction and seal in both directions.
- b) The butterfly valve shall be suitable for waterworks and rated Pressure requirement as mentioned in the Schedule of quantities.

- c) The body shall be of cast iron to IS:210 in circular shape and of high strength to take the water pressure. The disc shall be heavy duty cast iron with anti corrosive epoxy or nickel coating.
- d) The valve seat shall be of high grade elastomer or nitrile rubber. The valve in closed position shall have complete contact between the seat and the disc throughout the perimeter. The elastomer rubber shall have a long life and shall not give away on continuous applied water pressure. The shaft shall be EN 8 grade carbon steel.
- e) The valve shall be fitted between two flanges on either side of pipe flanges. The valve edge rubber shall be projected outside such that they are wedged within the pipe flanges to prevent leakages.
- f) Butterfly valve shall conform to IS: 13095.

3.12.4 Non Return Valve

Where specified non return valve (swing check type) shall be provided through which flow can occur in one direction only. It shall be single door swing check type of best quality conforming to IS: 5312.

3.12.5 Forged Brass Ball Valve

Valves of size 50 mm dia. and below shall be full bore quarter turn lever operated female threaded forged brass hard chrome plated ball valves conforming to IS: 554. Valve shall have PTFE body seat rings and gland packing, forged brass ball, stem and bonnet, carbon steel nut washer and lever and finished in chrome. Valves shall have minimum working pressure of 16 bar. Valves shall be tested at manufacturer's works and the same stamped on it.

3.12.6 Ball Type Non Return Valve (NRV)

Ball type NRV shall be used in water treatment plants and sewage sump pump piping. NRV shall be constructed in cast iron body with epoxy coating, phenolic resin and NBR (Nitrile) seal. NRV shall have flanged ends and can be installed in horizontal as well as vertical position. NRV shall have minimum working pressure of 10 bar or as per system requirements. Valves shall be tested at manufacturer's works and the same stamped on it.

3.12.7 Air Release Valve (ARV)

Pressurised water supply lines shall be provided with air release valve at highest point to release accumulated air for piping system. Air release valve shall be automatic float operated; the diameter shall be as specified in the Schedule of Quantities. Air release valve shall be provided with ball valve for ease in Operation and Maintenance. Valve body shall be in cast iron stainless steel, brass and EPDM internal components. Valves shall have minimum working pressure of 10 Kgs.

3.12.8 Ball float valve

Ball valves with floats to be fixed in storage tanks shall consist of cast brass lever arm having copper balls (26 SWG) screwed to the arm integrally. The copper ball shall have bronze welded seams. The closing/opening mechanism incorporating the piston and cylinder shall be non-corrosive metal and include washers. The size and construction of ball valves and float shall be suitable for desired working pressure operating the supply system. Where called for brass valves shall be supplied with brass hexagonal back nuts to secure them to the tanks and a socket to connect to supply pipe.

These valves are required to maintain a constant level in service reservoirs and steel storage tanks. These shall be available for static pressure of 7 Kg/cm² flanges faced and drilled to BS 10, table C, tested to 250 pounds per square inch. These shall conform to BS-1212 Part-2 and IS 1703

3.13 TESTING

3.13.1 All pipes, fittings and valves shall be tested in accordance with IS: 2065 except as may be modified herein under. All pipes, fittings and valves, after fixing at site, shall be tested to a hydrostatic pressure of 10 kg/cm² or 1.5 times the shut off head of the pump whichever is greater.

3.13.2 The test pressure shall be maintained for a period of at least thirty minutes without any drop in pressure.

3.13.3 A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and the Engineer.

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

3.13.5 All pipes in wall chase or meant to be encased or buried shall be hydro tested before the chase is plastered or the pipe encased or buried.

3.13.6 INSULATION

- a) All open hot water flow and return pipes shall be insulated with preformed fibrous pipe sections conforming to IS: 9842.
- b)
- c) Insulation to pipes shall be with pre-moulded pipe sections, thickness for sections shall be:
- d) Pipe 50 mm dia. and below - 25 mm thick.
- e) Pipe 65 mm dia. and above - 40 mm thick.

3.13.7 Application

- a) All surfaces shall be thoroughly cleaned with a wire brush.
- b) One layer of approved primer shall be applied and premoulded pipe insulation sections shall be fixed.
- c) One layer of aluminium foil of thickness 0.711 mm (20 SWG), shall be applied as a finish layer.
- d) Insulation for hot water pipes in chase:
- e) All hot water pipes in chase shall be insulated with 3 mm elastomeric tape as per manufacturer's recommendations.

3.13.8 DISINFECTION OF INSTALLATION

- a) The water supply installation shall be disinfected as per standards and as follows:
- b) Tanks and pipes shall be filled and flushed out.
- c) All bib cocks (taps) shall be closed.
- d) Tanks and pipes shall be re-filled while adding a sterilising admixture containing 50 parts chlorine to one million parts water.
- e) When the installation is filled all bib cocks (taps) shall be opened progressively and each allowed to run until the water smells of chlorine.
- f) The installation shall be topped up and more steriliser added.
- g) The installation shall then be left for three hours and shall then be tested for residual chlorine; if none is found, the installation shall be drained and the process repeated.
- h) The installation shall be finally drained and flushed with potable water before use.

3.13.9 MEASUREMENT AND RATES

3.13.9.1 GI and CPVC Pipes

- a) GI pipes above ground shall be measured per linear metre (to the nearest cm) along the centre line of the pipe and shall be inclusive of all fittings e.g. couplings, tees, bends, elbows, unions, flanges, etc. Deduction for valves shall be made. Rates quoted shall be inclusive of all fittings, clamps, cutting holes chases and making good the same and all other items mentioned in the specifications and Schedule of Quantities.
- b) GI pipes below ground shall be measured per linear metre (to the nearest cm) along the centre line of the pipe and shall be inclusive of all fittings e.g. couplings, tees, bends, elbows, unions and flanges, etc. Deduction for valves shall be made. Rates quoted shall be inclusive of all fittings, cutting holes and chases and making good the same and all other items mentioned in the specifications and Schedule of Quantities. Excavation, filling, back filling with selected excavated earth, compaction and disposal of surplus earth, fine sand filling around GI pipes, in external work shall be measured separately, as per respective items.

3.13.10 VALVES, BIB COCKS AND STOP COCKS

- a) Gunmetal and cast iron valves, Bib cocks and stop cocks shall be measured by numbers.
- b) Flanges for Nozzles
- c) Flanges for nozzles shall be measured by numbers and the quoted rate shall include welding of the flanges to the pipe nozzles.
- d) Painting/ Pipe Protection/ Insulation
- e) Unless otherwise specified painting/ pipe protection/ insulation for pipes shall be measured and paid for separately. These shall be measured per linear metre along the centre line of the pipe, over the finished surface and shall include all valves and fittings for which no deduction shall be made.

3.13.11 Pressure Reducing Valve Set

- a) Each pressure reducing valve set shall be complete with pressure reducing or pressure regulating valve, isolating valves, pressure gauges (fix with symphonic check) on inlet and outlet, pressure relief valve on outlet and filter on inlet.
- b) Each pressure reducing valve shall contain loading neoprene diaphragm and a full floating, self aligning, ignition resistant seat and shall be of the single stage, pressure reduction type with provision for manually adjusting the delivery pressure. The valve shall fail safe to the low pressure.
- c) Valves shall be capable of operating at the maintaining automatically the respective delivery pressure and flow rates as indicated and shall not be liable to creep. Valves shall also be capable of maintaining the pre-set down stream pressure under static condition.
- d) The filter on each inlet to a pressure reducing valve shall be of replaceable porous sintered metal type.

3.13.12 Water Meters.

- a) Water meter shall communicate with DDC or PLC through open communication protocol such as RS-485, MODBUS, BACnet etc. Plumbing Contractor shall co-ordinate with IBMS contractor for the connection purpose
- b) Water meters of approved make and design shall be supplied for installation at locations as shown.
- c) The water meters shall meet with the approval of local supply authorities. Suitable valves and chambers or wall meter box to house the meters shall also be provided along with the meters.
- d) The meters shall conform to Indian Standard IS:779 and IS:2373. Calibration certificate shall be obtained and submitted for each water meter.
- e) Provision shall also be made to lock the water meter. The provision shall be such that the lock is conveniently operated from the top. Where the provision is designed for use in conjunction with padlocks, the hole

provided for padlocks shall be a diameter not less than 4mm.

- f) The G.I. lines shall be cut to the required lengths at the position where the meter and stop cock are required to be fixed. Suitable fittings shall be attached to the pipes. The meter and stop cock shall be fixed in a position by means of connecting pipes, jam nut and socket etc.
- g) The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed. And the meter installed exactly horizontal or vertical in the flow line in the direction shown by the arrow cast on the body of the meter. 15.8 Care shall be taken that the factory seal of the meter is not disturbed. Wherever the meter shall be fixed to a newly fitted pipe line, the pipe line shall have to be completely washed before fitting the meter.

3.13.13 Expansion Bellow

- a) Rubber expansion joint with unit control (tie rod & gusset plate) shall be as per manufacturers specifications of standard length complete with all accessories tested to a pressure not less than 15 Kg./sqcm including rubber gaskets, flanges, nuts, bolts & washers complete as required.
- b) Pressure Gauge
- c) The pressure gauge shall be constructed of die cast aluminium and stove enamelled. It shall be weather proof with an IP 55 enclosure. It shall be a stainless steel Bourden tube type pressure gauge with a scale range from 0 to 16 Kg / cm square and shall be constructed as per IS:3524. Each pressure gauge shall have a siphon tube connection. The shut off arrangement shall be by Ball Valve. Calibration certificate shall be obtained and submitted for each pressure gauge

3.13.14 DRAINAGE

3.13.15 SCOPE OF WORK

- a) The scope shall include supply, installation, testing, commissioning and satisfactory handing over of the complete drainage system to client as per drawings, specifications and schedule of quantities.
- b) Without restricting to the generality of the foregoing, the drainage system shall inter-alia include:
- c) Sewer lines including earthwork for excavation, disposal, backfilling and compaction, pipelines, manholes, drop connections and connections to the municipal or existing sewer.
- d) Storm water drainage, earth works for excavation, disposal, backfilling and compaction, pipe lines, manholes, catch basins and connections to the existing municipal storm water drain or connected as indicated by the Engineer.

3.13.16 GENERAL REQUIREMENTS

- a) Drainage lines and open drains shall be laid to the required gradients and profiles.
- b) All drainage work shall be done in accordance with the Local municipal bye-laws.
- c) Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent Authority.
- d) Location of all manholes, etc. shall be got confirmed by the Engineer-in-Charge before the actual execution of work at site. As far as possible, no drains or sewers shall be laid in the middle of road unless otherwise specifically shown on the drawings or directed by the Engineer-in-Charge in writing.

3.13.17 GULLY TRAPS

Gully traps shall be of the same quality as described for stoneware pipes. Gully traps shall be fixed in a masonry chamber as per specifications. The CI sealed cover and frame shall weigh not less than 7.3 kg. Where necessary, sealed cover shall be replaced with CI grating of the same size. Rubber rings shall conform to IS: 5382. Gully traps shall be measured by the number and rate shall include all excavation, back filling, foundation, concrete brick masonry, cement plaster inside and outside, CI grating and sealed cover and frame, etc. complete.

3.13.18 Cast Iron Pipes

Cast iron pipes and fittings shall be of good and tough quality and dark grey on fracture. The pipes and fittings shall be true to shape, smooth and cylindrical, their inner and outer surface being as nearly as practicable concentric. They shall be sound and nicely cast, shall be free from cracks, taps, pinholes and other manufacturing defects.

The pipes and fittings shall conform to IS:3989 / IS:1729 as called for. Fittings shall be of required degree with or without access door. All access doors shall be made up with 3mm thick insertion rubber gasket of white lead and tightly bolted to make the fittings air and water tight. The fittings shall be of the same manufacture as the pipes used for soil and waste.

All CI pipes and fittings shall bear the manufacturer's name and ISI specification to which it conforms.

All pipes and fittings shall be coated internally and externally with the same material at the factory, the fittings being preheated prior to total immersion in a bath containing a uniformly heated composition having a tar/other suitable base. The coating material shall have good adherence and shall not scale off. The coating shall be smooth and tenacious and hard enough not to flow when exposed to a

temperature of 77 degree C but not so brittle at a temperature of '0' degree C as to chip off when scratched lightly with a pen knife.

All pipes and fittings before installation at site shall be tested hydrostatically to a pressure of 0.45 Kg/sq. cm without showing any sign of leakage, sweating or other defects of any kind. The pressure shall be applied internally and shall be maintained for not less than 15 minutes. All these tests shall be carried out in the presence of the representative of the Project Manager. Alternatively a test certificate from manufacturers be obtained before dispatch of material to site.

Cast Iron Specialities

If required, Cast iron speciality items such as deep seal floor traps, urinal traps, trap integral pieces with integral inlet/outlet connections, manhole cover with frame, chamber cover etc. shall be fabricated to suit individual location requirements. The contractor shall arrange the fabrication of these items from an approved source.

Lead Caulked joints with pig lead:

The approximate depth and weights of pig lead for various diameters of CI pipes and specials shall be as follows:

Nominal size of Pipe (mm)	Lead per Joint (Kg)	Depth of Lead Joint (mm)
50	0.77	25
80	0.88	25
100	0.99	25
150	1.5	38

Pipe Joint Sealant:

Pipe joint sealant shall be used for joining various diameters of C.I. pipes and specials. This sealant replaces the standard lead caulked joints. The application is by Homogenously mixing the two pack system in cold condition.

Application Procedure:

Clean the pipe joints thoroughly to ensure it is free from any traces of oil, dirt or any other foreign body. Mix two parts of Drip Seal thoroughly with an iron flat to get a homogenous compound. * Place Spun yarn in the pipe joint as a filler and then take the required quantity of the compound and push it in the joint with a caulking tool, MS flat / damp finger uniformly all over to obtain a smooth and uniform joint. Dip the fingers in water every often to ensure the compound does not stick to the hands of the workmen, but this will ensure perfect sealing and the smooth surface for the joint cement. (* The compound prepared from the two mixtures is to be used within

30 minutes) Precaution to be taken to wash hands thoroughly with soap before and after use. Preferably use disposable gloves for hand application.

3.14 PUMPS

3.14.1 Inline Pumps

- a) Pumps shall be suitable for single as well as parallel efficient operation at any point in between the maximum and minimum system resistances.
- b) Pumps shall run smooth without undue noise and vibration, cavitations, oil or water leaks over the range of operation. To ensure vibration free operation, all rotating components of pump shall be statically and dynamically balanced to BS 6861/ as per zones A & B of ISO 10816 -1
- c) The pump set shall be suitable for starting with discharge valve open and/or closed.
- d) The pump set shall be capable of withstanding the accidental rotation in reverse direction.
- e) Pumps shall be so selected that the design duty point is within 5% of the maximum efficiency point.
- f) The pump casing shall have ample space to take an impeller one size larger than that capable of performing the design duty.
- g) The pump shall have a speed of not more than 1500 rpm. The pump shall be lubricated in strict accordance with the manufacturer's instructions and shall be factory aligned prior to shipment.
- h) Facilities to select which pump to be duty pump and standby pump shall be provided and shall be interchangeable. Leakage from pump gland shall be drained to the nearest floor waste.

3.14.2 . Features of construction

- a) Pump shall be Vertical, centrifugal, with enclosed, radial impeller. Impeller shall be hydraulically balanced and keyed to shaft. The impeller shall have superior suction eye design to ensure the lower NPSH.
- b) Pump casing shall be of robust construction. Liquid passages shall be finished smooth and designed as to allow smooth flow. The volute tongue shall be filed to a smooth rounded edge.
- c) The vertical shaft shall be of high tensile stainless steel supported by bush bearings shall. The shaft shall be sealed with mechanical seal of DIN 24960 standard.
- d) The bearing shall be radial type bush bearing of tungsten carbide on shaft and ceramic bearing in the diffuser. The bearing shall be self lubricated and highly wear resistant. The motor bearing shall be capable of withstanding the axial thrust. Bearings shall be capable of taking the static weight of the rotating parts and any thrust generated by the operation of the pump. The bearing life shall be minimum 40,000 hrs of operation.

- e) The diffusers shall be made with pressed stainless steel and shall be designed to reduce the internal losses.
- f) Each pump shall be provided with an automatic coupling device for attaching the crane hook to the pump at low level, this automatic coupling device shall easily and automatically couple and uncouple the hoist hook and be complete with necessary accessories.

The materials of construction for Vertical in line pumps shall be as follows:

3.14.3 Capacity:	3.14.4 Refer GA drawing
3.14.5 Head	3.14.6 Refer GA drawing
3.14.7 Shut off head	3.14.8 110% of head
3.14.9 Efficiency	3.14.10 Bidder to furnish
3.14.11	3.14.12
3.14.13 Component	3.14.14 Material
3.14.15 Impeller	3.14.16 AISI 304
3.14.17 Casing	3.14.18 Cast Iron to IS:210 Gr FG 200 with 1.5 to 2% Nickel
3.14.19 Shaft	3.14.20 Stainless Steel : BS:970 Gr 316
3.14.21 Fasteners and Foundation Bolts	3.14.22 Stainless Steel AISI 316
3.14.23 Motor Stool	3.14.24 Cast Iron
3.14.25 'O' Rings	3.14.26 EPDM
3.14.27 Drain Plug	3.14.28 Brass

- g) Material test certificates from Government approved metallurgical laboratory shall be furnished by the Contractor
- h)
- i) Each pump shall be tested at the manufacturers premises for the full operating range of the pump to BS 5316 Part 1 .Pump performance shall be within the tolerance limits specified in the above said BS.
- j) Y-Strainers shall be provided as the suction side of the pump as shown in GA of UGT

3.14.29 Tests

- a) Hydro test pressure on casing shall be 1.5 times maximum discharge head or twice differential head whichever is higher. (Maximum discharge head = shut-off head + maximum suction head). Unless otherwise stated in data sheet A, the hydrostatic tests on the casing shall be conducted for a minimum duration of 30 minutes.
- b) The pumps shall be tested as per IS 11346:2004, at rated speed at MANUFACTURER's works to measure capacity, total head, efficiency and power. These tests shall form the basis for acceptance of pumps except for vibration and noise. The pumps shall be tested over the range

covering from shut-off head to the maximum flow. The duration of the test shall be minimum one (1) hour. Minimum five (5) readings approximately equidistant shall be taken for plotting the performance curves.

- c) After installation, the pumps shall be subjected to performance testing at site also. If the site performance is found not to meet the requirements regarding vibration and noise as specified, the equipment shall be rectified or replaced by the VENDOR, at no extra cost to the EMPLOYER.

3.14.30 Inspection

- a) The contractor shall provide facilities for inspection of the components of the pump during all stages of manufacture to check conformity to specification. The following inspection shall be invariably be witnessed by the Employer.
- b) Vertical inline pumps - Casing Hydro test, Performance Testing
- c) General purpose induction motor Performance and characteristics
- d) Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under either of the following supply conditions:
 - e) Variation of supply voltage from rated motor voltage $\pm 10\%$
 - f) Variation in supply frequency from rated frequency $\pm 5\%$
 - g) Combined voltage and frequency variation $\pm 10\%$
- h) Motors shall be capable of starting and accelerating the load with the applicable method of starting, without exceeding acceptable winding temperature, when the supply voltage is in the range of 85% of the rated voltage. Starting current of motor shall not exceed 200% of rated full load current.
- i) Motors shall be capable of satisfactory operation at full load at a supply voltage of 80% of the rated voltage for 5 minutes, commencing from hot condition.
- j) Motors shall be capable of developing the rated full load torque even when the supply voltage drops to 70% of the rated voltage. Such operation is envisaged for a period of 1 second. The pull out torque of the motor, to meet this requirement, shall be at least 205% of full load torque.
- k) The locked rotor current of the motors shall not exceed (inclusive of 20% tolerance) 600% of full load current for motors.
- l) Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under the specified supply conditions.
- m) The locked rotor withstand time under hot conditions at 110% rated voltage shall be more than the starting time at 80% voltage by at least two seconds or 15% of the accelerating time whichever is greater.
- n) Motors when started with the drive imposing its full starting torque under the supply voltage variations specified shall be capable of withstanding at least two successive starts from cold condition and one start from hot

condition without injurious heating of windings. The motors shall also be suitable for four equally spread starts per hour under the above referred supply conditions.

3.14.31 Insulation

Any joints in the motor insulation such as at coil connections or between slot and winding sections, shall have strength equivalent to that of slot sections of the coil. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The motors shall be provided with Class F insulation with temperature rise limited to that of Class B insulation

3.14.32 Temperature rise

The temperature rises shall not exceed the values given in IS 12802. Under extremes of supply condition, the temperature rise shall not exceed the value indicated in IS by 10°C.

3.14.33 Constructional features

The motor construction shall be suitable for easy disassembly and re-assembly. The enclosure shall be sturdy and shall permit easy removal of any part of the motor for inspection and repair. Motors weighing more than 25 kg shall be provided with eyebolts, lugs or other means to facilitate safe lifting. The rotor bars shall not be insulated in the slot portion between the iron core laminations for squirrel cage motors.

3.14.34 Bearings

Unless otherwise specified motor bearings shall not be subjected to any external thrust load. Unless otherwise specified, motor bearings shall have an estimated life of at least 40,000 hrs. The bearings shall permit running of the motor in either direction of rotation. It shall be possible to lubricate the bearings without dismantling any part of the motor.

3.14.35 Terminal box

- a) Terminal boxes shall be of weather proof construction designed for outdoor service, to eliminate entry of dust and water, gaskets of neoprene or approved equivalent shall be provided at cover joints and between box and motor frame. The cable terminal box shall be right hand side looking from coupling end.
- b) The terminal box shall be capable of being turned through 360 deg instead of 90 deg. The terminals shall be of the stud type with necessary plain washers, spring washers and check-nuts. Ample phase to phase and phase

to ground clearances shall be kept. Suitable cable glands and cable lugs shall be supplied along with the motor. Separate terminal boxes shall be provided for stator leads and space heater.

3.14.36 Paint and finish

All motor parts exposed directly to atmosphere shall be finished and painted to produce a neat and durable surface which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, all rust, sharp edges and scale removed and treated with one coat of primer and finished with two coats of grey enamel paint.

3.14.37 Heating during idle periods

Motors rated above 30 kW shall have space heaters suitable for 240V, single phase, 50 Hz, AC supply. Space heaters shall have adequate capacity to maintain motor internal temperature above dew point to prevent moisture condensation during idle period. The space heaters shall be placed in easily accessible positions in the lowest part of the motor frame.

3.14.38 Accessories

Motors shall have drain plugs so located that they will drain water, resulting from condensation or other cases from all pockets in the motor casing. The earthing pads shall be of non-corrodible metal welded or brazed at two locations on opposite sides.

3.14.39 Tests

- a) Motor shall be subjected to all the routine tests as per applicable standard in the presence of the EMPLOYER'S representative. Copies of test certificates of type and routine tests shall be furnished as specified in the distribution schedule, for the EMPLOYER'S approval. The VENDOR shall ensure to use calibrated test equipment/instruments having valid calibration test certificates from standard laboratories traceable to national/international standards
- b) If type tests have not been carried out on similar Motors, or if the type test reports submitted are not found in order, then VENDOR shall carry out these tests without any extra cost to the Employer.

This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at manufacturer's works and delivery at site of Horizontal Centrifugal Pumps.

3.14.40 CODES AND STANDARDS

The design, materials, construction, manufacture, inspection, testing and performance of horizontal centrifugal pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to latest applicable Indian or equivalent standards. Other international standards are also acceptable, if these are established to be equal or superior to the listed standards. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

3.14.41 DESIGN REQUIREMENTS

- a) Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division. Components of identical pumps shall be inter-changeable.
- b) Flow rate versus head curve shall have stable and continuously rising characteristics towards the shut-off head. In case of unstable (drooping) characteristics the duty point shall be well away from the unstable region. Besides the actual flow rate versus head curve, curves for minimum and maximum impeller diameters shall also be shown.
- c) The shut-off head shall be at least 110% of the differential head.
- d) The required NPSH at duty point shall be at least one (1) metre less than the available NPSH.
- e) The rating of the pump driver shall be the larger of the following:
- f) The maximum power required by the pump from zero discharge to run-out discharge at site climatic conditions.
- g) 110% of the power required at the duty point at site climatic conditions.
- h) The corrosion allowance for pressure parts shall be 3 mm
- i) Pumps shall run smooth without undue noise and vibration. Noise level produced individually or collectively shall not exceed 85 dB (A) measured at a distance of 1.86 metres from the source in any direction. The overall vibration level shall be as per zones A and B of ISO 10816-1.

3.14.42 CONSTRUCTION FEATURES

- a) In addition to static balancing, impeller and balancing drum shall be balanced dynamically at or near the operating speed.
- b)
- c) Pump shall be provided with renewable type casing ring. Pump having capacity 1,000 M³/Hr and above shall be provided with impeller ring in addition to casing ring. The hardness of impeller ring shall be 50 BHN higher than that of casing ring.
- d) Pump casing shall be provided with drain and vent connection with plugged or valve connection.
- e) Bearing shall be oil-lubricated or grease-lubricated and shall have a life of 40,000 hours of working. In case of oil-lubricated bearing, constant oil leveller with magnetic drain plug shall be provided.

- f) Replaceable shaft sleeves shall be provided to protect the shaft where it passes through stuffing box.
- g) Stuffing box shall be of such design that it can be repacked without removing any part other than the gland and lantern ring.
- h) Mechanical seals shall be provided if called for in data sheet - A. If required, a flushing line shall be furnished, complete with strainer and orifice, from the pump discharge to the sealing face. When pumping liquid is not suitable for this purpose, a flushing connection shall be provided so that it can be connected to an external source.
- i) All pumps, except for back-pull out type, shall be provided with flexible coupling. Back-pull out type pumps shall be provided with spacer type coupling.
- j) Coupling guard made of expanded metal and bolted to the base plate shall be furnished for all coupled pumps.
- k)
- l) In addition to accessories listed in data sheet A, any other accessories required for safe and efficient operation of pump shall be provided.
- m) All incidental piping and valves required for sealing, lubrication and cooling for stuffing box packing and/or bearing of pump shall be furnished by the VENDOR.
- n)
- o) Leakage from the pump shall be led to the nearest surface drain by OTHERS. Pump vendor shall provide necessary arrangement like drip tray, base plate drain connection etc.

3.14.43 TESTS AND INSPECTION

- a) Hydro test pressure on casing shall be 1.5 times maximum discharge head or twice differential head whichever is higher. (Maximum discharge head = shut-off head + maximum suction head). Unless otherwise stated in data sheet A, the hydrostatic tests on the casing shall be conducted for a minimum duration of 30 minutes.
- b) The pumps shall be tested as per IS 5120, at rated speed at MANUFACTURER's works to measure capacity, total head, efficiency and power. The negative tolerance on efficiency shall be limited to 2.5% and not 5% as indicated in IS 5120. These tests shall form the basis for acceptance of pumps except for vibration and noise. The pumps shall be tested over the range covering from shut-off head to the maximum flow. The duration of the test shall be minimum one (1) hour. Minimum five (5) readings approximately equidistant shall be taken for plotting the performance curves.
- c) After installation, the pumps shall be subjected to testing at site also. If the site performance is found not to meet the requirements regarding vibration and noise as specified, the equipment shall be rectified or replaced by the VENDOR, at no extra cost to the EMPLOYER.

3.14.44 PERFORMANCE GUARANTEE

Performance parameters to be guaranteed by the VENDOR and tolerances permitted shall be as indicated. BIDDER shall confirm acceptance of these by indicating values in data sheet B. Pump or any portion thereof is liable for rejection, if it fails to give any of the guaranteed performance parameters.

3.15 SUBMERSIBLE PUMPS FOR WASTE WATER

3.15.1 SCOPE

This specification covers the general design, materials, manufacture, shop inspection and testing at manufacturer's works, delivery at site, handling at site, installation, testing, commissioning and carrying out performance test of submersible pumps for waste water with their accessories.

3.15.2 CODES AND STANDARDS

The design, materials, manufacture, inspection, testing and performance of the submersible (waste water) pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality where equipment is to be installed. The equipment shall also conform to the latest editions of the relevant codes and standards existing as on the date 180 days prior to the deadline for submission of bids, unless otherwise specified. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

3.15.3 DESIGN REQUIREMENTS

- a) Pump shall be submersible, non-clog, wet & dry pit installation, fixed or portable type and shall be suitable for working with the minimum liquid level. The Pump shall be designed to handle solid sizes Fixed type pump set shall be with control panel with all safety devices. The pump shall be capable of delivering the required flow rate for both continuous and intermittent operations, at the specified operating conditions. The pump shall be designed to have minimum maintenance and easy accessibility to all components. Flow rate versus head curve shall have stable and continuously rising characteristics towards the shut-off with the highest at shut off. In case of unstable (dropping) characteristics the duty point shall be well away from the unstable region. Besides the actual flow rate versus head curve, curves for minimum and maximum impeller diameters shall also be shown.
- b)
- c) Pumps of a particular category shall be identical and shall be suitable for single as well as parallel operation with equal load division at any point in between the maximum and minimum system resistance. Components of identical pumps shall be inter-changeable.
- d) Pumps shall run smooth without undue noise and vibration. Noise level produced individually or collectively shall not exceed 85 dB (A) measured at a distance of 1.0 metres from the source in any direction. The overall vibration level shall be as per zones A and B of ISO 10816-1.

- e) The power rating of the pump driver shall be the larger of the following considering the frequency variation indicated in Data Sheet -A:
- f) The maximum power required from zero discharge to run-out discharge at site climatic condition.
- g) 110% of the power required at any operating point in between the maximum and minimum system resistance curves for any combinations of pumping.
- h) 115% of the power required at the design point.
- i) The critical speed of the pump shall be not less than 130% of the normal operating speed of the pump. The pump set shall be capable of withstanding the accidental rotation in reverse direction. The direction of rotation shall be clockwise viewed from the drive end.

3.15.4 CONSTRUCTION FEATURES

- a) Pump casing shall be of robust construction. Liquid passages shall be finished smooth and designed as to allow free passage of solids and stringy materials.
- b)
- c) Impeller shall be non-clog, vortex or vane type with smooth blunt inlet edge and large waterways so as to allow free passage of the large size solids. It shall be free from sharp corners and projections likely to catch and hold rags and stringy materials. The impeller shall be statically and dynamically balanced. Pumps up to 1000 M3/Hr shall have maximum 2 vanes; pumps having capacity 1000 M3/Hr and above shall have maximum 3 vanes.
- d) Double Mechanical seals shall be provided to protect the motor from ingress of waste water along the shaft. The preliminary and secondary seals shall be oil- lubricated with tungsten carbide or silicon-carbide faces and they should be equipped with an electrical monitoring system for seal failure detection.
- e) Motor and Pump shall have a common shaft with bearings. The bearing shall be permanently greased and maintenance free.
- f) Portable type submersible pump should be equipped with pump base stand / legs, adequate length of chain and flexible type discharge hose pipe suitable for directly lowering into the well.
- g) Fixed type submersible pump shall be provided with a 90° duck foot bend for fixing to the concrete floor of the well. The joint between the pump discharge flange and the delivery piping shall be made by merely lowering the pump into guide system at the access level. It shall be provided with all necessary fixings for guiding the pumps during lifting/lowering.
- h) Replaceable shaft sleeves shall be securely locked or keyed to the shaft to prevent loosening. The surface hardness of the shaft sleeve shall be minimum.
- i) In addition to accessories listed in data sheet A, any other accessories required for safe and efficient operation of pump shall be provided.

3.15.5 INDUCTION MOTOR FOR SUBMERSIBLE PUMPS

3.15.6 The submersible motor shall confirm to IS: 9283:2013.

3.15.7 PERFORMANCE AND CHARACTERISTICS

- a) Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under varying voltage and frequency supply conditions as called for in Data Sheet - A.
- b) Motors shall be suitable for full voltage direct-on-line starting or star-delta starting.
- c) The starting current of motor shall not exceed 200% of rated full load current for star/delta starting and 600% of rated full load current for DOL starting, under any circumstances.
- d) Motors shall be capable of starting and accelerating the load with the applicable method of starting, without exceeding acceptable winding temperatures, when the supply voltage is in the range 85% of the rated motor voltage to maximum permissible voltage, for category B type motors.
- e) The locked rotor current of the motor shall not exceed 600% of full load current (subject to tolerance as per the applicable standard).
- f) Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation.
- g) The motor vibrations shall be within the limits specified in applicable standard unless otherwise specified for the driven equipment.
- h) Except as mentioned herein, the guaranteed performances of the motor shall be met with tolerances specified in applicable standard (IS: 9283:2013).
- i) Protection against increase in stator winding temperature, bearing temperature, leakage in stator housing and terminal box shall be provided. Minimum 3 nos. thermostats in series to be provided to sense the stator winding temperature. Sensors to be provided to detect leakage of waste water into oil housing.

3.15.8 SUBMERSIBLE CABLE

- a) The cable shall be PVC insulated and PVC sheathed, flexible, 3 core flat type. The size of the conductor shall be adequate for continuous use under water and air.
- b) In case a joint is required to be made between the lead cable supplied with the motor and the user's cable connectors, a detailed procedure of cable jointing to make a watertight joint shall be provided by the manufacturer.
- c) The size of the conductor and length of cable should be suitably selected so that the voltage drop at motor terminals does not exceed 3 percent of the rated voltage.

3.15.9 EARTHING

- a) Earthing of the motor shall be done in accordance with the relevant provisions of IS: 3043:1987.

- b) For fixed installation, earthing connection may be made to discharge pipe clamp.

3.15.10 INSULATION

Any joints in the motor insulation such as at coil connections or between slot and end winding sections shall have strength equivalent to that of the slot sections of the coil.

The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The tropical sing treatment shall be as per the applicable standard.

3.15.11 TEMPERATURE RISE

The temperature-rise test of the motor shall be taken with the motor coupled to the suitable pump to give the full load output of the motor. When the various temperatures are stabilized, the set is stopped and the temperature-rise of the stator winding by the resistance method shall not exceed 35°C at rated voltage and 45°C at 85% of the rated voltage. During the test, the temperature of the cooling water may not exceed 45°C. As the cable resistance will also be substantial, it is necessary that while calculating the temperature rise by resistance method, due care is taken to account for the correct hot and cold resistance of windings.

3.15.12 CONSTRUCTION FEATURES OF MOTOR

The motor shall be suitable for continuous use in fully or partially submerged condition. A built-in cooling system if required shall be provided to allow the motor to operate continuously at its rated output regardless of whether the electric motor is submerged or not by providing either external or internal cooling arrangement.

3.15.13 TESTS AND INSPECTION

- a) Hydro-test pressure on casing shall be 1.5 times maximum discharge head or twice differential head whichever is higher. Maximum discharge head is defined as the sum of the shut-off head and maximum suction head. Unless otherwise stated in data sheet A, the hydrostatic tests on the casing shall be conducted for a minimum duration of 30 minutes.
- b) The pumps shall be tested in accordance with HIS, ISO 9906 and IS 5120, at rated speed at MANUFACTURER's works to measure capacity, total head, efficiency and power. The negative tolerance on efficiency shall be limited to 2.5% and not 5% as indicated in IS 5120. These tests shall form the basis for acceptance of pumps except for vibration and noise. The pumps shall be tested over the range covering from shut-off head to the maximum flow. The duration of the test shall be minimum one (1) hour. Minimum five (5) readings approximately equidistant shall be taken for plotting the performance curves.
- c) After installation, the pumps shall be subjected to testing at site also. If the site performance is found not to meet the requirements regarding vibration and noise as specified. The equipment shall be

rectified or replaced by the VENDOR, at no extra cost to the EMPLOYER.

3.15.14 PERFORMANCE GUARANTEE

Performance parameters to be guaranteed by the VENDOR and tolerances permitted shall be as indicated. BIDDER shall confirm acceptance of these by indicating values in data sheet B. Pump or any portion thereof is liable for rejection, if it fails to give any of the guaranteed performance parameters.

3.15.15 DRAWINGS

The following drawings shall be submitted by the BIDDER along with their proposal. Preliminary outline dimensional drawing showing details of pump set, installation details, civil foundation, clearances, minimum submergence, etc. Performance curves for capacity vs total head, efficiency, and input to motor. The capacity range shall be zero flow to run out flow. Typical cross sectional drawing showing constructional details.

3.15.16 BID EVALUATION

For every kW of differential power input to the motor at duty point, pump sets will be cost loaded at the rate specified in data sheet A.

3.15.17 Submersible

These shall be fully submersible with a fully submersible motor. The pumps shall be provided with an automatic level controller and all interconnecting power and control cabling which shall cause the pumps to operate when the water level in the sump rises to a preset level and stop when the preset low level is reached.

Pumps for drainage shall be single stage, single entry.

Pump shall be C.I. casing and C.I. two vane open type with a dynamically balanced impeller connected to a common shaft of the motor. The vane for sewage pump will be open type, while for drainage pump, etc. it will be of semi open type. The MOC of the sump shall be in accordance to schedule of quantity.

Stuffing box shall be provided with mechanical seals.

Each pump shall be provided with a suitably rated induction motor suitable for 415 volts, 3 phase, 50 Hz A.C. power supply.

Each pump shall be provided with in built liquid level controller for operating the pump between predetermined levels.

The pumping set shall be for stationary application and shall be provided with pump connector unit. The delivery pipe shall be joined to the pump through a rubber diaphragm, and bend and guide pipe for easy installation.

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

Sump pump shall be complete with level controllers, power and control switch gear, Auto/off/Manual switches, pumps priority selections and control and power cabling upto motor and controller/probes etc. (Including earthing). Level control shall be such that one pump starts on required level, 2nd pump cuts in at high level and alarms is given at extra high level. All level controllers shall be provided with remote level indications

3.15.18 Motor Design

The pump motor shall be a squirrel cage induction, housed in air filled water-tight enclosure. Oil filled motors are not acceptable. The stator windings shall be Class "F" insulation (155 degree C or 311 degree F) for general usage and class 'H' insulation (180 degree C or 317-8 grade 2) for submersible type.

The stator shall be heat shrunk fitted into the enclosure and shall not use bolts, pins or other fasteners that penetrate through the stator enclosure. The starter shall be equipped with a thermal switch embedded in series in the coils of the stator windings to protect the stator from wheel. The motors shall be designed for continuous running duty type at 415 volts, 3 phase, 50 Hz power supply and capable of sustaining a minimum of 20 starts/stops per hour. Between stator housing and pump, a tandem seal arrangement will be provided with an oil barrier. Both seals run in oil, allowing dry running without seal damage. Both seals shall be of the rubber bellows or metallic bellow type with positive drive between shaft and rotating seal face.

3.16 PLUMBING SYSTEM-ELECTRICAL REQUIREMENTS

3.16.1 SCOPE OF WORK

- a) Power and Control cabling from MCC to Plumbing pumps panel including cable carrier system.
- b) Local Push button station
- c) Earthing system above ground
- d) Structural steel for supporting the panels, LPBS, Cable trays etc.

3.16.2 ELECTRICAL PANELS

- a) The Contractor's scope includes 1 No. MCC for Plumbing System.
- b) 415 Volts, 50 Hz, TPN supply at the incomer of MCC will be made available by the Employer. Further distribution of power and derivation of any other voltage shall be in Contractor's scope.
- c) MCC incomer shall be suitable for termination of 1RX3.5CX120 sqmm, AL, XLPE The Contractor's scope includes 1 No. MCC for Plumbing System.
- d) All potential free contacts (Feedback & command from PLC) shall be wired upto Marshalling compartment of MCC.

3.16.3 LOCAL PUSH BUTTON STATIONS (LPBS)

- a) LPBS for motors shall be provided by contractor. Necessary supporting structural steel for the same is in Contractor's scope.
- b) LPBS shall be metal enclosed, weather proof, dust and vermin-proof, suitable for mounting on wall or structures. The enclosure shall be sheet steel, 2 mm thickness and shall have degree of protection not less than

IP55. The enclosure shall be painted with one coat of epoxy primer and two coats of Epoxy Light Gray paint – 631 shade as per IS-5.

- c) LPBS for shall be provided with 1no. recessed type start push button and 1No. Palm push, mushroom head type stop push button.
- d) All push buttons shall be fitted with two (2) NO and two (2) NC contacts, rated for 10 A at 240V AC.
- e) LPBS shall be suitable for bottom cable entry with stopping plugs.
- f) Internal wiring shall be done with copper conductor HFFR wires shall be neatly done.
- g) All spare contacts shall be wired upto terminal block.
- h) Distance between cable gland plate and terminal block shall be minimum 75mm for ease of termination.
- i) Two (2) Nos. earthing terminals shall be provided for external earthing. Earthing continuity bonds shall be provided

3.16.4 CABLING SYSTEM

- a) For MCC, Power supply will be made available at incomer with the help of 1.1 kV, XLPE Power Cables by others. Further Power and control cabling from MCC to motors shall be in the in scope of Contractor. Incoming Cable sizes will be indicated to successful bidder during execution based on total load of each plant.
- b) FPS MCC shall be installed in Pump House.
- c) MCC shall be provided with Top Cable entry. Anchor Fasteners, Bolts and other necessary supporting structure required for Panel installation shall be provided by bidder.
- d) Contractor shall furnish Cabling layout & Cable Schedule for each Area.
- e) For overhead cable trays, foundation (if required) for cable tray supporting structure will also be provided by Bidder.
- f) LV Power Cables shall be 1.1 kV grade stranded copper conductor (up to 6 sq. mm) and stranded aluminium conductor (above 6 sq. mm) multi core, XLPE insulated, extruded PVC inner sheathed, GI wire / strip armoured, and extruded FRLS PVC outer sheathed, as per IS:7098 (Part-1).
- g) Control Cables shall be 1.1 kV grade stranded copper conductor (of minimum 2.5sq.mm.), XLPE insulated, extruded PVC inner sheathed, GI wire / strip armoured, extruded FRLS PVC outer sheathed as per IS:7098 (Part-1).
- h) Minimum 1 core shall be kept spare in control cable.
- i) Cable trays shall be Hot dipped Galvanised Iron (85 micron galvanising) with accessories such as coupling plates (with minimum 8 nos. holes), bends, tees, reducers, coupling nut-bolts etc. of following width. All the hardwares used for cable tray jointing, cable supporting & clamping shall be of SS304 material.
- j) Nylon ties shall not be used for clamping cables, GI strip with SS304 hardware shall be used.

- k) While sizing of Cables, Bidder shall consider voltage drop of 1.0% (max.) from MCC to Motor.
- l) Cable sizes indicated in data sheets of low voltage induction motor are for General Guidelines only. Contractor shall provide cable sizing calculation based on design criteria mentioned above.

3.16.5 EARTHING SYSTEM

- a) Earthing below ground shall be by others. Earthing above ground i.e. equipment earthing upto earthing bus shall be in the scope of Bidder.
- b) Earthing shall be of GI.
- c) Earthing connection at equipment shall be of bolted type.
- d) 1 Run of 50x10mm GI Strip shall be provided by contractor along Cable Tray and shall be connected at suitable point to Earth Grid.
- e) Bidder shall furnish the Earthing layout along with calculations (below as well as above ground).
- f) LV MOTORS
- g) Motors shall be suitable for 415 V, 3 phase, 50 Hz supply, squirrel cage type.
- h) Motors shall be squirrel cage type, energy efficient (IE-3 class as per IS-12615, 2011) squirrel cage induction motors having TEFC, IP-55 enclosure (including terminal boxes and bearing housing) with Class-F insulation (and temperature rise limited to Class B) conforming to IS 325.
- i) Motors shall be energy efficient (IE-3) type.
- j) Motors will be with Direct On Line starter (DOL).
- k) Bidder shall follow below mentioned values of Efficiency as per ECBC.

Motor Size (kW)	Efficiency (%)	
	2 Pole	4 Pole
1.1 (1.5 hp)	82.2	83.8
1.5 (2 hp)	84.1	85
2.2 (3 hp)	85.6	86.4
3.0 (4 hp)	86.7	87.4
4.0 (5.5 hp)	87.6	88.3
5.5 (7.5 hp)	88.5	89.2
7.5 (10 hp)	89.5	90.1
11.0 (15 hp)	90.6	91
15.0 (20 hp)	91.3	91.8
18.5 (25 hp)	91.8	92.2
22.0 (30 hp)	92.2	92.6
30.0 (40 hp)	92.9	93.2
37.0 (50 hp)	93.3	93.6
45.0 (60 hp)	93.7	93.9
55.0 (75 hp)	94	94.2

75.0 (100 hp)	94.6	94.7
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3.16.6 TERMINAL POINTS (BATTERY LIMIT)

- a) 415 Volts, 50 Hz, TPN supply at the incomer of MCC shall be made available by the Employer. Further distribution of power and derivation of any other voltage shall be in Contractor's scope.
- b) Termination of incomer and outgoing cables is in scope of contractor.
- c) Earthing above ground shall be considered in contractor's scope as per clause no.2.5

3.16.7 PREFERRED MAKE

- a) L V Switchgear – L&T
- b) L V Switchgear – L&T/ Schneider/ ABB
- c) Distribution Boards – L&T/ Legrand/ ABB
- d) Moulded Case Circuit Breaker - L&T/ Schneider/ ABB
- e) Motor Protection Circuit Breaker – L&T/ Schneider/ ABB
- f) Contactors – L&T/ Legrand/ Schneider
- g) Current Transformer - Kappa/ Silkans / Pragati / Indcoil / Precise
- h) Ammeter and Voltmeter - AE/Rishabh / Conserve
- i) Push buttons - Siemens/Teknic/Vaishno/BCH
- j) LED Indicating lamps - Teknic / Mathura / Siemens / Binay
- k) MCB – L&T/ Schneider/ ABB
- l) Control fuses – SIEMENS / GE
- m) Terminal Block – Connectwell / Elmex / Wago
- n) Switch-socket – Anchor / Reputed
- o) Space Heater – Girish / reputed
- p) L T Motor –Siemens
- q) L T Cable – KEI/ CCI/ Finolex
- r) HFFR wires (including panel wiring) – Finolex/ LAPP/ RR KABEL
- s) Local Push button station (LPBS) – L&T/ Teknic/ Schneider/ Mathura
- t) Cable Trays – Indiana/ Patny/ Profab/ OBO

3.16.8 Any other make subjected to prior approval of Employer / Project Manager

3.17 COMMISSIONING & GUARANTEE

3.17.1 SCOPE OF WORK

- a) Work under this section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section.
- b) Contractor shall provide all tools, equipment, metering and testing devices required for the purpose.

- c) On award of work, Contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.
- d) All tests shall be made in the presence of the Architect or his representative or any inspecting authority. At least five working days notice in writing shall be given to the inspecting parties before performing any test.
- e) Water flow rates of all equipment and in pipe lines through valves shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.
- f) Contractor shall ensure proper balancing of the hydraulic system and for the pipes / valves installed in his scope of work by regulating the flow rates in the pipe line by valve operation. The contractor shall also provide permanent Tee connection (with plug) in water supply lines for ease of installing pressure gauge, temperature gauge & rota meters. Contractor shall also supply all required pressure gauge, temperature gauge for system commissioning and balancing. The balancing shall be to the satisfaction of Project Manager / Project Manager.

3.17.2 PRECOMMISSIONING

- a) On completion of the installation of all pumps, piping, valves, pipe connections, insulation etc. the Contractor shall proceed as follows:
- b) Prior to start-up and hydraulic testing, the Contractor shall clean the entire installation including all fitments and pipe work and the like after installation and keep them in a new condition. All pumping systems shall be flushed and drained at least once through to get rid of contaminating materials. All pipes shall be rodded to ensure clearance of debris, cleaning and flushing shall be carried out in sections as the installation becomes completed.
- c) All strainers shall be inspected and cleaned out or replaced.
- d) When the entire systems are reasonably clean, a pre-treatment chemical shall be introduced and circulated for at least 8 hours. Warning signs shall be provided at all outlets during pre-treatment. The pre-treatment chemical shall:
 - e) Remove oil, grease and foreign residue from the pipe work and fittings;
 - f) Pre-condition the metal surfaces to resist reaction with water or air.
 - g) Establish an initial protective film;
 - h) After pre-treatment, the system shall be drained and refilled with fresh water and left until the system is put into operation.
- i) Details and procedures of the pre-treatment shall be submitted to the Architect for approval.
- j) Check all clamps, supports and hangers provided for the pipes.
- k) Check all the equipment, piping and valves coming under hot water system and operate each and every valve on the system to see if the valves

are functioning properly. Thereafter conduct & hydro test of the system as for (b) above.

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

3.17.3 STATUTORY AUTHORITIES' TESTS AND INSPECTIONS

- a) As and when notified in writing or instructed by the Architect, the Contractor shall submit shop drawing and attend all tests and inspections carried out by Local Fire Authorities, Water Authority and other Statutory Authorities, and shall forthwith execute free of charge any rectification work ordered by the Architect as a result of such tests and inspections where these indicate non-compliance with Statutory Regulations. Some of these tests may take place after the issue of Practical Completion of the Main Contract and the Contractor shall make all allowances in this respect.
- b) The Contractor shall be responsible for the submission of all necessary forms and shop drawings to the Statutory Authorities which shall conform in layout to the latest architectural plans submitted to and kept by these Authorities.
- c) The submission shall comply with the requirements set forth in the current Codes of Practice and circular letters of the Statutory Authorities. The shop drawings to be submitted shall be forwarded to the Architect for checking before submission.
- d) The Contractor shall allow for at least two submissions of complete sets of shop drawings to the Authorities, one to be made within six months after the award of the Contract but not less than six weeks before the inspection. The Architect may at his discretion instruct the Contractor for additional submissions to the Local Authorities whenever necessary.
- e) The Contractor shall notify the Architect at least seven days in advance of his application for local Authority tests and inspections. On receipt of a confirmed date for test and inspection the Contractor shall inform the Architect without delay.

3.17.4 FINAL ACCEPTANCE TESTS

- a) Following commissioning and inspection of the entire installation, and prior to issue of the Completion Certificate, the Contractor shall carry out final acceptance tests in accordance with a programme to be agreed with the Architect.
- b) Should the results of the acceptance tests show that plant, systems and/or equipment fail to perform to the efficiencies or other performance figures as given in this Specification, the Contractor shall adjust, modify and if necessary replace the equipment without further payment in order that the required performance is obtained.

- c) Where acceptance tests are required by the relevant Authorities having jurisdiction, these tests shall be carried out by the Contractor prior to the issue of Completion Certificate to the acceptance of the Authorities.

3.17.5 REJECTION OF INSTALLATION / PLANT

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

3.17.6 WARRANTY AND HANDOVER

The Contractor shall warrant that all plant, materials and equipment supplied and all workmanship performed by him to be free from defects of whatsoever nature before handover to the Employer.

3.17.7 HANDING OVER OF DOCUMENTS

All testing and commissioning shall be done by the Contractor to the entire satisfaction of the Employer's site representative and all testing and commissioning documents shall be handed over to the Employer's site representative. The Contractor shall also hand over all maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the Employer's site representative.

3.17.8 CHECKLIST FOR COMMISSIONING.

3.17.9 Water Supply& Drainage Equipment

- a) Operate each and every valve on the system to see if the valves are functioning properly.
- b) Check all clamps, support and hangers provided for the pipes.
- c) Check rotation of each motor and correct the same if required.
- d) All the pumps shall run continuously for one hour. Record the pressure and motor current and voltage readings.
- e) Check all annunciations by simulating the alarm conditions if any at site.
- f) Remove grease trap manhole covers. Check for cleanliness, check for partitions, and put back the cover.

- g) Remove manhole covers on sewer lines, inspect for cleanliness. After they are found to be clean, pour water into the first manhole and see that all the lines are clear. Make sure that all the covers are put back after the inspection.
- h) Check gully traps by opening of covers and check that water seal in the traps are maintained. Check for general cleanliness.
- i) Check installation of proper vents and cowls at the roof level for all soil and waste pipes.
- j) Performance test to be carried out and recorded in the following table for the pumps.

Sr.No.	Pump Tag No.	Model No.	Design Flow LPS	Actual Flow LPS	ΔP kg/cm ²	Full load Amps	Remarks
1)	Domestic Water Pump No. 1						
2)	Domestic Water Pump No. 2						
3)	Flushing Water Pump No. 1						
4)	Flushing Water Pump No. 2						

- k) (Similar Readings shall be taken for all other pumps)
- l) Simulate low level in the domestic water tanks to trip domestic Filter Feed Pumps. Simulate high level in treated water tanks to trip softener feed pumps. Simulate low level in treated water tanks to trip treated water hydro-pneumatic pumps.
- m) Submersible Sump Pumps
- n) Fill the sump with water, while observing the level.
- o) Keep the pump starter switch on 'OFF' position to check for start of pump.
- p) By keeping the starter switch on 'Auto' position, both the pumps should start. As the water level starts receding, one pump should switch off by itself. The second pump should switch off on further reduction in water level.
- q) Fill the sump with a little water and check both the pumps in 'Manual' position momentarily.
- r) Leave the switches in 'Auto' position for both the pumps.

3.18 DATA SHEETS

3.18.1 BUTTERFLY VALVES

SL. NO.	DATA SHEET A BUTTERFLY VALVES ITEM	UNIT	Blank Spaces to be filled by vendor		
1.0	GENERAL				
1.1.	SERVICE				
1.2.	TAG NOs.				
1.3.	NO. OF VALVES	No.	As per BOQ		
1.4.	DESIGN STANDARD				
1.5.	VALVE CATEGORY				
1.6.	DISC				
1.7.	BODY TYPE		Cast Iron		
1.8.	VALVE SIZE	NB	65 mm to 150 mm		
1.9.	VALVE RATING / CLASS		PN 10		
1.10.	FLUID HANDLED WITH ITS SPEC. GRAVITY				
1.11.	COMPANION FLANGE TYPE AND CLASS		ANSI B16.5 Class 150		
1.12.	TYPE OF VALVE OPERATOR		•		
1.13.	MAXIMUM FLOW (INDICATE THE RELATED PRESSURE ALSO)	M ³ /hr, KPa	MAX.	MIN.	OPE
1.14.	MAXIMUM FLOW VELOCITY	m/s			
1.15.	DESIGN PRESSURE	KPa			
1.16.	OPERATING PRESSURE	KPa			
1.17.	DESIGN TEMPERATURE	°C			
1.18.	OPERATING TEMPERATURE	°C			
1.19.	VALVE LOCATION				

SL. NO.	DATA SHEET A BUTTERFLY VALVES ITEM	UNIT	Blank Spaces to be filled by vendor
4.0	MATERIALS OF CONSTRUCTION		
4.1	• BODY		CAST IRON
3.2.	• DISC		CAST IRON
3.3.	STEM		STAINLESS STEEL
3.4.	SEAT		EPDM
3.5.	BODY SEAT RINGS		
3.6.	DISC SEAL RINGS		
3.7.	SEAT RETAINING RINGS		
3.8.	COMPANION FLANGE		
5.0	TESTS AND INSPECTION		
4.1.	HYDROSTATIC TEST PRESSURE FOR BODY	Kg/cm ²	15 BAR
4.2.	HYDROSTATIC TEST PRESSURE FOR DISC	Kg/cm ²	15 BAR
4.3.	DISC STRENGTH TEST PRESSURE	Kg/cm ²	
4.4.	ACTUATOR PERFORMANCE TEST PRESSURE	Kg/cm ²	
4.5.	AIR LEAK TEST PRESSURE	Kg/cm ²	
4.6.	ELECTRICAL CONTINUITY TEST		
4.7.	SPARES		
6.0	DISC SEAL RINGS		
5.1.	FLANGE GASKET		
5.2.	SEAT/SEAL CLAMPING BOLTS		
5.3.	'O' RING SEALS OR GLAND		

SL. NO.	DATA SHEET A BUTTERFLY VALVES ITEM	UNIT	Blank Spaces to be filled by vendor
	PACKING		
5.4.	• (REF. NOTE -10)		

NOTES :-

1. FOR GENERAL REQUIREMENTS. HOWEVER, IN CASE OF OVERLAPPING REQUIREMENTS, THOSE OF THE DATA SHEET A, TO BE CONSIDERED AS THE FINAL ONE.
2. THE VALVE SHALL BE DESIGNED CONSIDERING THE LARGER OF THE FOLLOWING TORQUE REQUIREMENTS FOR WHICH CALCULATIONS SHALL BE SUBMITTED:
 - a) CALCULATED AS PER AWWA-C504-80
 - b) CALCULATED AS PER THE STANDARD TO WHICH VALVE IS DESIGNED.
3. FOR MANUALLY OPERATED VALVES, TORQUE REQUIRED AT HAND WHEEL SHALL NOT EXCEED 7 KG.M.
4. MOTOR OPERATED VALVE ACTUATOR SHALL BE RATED TO PROVIDE AN OUTPUT TORQUE OF ATLEAST 150% OF TORQUE REQUIRED AS PER NOTE-2 ABOVE UNLESS OTHERWISE NOTED.
5. THE ACTUATOR SHALL BE CAPABLE OF OPERATING IN ANY MOUNTING ANGLE.
6. THE TRANSMISSION UNIT SHALL BE DESIGNED TO TRANSMIT TWICE THE VALVE DESIGN TORQUE UNLESS OTHERWISE NOTED.
7. THE ACTUATOR SHALL PROVIDE AN UNSEATING TORQUE OF AT LEAST 50% IN EXCESS OF VALVE SEATING TORQUE AT THE SPECIFIED VOLTAGE UNLESS OTHERWISE NOTED.
8. SEGMENTAL WELDED CARBON STEEL FLANGE PLATES ABOVE 20 MM THICKNESS SHALL BE SUBJECTED TO PREHEATING BEFORE WELDING AND STRESS RELIEVING AFTER WELDING AS PER IS 2825 UNLESS OTHERWISE SPECIFIED.
9. UNLESS OTHERWISE SPECIFIED IN BOQ , ONE COAT OF ZINC RICH PRIMER AND TWO COATS OF ENAMEL SHALL BE APPLIED TO ALL STEEL AND CAST IRON EXPOSED SURFACES. THE MINIMUM THICKNESS OF COATING SHALL BE 100 MICRONS.
10. THE VENDOR MAY ALSO SUGGEST ANY ADDITIONAL SPARES AND TOOLS REQUIRED FOR THE SUCCESSFUL OPERATION, START UP AND MAINTAINENCE OF THE VALVE.
11. IN THE ABSENCE OF ANY TEST RELATED DATA, THE RELEVANT

TESTING STANDARD FOR BUTTERFLY VALVES MAY BE INDICATED.

3.18.2 Y STRAINER

		DATA SHEET A STRAINERS (Y TYPE)	
DESIGN DATA	1. TAG NO.		
	2. QUANTITY REQUIRED	As per BOQ	
	3. LOCATION		
	4. TYPE	Y STRAINER	
	5. FLUID	DOMESTIC AND TREATED WATER	
	6. FLOW RATE		
	7. OPERATING PRESSURE		
	8. OPERATING TEMPERATURE	Ambient	
	9. DESIGN PRESSURE		
	10. DESIGN		
	11. FLUID VISCOSITY (Cp)		
	12. FLUID SP. GRAVITY AT		
	13. MAX. PERMISSIBLE PR. DROP		
	14. SCREEN BASKET		
	1. DIA OF	3 MM	
	2. MIN. THICKNESS,		
	3. FREE STRAINING AREA		
	15. STEAM JACKET		
	1. INLET PR. barg, OP. /		
	2. INLET TEMP. ° C,		
	16. END CONNECTIONS		
	1. SIZE, NB mm		
2. TYPE			
3. DETAILS/			
17. COVER			
18. IBR APPROVAL			
MATERIALS	19. BODY	CAST IRON	
	20. COVER	CAST IRON	
	21. SCREEN BASKET	STAINLESS STEEL	
	22. BOLTS/ STUDS		

	23. NUTS	CARBON STEEL
	24. GASKETS	Rubber
	25. JACKET	
	26. JACKET COUPLINGS/ FLANGES	
27.	ACCESSORIES BY VENDOR:	
27.1	FOUNDATION BOLTS	
27.2	DIFFERENTIAL PRESSURE GAUGE	
27.3	DRAIN/ VENT COCK (SS 316)	
27.4	SUPPORT LEGS	
26.	HYDROSTATIC TEST PRESSURE, barg	10.55 Bar
26.1	SHELL SIDE	20 Bar
26.2	JACKET SIDE	
27.	VACUUM TEST REQUIRED	
28.	PRESSURE DROP TEST REQUIRED	
	CLEAN/ 50% CLOGGED	
29.	INSPECTION:	
30.		
<p><u>NOTES:</u></p> <p>1. GENERAL REQUIREMENTS:</p> <p>2. '*': BIDDER TO FURNISH INFORMATION.</p> <p>3 GASKET SHALL BE METAL WIRE-REINFORCED AND GRAPHITED BOTH SIDES.</p>		

3.18.3 WAFER CHECK VALVES

		DATA SHEET A		SHEET : 1 OF 1				
		WAFER CHECK VALVES						
GENERAL	1 TAG NO. :	4. FLUID : FRESH WATER	SIZ mm	QUANTITY				
	2 SIZE RANGE : ≥ 50 NB	5. DES. PR. : *						
	3 RATING : PN 1.0	6. DES. TEMP. : AMBIENT		P0	R0	R1	R2	
	7 STANDARD : IS 5312	GRADE: CT						
CONSTRUCTION FEATURES	8 TYPE : DUAL PLATE, SPRING-LOADED		As per BOQ					
	9 ENDS : WAFER TO SUIT ANSI 150 CLASS FLANGES, RF, SERR. FINISH							
	10							
	11							
	12							
	13							
	14 OTHER REQUIREMENTS :							
MATERIALS	15 BODY : CI, IS 210 Gr. FG 260							
	16 PLATE : CARBON STEEL							
	17 SEAL : NITRILE							
	18 PLATE SEAT : MFR'S STANDARD							

TESTS & INSPEC	19	SPRING : SPRING STEEL					
	20	HINGE PIN & STOP PIN : SS 304					
	21						
	24	SHELL HYDRO : 15 Bar					
	25	SEAT HYDRO : 10 Bar					
	26	INSPECTION :					
<p><u>NOTES:</u> 1. GENERAL REQUIREMENTS :.</p>							

3.18.4 BALL VALVES

		DATA SHEET A		SHEET : 1 OF 1				
		BALL VALVES						
GENERAL	1. TAG NO. :	SIZE mm	QUANTITY					
	2. SIZE RANGE : ≤ 50 NB							
	3. RATING :		P0	R0	R1	R2		
	4. GRADE :							
CONSTRUCTION FEATURES	5. PORT :	As per BOQ						
	6. STEM :							
	7. ENDS : Screwed							
	8. OPERATION :							
	9. ANTISTATIC FEATURE :							
	10. FIRE SAFE DESIGN : NA							
	11. OTHER REQUIREMENTS :							
		SIZE, (in/ mm) :						
	INS. THK., mm :							
MATERIALS	12. BODY FORGED BRASS							
	13. BALL (MIRROR FINISHED) STAINLESS STEEL							
	14. STEM STAINLESS STEEL							
	15. SEAT GLASS FILLED							
	16. SEAL (STEM & BODY) -							
	17. BOLTS, STUDS & NUTS MILD STEEL							
	18.							
INSPECTION	19. SHELL HYDRO :25Bar							
	20. SEAT HYDRO :16 Bar							
	21. SEAT AIR :							
	22. INSPECTION :							

3.18.5 TRANSFER PUMPS		
Pump		DOMESTIC WATER TRANSFER PUMP (2W+1S)
Make	:	
Type & Model	:	
Discharge in LPS / GPM	:	3.5lps
Head (Meters of WC)	:	60
Shut off Head (Meters of WC)	:	
Efficiency (%)	:	70
No. of Stages		
Suction End I.D.	:	
Delivery End I.D.	:	
Details of N.P.S.H.	:	
Vibration Isolation Detail	:	
Skid Details	:	
Operating Weight	:	
Overall Dimension (MM)	:	
Mechanical Seal Detail	:	
Material		
Body	:	c.i
Impeller	:	ss

Type of Impeller		
Shaft	:	SS
Is it suitable for direct coupling	:	
Motor	:	
Make	:	
Model	:	
Power Requirement (HP / KW)	:	5.25 HP
R.P.M.	:	2900
Rating	:	
Over Load Capacity	:	
Class of Insulation	:	
Details of Additional protection in winding	:	
Motor Efficiency	:	
It it suitable for direct coupling to pump?	:	
Type of rotary movement	:	
Method of Starting	:	
Size and type of cable for connections.	:	
Number of variable frequency drive	:	
Detail of VFD	:	
TRANSFER PUMPS 2		
Pump		FLUSHING WATER TRANSFER S PUMP (1W+1S)
Make	:	
Type & Model	:	
Discharge in LPS / GPM	:	4lps

Head (Meters of WC)	:	60
Shut off Head (Meters of WC)	:	
Efficiency (%)	:	70
No. of Stages		
Suction End I.D.	:	
Delivery End I.D.	:	
Details of N.P.S.H.	:	
Vibration Isolation Detail	:	
Skid Details	:	
Operating Weight	:	
Overall Dimension (MM)	:	
Mechanical Seal Detail	:	
Material		
Body	:	C.I
Impeller	:	SS
Type of Impeller		
Shaft	:	SS
Is it suitable for direct coupling	:	
Motor	:	
Make	:	
Model	:	
Power Requirement (HP / KW)	:	6 HP
R.P.M.	:	2900
Rating	:	

Over Load Capacity	:	
Class of Insulation	:	
Details of Additional protection in winding	:	
Motor Efficiency	:	
It it suitable for direct coupling to pump?	:	
Type of rotary movement	:	
Method of Starting	:	
Size and type of cable for connections.	:	
Number of variable frequency drive	:	
Detail of VFD	:	

3.18.6 FLOAT TYPE LEVEL SWITCHES

1.	FLOAT TYPE LEVEL SWITCHES DATA SHEET A GENERAL	
2.	Manufacturer :	*
3.	Model no.:	*
4.	FEATURES	
5.	Type: Magnetic float with guide tube <input checked="" type="checkbox"/> Tilt type <input type="checkbox"/>	✓
6.	Accuracy: ± 2 MM	✓
7.	Mounting: Direct <input checked="" type="checkbox"/> External chamber <input type="checkbox"/>	✓
8.	GUIDED FLOAT TYPE	
9.	Switch type: glass encapsulated hermetically sealed reed switch <input type="checkbox"/>	✓
10.	Minimum distance between reed switches	*
11.	No. of floats: single <input type="checkbox"/> multiple <input checked="" type="checkbox"/> Refer followup sheet	✓
12.	C-C distance for external chamber mounted switches:mm	✓
13.	TILT TYPE	
14.	Switch type: Microswitch encapsulated in float	
15.	No. of floats: single <input type="checkbox"/> multiple <input type="checkbox"/>	

	Refer followup sheet	
16.	ENCLOSURE PROTECTION:	
17.	Housing : IP-65 <input checked="" type="checkbox"/> IP_ <input type="checkbox"/> <input type="checkbox"/>	<input checked="" type="checkbox"/>
18.	Certification/ approval type: Ex d <input type="checkbox"/> Ex ia <input type="checkbox"/> NA <input type="checkbox"/>	<input checked="" type="checkbox"/>
19.	Housing colour: Grey <input type="checkbox"/> Black <input type="checkbox"/>	<input checked="" type="checkbox"/>
20.	Ex-proof to zone: 0 <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> Group: I <input type="checkbox"/> IIA <input type="checkbox"/> IIB <input type="checkbox"/> IIC <input type="checkbox"/> Temperature class: T1/2/3/4/5/6	<input checked="" type="checkbox"/>
21.	SUPPLY / SIGNAL	<input type="checkbox"/>
22.	Switch contacts: SPDT <input checked="" type="checkbox"/> 1 NO	<input checked="" type="checkbox"/>
23.	Switch contact rating : 0.2A, 220V DC / 5A , 230VAC	<input checked="" type="checkbox"/>
24.	MATERIAL:	
25.	External chamber with drain/ vent arrangement: CS A105 <input type="checkbox"/> SS 316 <input checked="" type="checkbox"/> PP <input type="checkbox"/>	<input checked="" type="checkbox"/>
26.	Float: 316 SS <input checked="" type="checkbox"/> PP <input type="checkbox"/> Others <input type="checkbox"/>	<input checked="" type="checkbox"/>
27.	Guide tube: 316 SS <input checked="" type="checkbox"/> PP <input type="checkbox"/>	<input checked="" type="checkbox"/>
28.	Bolts & nuts : ASTM A 193 Gr.B7 / A194 Gr.2H	<input checked="" type="checkbox"/>
29.	Gaskets : PTFE <input checked="" type="checkbox"/> OTHERS <input type="checkbox"/>	<input checked="" type="checkbox"/>
30.	Wetted parts: SS 316 <input checked="" type="checkbox"/> PP <input type="checkbox"/> OTHERS <input type="checkbox"/>	<input checked="" type="checkbox"/>
31.	Flange: SS 316 <input checked="" type="checkbox"/> PP <input type="checkbox"/>	<input checked="" type="checkbox"/>
32.	Housing: Die cast Aluminium <input checked="" type="checkbox"/> SS 316 <input type="checkbox"/> Polyamide <input type="checkbox"/>	<input checked="" type="checkbox"/>
33.	Cable for tilt switch:	
34.	Counter weight for titl type switch:	
35.		
36.	CONNECTION & DIMENSIONS	
37.	External chamber connection type: Upper side - lower side <input type="checkbox"/> Upper side - lower bottom <input type="checkbox"/>	<input checked="" type="checkbox"/>
38.	External chamber process connection size: ½" <input type="checkbox"/> 1" <input type="checkbox"/> others <input type="checkbox"/> Type : NPT <input checked="" type="checkbox"/> flange <input type="checkbox"/> SW <input type="checkbox"/>	<input checked="" type="checkbox"/>
39.	External chamber instrument flange: ANSI class 150 RF flanged (Refer note 3.0)	<input checked="" type="checkbox"/>
40.	Drain arrangement for external chamber Valve <input type="checkbox"/> Plug <input type="checkbox"/>	<input checked="" type="checkbox"/>
41.	Vent plug	<input checked="" type="checkbox"/>

42.	Process connection for direct mounted: ANSI class 150 RF flanged(Refer note 3.0)	✓
43.	Cable entry: 1"ET <input type="checkbox"/> ½ " NPT <input type="checkbox"/> others <input type="checkbox"/>	✓
44.	ACCESSORIES	
45.	Still well for direct mounting	✓
46.	Counter weight to keep tilt type switch cable and float in position	
47.	Name plate : Removable – SS	✓
48.	Metal tag – SS	✓
49.	Counter flanges	✓
50.	CODES AND STANDARDS	
51.	Refer note no. 6.0	✓

52.	<u>SPARES</u>	
53.	Minimum one (1) no. Or 10% of total qty., whichever is higher, for each type and model no.	✓
54.		
55.	<u>TESTS</u>	
56.	Material test / contact rating test / hydro test / calibration test	✓
57.	Valid type test certificate to be provided for enclosure protection .	✓
58.	Vendor to submit test certificates for Employer / engineer's review & records	✓
59.	<u>DRAWING</u>	
60.	The vendor to submit data sheet, dimensional drawing and erection sketch for review and comments by Employer/ Project Manager.	✓
61.	The vendor shall submit all operating and service manuals for the equipment supplied for records	✓

<u>NOTES:</u>	
1.0	Bidder to submit list of installations and commissions for the make & type of instrument offered and user's certificates.
2.0	Bidder to furnish details (*); required (✓); not required (-).
3.0	Float size shall be suitable to process conditions and tank height. Accordingly, instrument flange size shall be selected.
4.0	For qty. Refer to the attached bill of material.

NOTES:

5.0	All accessories shall be supplied as specified. In addition, any other accessories required shall be supplied without any price implication to make the measurement complete to match with process requirement.
6.0	Bidder shall indicate all applicable codes and standards.

3.39.6 SOLENOID VALVE

1.	DATA SHEET A GENERAL	35.	Protection For Rust Prevention
2.	Manufacturer	36.	Painting Standard : As Per IS-6005, 1970
3.	Model No.	37.	Painting Standard : As Per IS-6005, 1970
4.	Service	38.	ACCESSORIES
5.	PROCESS DATA	39.	Name Plate : Required
6.	Fluid	40.	Metalling enclosure for connecting flying leads: Required
7.	Pipe size	41.	CODES AND STANDARDS
8.	Operating Pressure : kg/sQcm	42.	ASME, ASTM, IEEE, IBR
9.	Operating Temperature : °C	43.	Weather Proof : IS 13947 PART I
10.	Operating Flow		Ex. Proof : IS 2148 / BS EN 50014 / BS EN 50020
11.		44.	TEST
12.	FEATURES	45.	Performance; Required
13.	Shut Off Class (Leakage)	46.	Hydro Test : Required
14.	Type : Pilot <input checked="" type="checkbox"/> Direct <input type="checkbox"/>	47.	Seat Leakage Test : Required
15.	Body Rating : ANSI Class 300 <input type="checkbox"/>	48.	CV Test : Certificate to be furnished
16.	Duty : Continuous <input type="checkbox"/> Intermittent <input type="checkbox"/>	49.	Coil Insulation Test : Required
17.	No. of Ports / No. of Ways : 3/2 <input type="checkbox"/> 5/2 <input type="checkbox"/>	50.	Test Certificate From PESO : Required for all exproof solenoid valves
18.	Power Supply : 230 V AC <input type="checkbox"/> 110 VAC <input type="checkbox"/> 24 VDC <input type="checkbox"/>		
19.	Style Of Coil : Moulded		
20.	Coil Insulation : Class F for high temp. as per IEC 60085/IS 1271		
21.	MATERIAL OF CONSTRUCTION		

22.	Body Material : Bronze <input type="checkbox"/> SS 316 <input checked="" type="checkbox"/>				
23.	Seat Material : SS 316 <input checked="" type="checkbox"/> Teflon <input type="checkbox"/>				
24.	Plunger Material : SS316 <input type="checkbox"/> <input type="checkbox"/>				
25.	Packing Material				
26.	ENCLOSURE PROTECTION				
27.	Weather Proof To : IP 67 & 68				
28.	Ex-Proof To: Zone 1 <input type="checkbox"/> ZONE 2 <input type="checkbox"/> Group IIA <input type="checkbox"/> IIB <input type="checkbox"/> IIC <input type="checkbox"/> Temp.Class : T1 <input type="checkbox"/> T2 <input type="checkbox"/> T3 <input type="checkbox"/> T4 <input type="checkbox"/> T5 <input type="checkbox"/> T6 <input type="checkbox"/>				
29.	Intrinsic safe certified				
30.	CONNECTION AND DIMENSIONS				
31.	Process Connection Type : NPT <input type="checkbox"/> BSP <input checked="" type="checkbox"/>				
32.	Size				
33.	Cable Entry Size : 1" ET <input type="checkbox"/> <input type="checkbox"/>				
34.	PAINTING				

Notes:-

1.	* - Bidder to furnish details.
2.	All accessories shall be supplied as applicable.
3.	The bidder shall indicate all applicable codes and standards
4.	The solenoid coil shall operate the valve even when the supply voltage drops down by 15% or goes up by 10%.
5.	The coil shall be wired to a terminal block located inside the housing. Flying lead wires of the coil are not acceptable.the material of housing shall be metallic unless otherwise indicated in data sheet.
6.	Each solenoid valve body shall be subjected to pneumatic pressure test by air / nitrogen with test pressure not less than 1.5 times the maximum working pressure (rated) of the valve. There shall not be any visible leakage during the test
7.	Each solenoid valve shall be subjected to seat leakage test by air / nitrogen with test pressure equal to maximum working pressure (rated) of the valve for one minute. There shall not be any seat leakage during this test.
8.	The coil shall be low power consumption type. Generally the power consumption of coil shall be less than 5 W.

3.18.7 ELECTRICAL TECHNICAL DATA SHEETS

For MCC +PDBs+MLDBs/SLDBs/DBs (To be filled by the bidders)

S.No.	Description	Recommended Specification	Confirmation by the Bidders
1	Type of Panel	a. MCC non drawout type compartmentalized. b. Panels non drawout type, non compartmentalized	
2	Type of Mounting	Free standing Floor Mounted	
3	Fault kA	50kA -1 Sec for MCC	
4	Thickness of CRCA sheets		
a	Structural members	3mm	
b	Covers and doors	2mm	
c	Base channel	MCC - ISMC 100	
d	Gland plate	3mm	
5a.	Painting/ Process	Synthetic Enamel Paint	

		As per seven tank process Oven baked.	
b	Paint shade; a. Inside b. Outside	RAL – 7032 RAL - 7032	
6	Details of busbars	Electrolytic grade Copper of specified rating for details see constructional features mentioned in specifications	
7	Cable Entry	For MCC & other Panels Top or Bottom depending upon location of Panel.	
8	Enclosure Protection/ Ventilation	For MCC – IP -52 with louvers for Ventilation.	
9	Control Wiring/ Power Wiring	Insulated 660Volts Cu wire.	
a.	Voltage Circuit	1.5 sq mm	
b.	Current Circuit	2.5 sq mm	
c.	Minimum size of Power wiring	16 sq mm	

	CKt		
10	Maximum Operating Height	2100	
11	Mounting height of Relays/Meters Control Switches	Range 350mm to 1900mm	

3.18.8 CONSTRUCTIONAL FEATURES FOR MCC

S.No.	Description	Recommended Specification	Confirmation by the Bidders
1	MCC		
a.	Busbar Chamber	400mm ht	
b.	Metering Chamber	400mm ht	
c.	Incoming Compartment	1000mm wide Module Single Tier	

d.	Overall Height	2100 mm	
e.	Overall Depth	1300 & 900 mm	
f.	Overall Length	(To be indicated by the bidder)	
g.	Construction	IP-52 with louvers for ventilation	
h.	Current Density	1.25 Amp / Sq.mm	
i.	Main Bus	1.75 Amp / Sq.mm	
ii.	Branch Bus Rating	75% of aggregate Switches connected. 1.25 Amp / Sq.mm Density	
iii.	Neutral Bus	Half of the size of phase bus	
iv.	Earth Bus	Half of the size of phase bus	
j.	Incoming and outgoing feeders.	As per SLD	

3.19 LIST OF APPROVED MAKES FOR PLUMBING AND SANITARY WORKS

NOTE:

- All materials and products shall conform to the relevant standards and shall be of approved make and design. A list of manufacturers/ vendors is given separately herein below for guidance. The Engineer shall give the approval of a manufacturer/ vendor/ only after review of the sample/ specimen. In case the same is not available in the market or in case of change in trade name, equivalent makes/ re-designated manufacturer then an equivalent approved make shall be used with the approval of Employer/ Engineer. The complete system and installation shall also be in conformity with applicable Codes & Standards and Tender specifications.
- Only “First” class quality materials shall be used.
- Employer reserves the right to choose any of the approved make / vendors as per this list.
- In case of products not indicated in this list, bis marked products shall be preferred.
- Specification of manufacturer’s item shall be checked against tender item / specifications before selecting any product or brand name. In case of any discrepancy, tender item/ specifications shall prevail, and any such brand of item shall not be used which is not conforming to tender specifications even if it is listed in this list.
- For use of material from a bis listed/ certified manufacturer, the contractor shall furnish a copy of the BIS certificate to Employer before procuring the material.
- In case non-availability of any item/ material among approved manufacturers/ brands at a particular site/ region, alternate manufacturers/ brands conforming to BIS/ BS etc. shall be used subject to approval by Employer.
- In case of non-availability of any manufacturer among approved manufacturers at a particular site/ region, alternate manufacturer’s name shall be proposed along-with required credentials for Employer’s approval.
- In case of any item/ product neither covered in this list nor having A BIS specifications, the contractor shall submit the proposed item/ product along-with technical details/ specifications (as per bid), test certificates etc. And other credentials of the manufacturer for Employers approval.

LIST OF APPROVED MAKES FOR PRODUCTS AND MATERIALS FOR PLUMBING AND SANITARY WORKS ARE INDICATED IN THE TABLE BELOW. HOWEVER, ANY OTHER MAKE WHICH IS EQUIVALENT AND MEETING THE TENDER SPECIFICATIONS ARE ALSO ACCEPTABLE WITH PRIOR APPROVAL OF THE ENGINEER

S.No.	Details of Materials / Equipment	Manufacturer's Name
1.	a. Vitreous China Sanitaryware	Hindustan Parryware /or Approved Local
2.	W.C Seat Covers	Admiral Tara or Approved Local
3.	a. Low level Flushing cisterns	Commander Duralite or Approved Local
	b. WC Connectors	Multiwik Viega or Approved Local
4.	Bath Tub and Shower Tray	Aquaplust Parryware or Approved Local

5.	Stainless Steel Sink	Cobra or Jayna Nirali Approved Local
6.	Cistern	Commandor or Approved Local Champion Parryware
7.	CP Brass Fittings	Parryware or Approved local
8.	Flow Control Devices	Jaquar RST or Approved Local
9.	Storage Type Geyser	Bajaj Venus or Approved Local
10.	Floor Drain Fixture, Rain Water Outlets	ACO GMGR Neer or Approved Local

11.	Urinal Trap	Chilly Neer or Approved Local
12.	ULTRA LOW FLOW FIXTURES- (Flush valves, Faucets, Bib taps) Low Flow C.P Fittings	Hindware Parryware or Approved Local
13.	Water Cooler	Aquaguard Blue star or Approved Local
14.	C.P. Grating for Floor Trap	Chilly GMGR Neer or Approved Local
16.	GI pipes fittings	Crescent Engg Corp. Jalandhar KS Engg RM Engg works, ahmedabad Zoloto or Approved Local
17.	GI/MS Pipe Protection Wrapping & Coating	IWL - Pypkote Neotape

		Rustech – Coatek STP Ltd. or Approved Local
18.	Pipe clamp & supports	Diamond Easyflex Intellotech or Approved Local
19.	Pipe Hangers	Hitech OM fasteners or Approved Local
20.	RO UNIT	Aqua Guard Kent Konark or Approved Local
21.	UPVC Pipe	Finolex Jain Kisan Prince
22.	CPVC pipes & fittings	Ajay Ashirwad

		Astral Prince
23.	Teflon Tape	Approved local
24.	Toilet Accessories	Akoi Parko or Approved local
25.	GM / Forged Brass Ball Valves	Jayhiwa Leader Zoloto or Approved local
26.	Gate Valve / Sluice Valves	Advance Kirloskar Jainsons SANT Zoloto
27.	Butterfly Valve	Zoloto Jayhiwa Pipeline Products or Approved local
28.	Check Valve – WaferType	Kirloskar Jayhiwa

			Zoloto or Approved local
29.	Check Valve – Dual Plate		Normex Sant Pipeline Products or Approved local
30.	Cast Iron Non Return valve		Leader Zoloto Pipeline Products or Approved local
31.	Check Valve Forged Screwed		Leader Pipeline Products RB Zoloto
32.	Pressure Reducing Valve		RB OR
33.	Solenoid Valve		Avcon Uflow Danfoss or local approveds
34.	Thermostatic mixing valve		Danfoss Overtrop
35.	Air Release Valve		OR Pipeline Products Zoloto

36.	Ball Float Valve		Prayag Zoloto Leader or local
37.	NRV – Ball type – Sewage application		Danfoss or Approved local Silverspark Normex
38.	HDPE Tanks		Sintex or Approved local Ashish

39.	Air Vent Inlet Valve		Jainsons SKS Studer
40.	FRP/GRP- SMC water tank		Devi Polymers pvt. Ltd. Approved local /Binani
41.	FRP/GRP storage tanks		Sintex or Approved local
42.	Y Strainer CI		Leader or Approved local Pipe line products Zoloto
43.	Storm Water Drainage & Sewage Sump Pumps (Submersible)		Aquasub Engineering HBD

		Kirloskar KSB
44.	Transfer Pumps	Aquasub Engineering CRI Pumps HBD Kirloskar Lubi/Local
45.	Self-Priming Pumps	Aquasub Engineering CRI Pumps Johnson Kirloskar Lubi/Local
46.	Borewell Pump	Aquasub Engineering CRI Pumps Grundfos Kirloskar
47.	Anti Vibration Mounting & Flexible Connections	Easyflex Resistoflex
48.	Pressure Gauge	Fiebig H Guru

49.	Water Meter (Mechanical Type)	Capstan or Approved local Kranti Kent
50.	Level Controller & Indicator (Water)	Pumptrol or Approved local RM Engg. Works, Ahmedabad
51.	Paints	Asian Paints Berger ICI Shalimar Paints
52.	MH / Water Tank Plastic Steps	KGM or Approved local Patel Pranali Industries
53.	Insulation for Hot Water Pipes	Armacell or Approved local Armaflex K-Flex Thermaflex
54	Electric Hot Water Generator / Heat Pump	A.O. Smith Bajaj Venus

55.	Solar Heating		A.O Smith Vijay Solar Overtrap Honeywell
56.	Grease Trap/Separator		ACO Kessels Wade
57.	Welding Rods		Ador Cosmos Prima (S) Super Bond (S)
58.	Fastener		Fisher Hilti
59.	Fire Sealant		Birla 3 M, Hilti Promat

60.	Level Indicator	HELLY, PUMPTROL TECHNIKA, TECHTROL
61.	Temperature Sensor	Forbes Marshall Danfoss
61.	Level Switch	SBEM RK DUTT

3.20 APPROVED MAKES/ MANUFACTURERS(Electrical Equipments):

NOTE:

- All materials and products shall conform to the relevant standards and shall be of approved make and design. A list of manufacturers/ vendors is given separately herein below for guidance. The Engineer shall give the approval of a manufacturer/ vendor/ only after review of the sample/ specimen. In case the same is not available in the market or in case of change in trade name, equivalent makes/ re-designated manufacturer then an equivalent approved make shall be used with the approval of Employer/ Engineer. The complete system and installation shall also be in conformity with applicable Codes & Standards and Tender specifications.
- Only “First” class quality materials shall be used.
- Employer reserves the right to choose any of the approved make / vendors as per this list.
- In case of products not indicated in this list, bis marked products shall be preferred.
- Specification of manufacturer’s item shall be checked against tender item / specifications before selecting any product or brand name. In case of any discrepancy, tender item/ specifications shall prevail, and any such brand of item shall not be used which is not conforming to tender specifications even if it is listed in this list.
- For use of material from a bis listed/ certified manufacturer, the contractor shall furnish a copy of the BIS certificate to Employer before procuring the material.
- In case non-availability of any item/ material among approved manufacturers/ brands at a particular site/ region, alternate manufacturers/ brands conforming to BIS/ BS etc. shall be used subject to approval by Employer.
- In case of non-availability of any manufacturer among approved manufacturers at a particular site/ region, alternate manufacturer’s name shall be proposed along-with required credentials for Employer’s approval.
- In case of any item/ product neither covered in this list nor having A BIS specifications, the contractor shall submit the proposed item/ product along-with technical details/ specifications (as per bid), test certificates etc. And other credentials of the manufacturer for Employers approval.

LIST OF APPROVED MAKES FOR PRODUCTS AND MATERIALS FOR PLUMBING AND SANITARY RELATED ELECTRICAL WORKS ARE INDICATED IN THE TABLE BELOW. HOWEVER, ANY OTHER MAKE WHICH IS EQUIVALENT AND MEETING THE TENDER SPECIFICATIONS ARE ALSO ACCEPTABLE WITH PRIOR APPROVAL OF THE ENGINEER

SL	DESCRIPTION	VENDOR/MANUFACTURER/MAKE
1	Protective relays (Numerical Type)	ABB Siemens GE SEL (Schweitzer Engineering Laboratories) Alstom
2	Protective relays (Electromechanical Type)	ABB Siemens GE Schneider Electric (formerly Areva/EE)
3	Auxiliary Relay	Schneider Electric (formerly Areva/EE) ABB Siemens VA Tech L & T
4	Electronic circuit Relay	OEN Omron Allen Bradley

		PLA
5	Control and Relay Panel	ABB Siemens Easun Reyrolle Alstom Schneider Electric
6	Instrument Transformers (CT/PT)	Automatic Electric Crompton Greaves Indcoil Kappa Precise Pragati Gilbert and Maxwell Silkaans Jyoti ECS Schneider Electric ABB Siemens
7	Switchgear/Switchboard L.V.- Drawout/Fixed Type (PCC/MCC/PMCC/M LDB/MPDB/ MOVDB/APFC)	Siemens L&T Schneider Electric ABB
8	Air circuit breakers	L & T Siemens

		<p>Schneider Electric (M&G)</p> <p>ABB</p>
9	MCCB's	<p>L & T</p> <p>Siemens</p> <p>Schneider Electric (M&G)</p> <p>ABB</p>
10	Switch Disconnector Fuse Unit (SDF) And Switch Disconnector Isolator	<p>Siemens</p> <p>Technoelectric</p> <p>Schneider Electric</p> <p>L&T</p>
11	Change-over switch	<p>Havells (euroload)</p> <p>C&S</p> <p>Schneider Electric</p> <p>GE Power</p> <p>Kraus & Naimer</p> <p>Siemens</p> <p>BCH</p> <p>L&T</p>
12	VVVF Drives / Electronic Softstarter	<p>Siemens</p> <p>Allen Bradley (Rockwell Automation)</p> <p>Yaskawa</p> <p>Schneider Electric</p> <p>ABB</p> <p>Danfoss</p>

13	LV capacitors (APP)	Universal Cables ABB Malde Madhav Epcos Aswani Schneider Electric L&T
14	Series Reactors For Capacitors	Manohar Brothers WHEPL Epcos
15	AC Power Contactor	Siemens ABB L&T BCH Schneider Electric (Telemecanique)
16	DC Power Contactor	BCH BHEL Siemens L&T Schneider Electric
17	Auxiliary contactors	Siemens L & T Schneider Electric (Telemecanique)

18	Electronic / Microprocessor based overload relay	Siemens ABB Schneider Electric
19	Bi-metal / Overload Relay	Siemens Schneider Electric L&T
20	Thermister relay	Alstom/ Minilec/ Insta controls
21	Single Phasing Preventer	Siemens Minilec Alstom Schneider Electric L & T
22	Time switch	GIC Theben Siemens Schneider Electric Legrand
23	Timers	GIC Theben BCH Siemens Electronic Automation Pvt Ltd. Minilec L&T

		<p>Legrand</p> <p>Schneider Electric</p>
24	Time Delay Relay	<p>Schneider Electric</p> <p>ABB</p> <p>Siemens</p> <p>BCH</p> <p>L&T</p> <p>Omron</p> <p>PLA</p>
25	Motors	<p>Siemens</p> <p>Bharat Bijlee</p> <p>Crompton Greaves</p> <p>Marathon Electric Motors (India) Ltd. (Formerly Alstom Ltd)</p> <p>BHEL</p> <p>ABB</p> <p>Kirloskar</p>
26	Battery Charger & DCDB	<p>Hitachi</p> <p>Caldyne Automatics</p> <p>Chhabi Electricals</p> <p>Mass-tech Controls</p> <p>HBL Power Systems</p> <p>Automatic Electric</p> <p>Amara Raja</p> <p>Universal Instruments</p>

27	Luminaire	Philips Zumtobel Crompton Greaves Bajaj GE
28	Lamps	Philips GE Osram Sylvania LVD Neptune, USA
29	Ballast	Philips Crompton Greaves Bajaj ATCO
30	LT Power Cables/ Earthing Cable	Universal Cables Ltd. NICCO KEC International Ltd Cable Corporation Of India Ltd Finolex INCAB Polycab LAPP RR Kabel

31	LT Control Cables	LAPP Polycab NICCO Universal Cables Ltd. KEC International Ltd Finolex INCAB KEI Cable Corporation Of India Ltd
32	HFFR wires (including panel wiring)	Finolex Polycab LAPP RR Kabel
33	Non-insulated Copper Earthing conductors	Gupta Industrial Corporation (Vasai, Palghar) Bharat Wires & Ropes Diamond Cables
34	Distribution Boards (other than MLDB, MPDB, MOVDB) / Panels / Enclosures / JB / Marshalling Panel	Siemens C&S Schneider Electric Rittal President Enclotek Eldon Hensel Legrand

		Manshu Comtel Pentair ABB BCH
35	MCB, RCCB, RCBO / MCB Isolators	Legrand Siemens Schneider Electric Klockner Moeller ABB
36	MPCB	Siemens Schneider Electric Moeller ABB L&T
37	Alarm Annunciators (solid state type with LED illumination) / Facia Annunciator	Digicont Industrial Instruments & Controls Procon Inst. (P) Ltd MTL India Pvt. Ltd. Rochester Instruments System Ltd. IDECIZUMI Minilec IICP Proton Electronics Alstom Yashmun

		ICA Ronan (Waree)
38	Decorative switches, sockets and metal boxes (single plate arrangement)	Honeywell (MK Electric) Anchor (Panasonic) Havells (Crabtree)
39	Modular switch & socket (wraparound) (twin plate arrangement)	Anchor (Panasonic) Anchor (Roma / Ave) Honeywell (MK Electric) Legrand Havells (Crabtree) Schneider Electric (Clipsal) Siemens ABB Gewiss
40	Ceiling fan	Usha Crompton Greaves Bajaj Orient Khaitan Almonard
41	Wall mounting fan	Almonard GEC Crompton Bajaj Orient

		Usha
42	Exhaust Fan / Ventilation Fan	Nadi Usha Almonard Bajaj Crompton Greaves
43	Air Circulators/Man Coolers (Pedestal/Wall Mounted)	Almonard Bajaj Crompton Greaves
44	Cable termination/jointing kits	Raychem (Tyco Electronics / RPG) 3M(Cold Shrink/Push-on) ABB Kabeldon
45	Control / selector switch	Kraus & Naimer Kaycee GE Power controls L&T Siemens ABB Schneider Electric
46	Indicating Lamps (Multi-chip LED)	Binay Teknic Controls Vaishno Siemens L & T

		Schneider Electric Concord BCH
47	Terminal Block / Connectors	Wago / Connectwell / Pheonix / Elmex
48	Control transformer	Indcoil Precise Silkaans NEC Gauss Electricals
49	Semiconductor Fuse	Siemens Schneider Electric (Ferraz Shawmut) Eaton (Cooper Bussmann) GE
50	HRC fuse (Power & Control)	Siemens L&T GE Eaton (Cooper Bussmann) Technoelectric Schneider Electric (Ferraz Shawmut)
51	Pushbuttons	Siemens Schneider Electric (Telemecanique) Teknic Controls L&T Concord

		BCH Vaishno Electricals
52	Push button station	Siemens Schneider Electric R Stahl Hensel Bals Gewiss
53	Non metallic enclosures (including Industrial Receptacles)	Rittal Hensel SCAME Menekkes Bals Siemens Schneider Electric BCH PCE Legrand Gewiss
54	Digital Meter – Ammeter & Voltmeter	Schneider Electric (Conzerv) AE Rishabh Schneider Electric (Power Measurement/ ION) Circutor Siemens

		Masibus
55	Electromechanical – Ammeter & Voltmeter	Automatic Electric MECO IMP Rishabh
56	Load Manager / Multi Function Meter / kWh	Schneider Electric (Conzerv / (Power Measurement / ION) Circutor Rishabh Schneider Electric Alpha (ABB) Schlumberger SEMS (Secure) Electro Industries / GaugeTech
57	Power quality analyser	A-eberle Schneider Electric (Power Measurement/ ION) Schneider Electric (Conzerv) Chino – Laxsons Yokogawa Rishabh Fluke Hioki
58	Cable lugs	Dowells Comet 3D (Billets Elektro Werke Pvt.Ltd)

59	Cable Glands (safe area - double seal cone grip type)	Comet Jainson Braco Baliga R. Stahl Crouse Hinds Siemens Hex (Brass Copper & Alloy(I)) Cosmos
60	Polyamide Cable Glands	Lapp Hensel Gewiss Fibox
61	Lightning Arrestors	WS Jayshree Elpro Oblum Crompton Greaves
62	Surge Suppressors	OBO Emerson Furse Dehn+Sohne Erico Pepperl+Fuchs MTL

		<p>Schneider Electric</p> <p>ABB</p> <p>Weid Muller</p> <p>Siemens</p> <p>Phoenix Contact</p>
63	Uninterrupted Power Supply (UPS)	<p>Emerson Network Power (India) Pvt. Ltd. (Liebert / Chloride)</p> <p>Schneider Electric (MGE / Gutor / APC / Invensys)</p> <p>Aplab</p> <p>Fuji Electric , Japan</p> <p>Hitachi</p> <p>Eaton</p> <p>Riello-PCI</p> <p>Socomec</p> <p>ABB (Newave)</p>
64	Floor trunking system (GI trays, troughs & pull boxes) and GI Cable trays	<p>OBO</p> <p>Honeywell</p> <p>Legrand</p> <p>Indiana</p> <p>Profab</p> <p>Patny</p> <p>Sadhana</p> <p>Sterlite</p> <p>Reliance</p> <p>Jenco/Pentax Ferro Incorporate</p>

65	Furniture trunking system / Cable management System	Legrand Schneider Electric Rittal Panduit Honeywell Eubiq
66	UPVC Conduit/JB/flexible conduit/tees/ Bevels,elbow & accessories/fittings	Precision Polycab Sudhakar AKG
67	GI Conduit / Pipes	JK Tube Company (AKG) BEC Industries Zenith SAIL TATA Steel Jindal
68	MS Conduit	JK Tube Company (AKG) BEC Industries Jindal TATA Steel SAIL
69	Casing Capping	Precision Circle ARK Mody

70	Lighting Controller / Lighting Management System	Lutron Zumtobel Philips Tridonic Atco
71	Lead Acid Battery (Plante / Tubular)	Exide HBL Power Systems Ltd. Amara Raja Batteries Ltd. Hoppecke
72	SMF/VRLA battery	Exide HBL Power Systems Ltd Amara Raja Batteries Ltd. Hoppecke
73	Ni – Cd Battery	HBL Power Systems Ltd. Hoppecke Amco Saft
74	High mast lighting system	Philips Bajaj Crompton Greaves BP Projects Valmont
75	SCADA / EMS	ABB Siemens Alstom Schneider Electric

		Electro Industries / GaugeTech Rishabh
76	Fire Barriers / Sealing	Brattberg Roxtec Signum Navell Multikil
77	Water barriers/sealing system	Roxtec Rayflate (Tyco Electronics)
78	Decontactor	BCH
79	Insulating mats	Electromat Dozz Raychem RPG
80	Emergency Light / Installite / Conversion module / Battery Pack	Prolite Legrand Philips Tridonic Atco Zumtobel
81	Choke (for VVVF)	Siemens ABB Danfoss Allen Bradley (Rockwell Automation) Yaskawa

82	Power Supply Unit	Siemens MTL Aplab Pheonix Cosel
83	PLC	Allen Bradley Siemens Schneider Electric
84	Voltage / Power / Current / Frequency / Energy Transducer	ABB AE Siemens Schneider Electric Rishabh Masibus
85	Encoders	Hubner Honeywell Turck
86	Limit Switch	BCH Honeywell Siemens Jay Balaji Wago
87	Aviation Obstruction Light (multiple LED type)	Binay

88	Diesel Engines	Cummins Caterpillar MTU Mitsubishi Wartsila Rolls Royce
89	Alternators for DG Sets	Cummins (Stamford / AvK) Leroy Somer BHEL
90	Digital Multimeter for Operation & Maintenance	Beckmann Fluke AVO
91	Clip-On Ammeter for Operation & Maintenance	HCK, Germany Kyoritsu Electrical , Japan

TECHNICAL SPECIFICATION
FOR
FIRE PROTECTION SYSTEM

FIRE FIGHTING WORKS

4.1 TECHNICAL SPECIFICATION FIRE PROTECTION SYSTEM

4.1.1 EQUIPMENT & SERVICES TO BE PROVIDED BY THE CONTRACTOR

4.1.1.1 This specification covers the general requirements of design, preparation of detailed drawings, supply of material, manufacture, testing, inspection at BIDDER'S works, packing, forwarding, transportation, transit insurance, delivery at site, erection / installation, testing, commissioning at site and carrying out performance / acceptance tests of the equipment, materials and services as per enclosed data sheets and other documents for fire protection system (FPS).

4.1.1.2 The scope of work is as listed below.

Sprinkler system, Hydrant system and Portable Fire Extinguishers shall be provided for various floors as per architectural floor plans. Bidder shall note that in areas where gap between false ceiling & ceiling slab exceeds 800 mm, sprinklers shall be provided.

4.1.1.3 Tentative layout drawings for fire water pump house and hydrant systems have been prepared by the PROJECT MANAGER and enclosed with this enquiry. However the following shall be in the scope of bidder.

- a) Preparation and submission of detailed engineering drawings based on these specifications and latest base drawings.
- b) Performing and submitting Hydraulic calculations for the entire firefighting system including sprinkler and hydrant system.
- c) Drawing(s) showing layout of portable extinguishers along with necessary calculations.
- d) Preparation of any specific fabrication drawings, as required.
- e) Obtaining approval of the system from client's insurance company, local authority(ies) having jurisdiction (Fire officer, Factory Inspector, etc.) and approving agency appointed by client, including taking out necessary number of prints of drawings, submission to approving agency, co-coordinating site visits, making any minor modification in drawings for the purpose, etc.
- f) Prepare and submit as-built drawings as per Document and drawing submission & distribution schedule.
- g) The specification covers Details of pumping and pipe mains for the water based systems. Main fire water pumps, standby pumps, jockey pumps along with their prime movers viz., electric motors and diesel engines.
- h) Piping inside and around pump house including suction and delivery piping, delivery header, recirculation piping.
- i) All the valves and specialties in above piping.
- j) Supporting arrangements needed (indoor & outdoor) for the piping, valves and instrumentation mentioned above.
- k) Hume pipes are as per standard practice to be provided wherever road crossings are shown.
- l) Wrapping & coating for underground piping.

- m) Excavation and back filling required for underground piping / outdoor supporting arrangement.
- n) Supply and application of painting for piping, fitting, valves, equipment, hose cabinets and structural steel and auxiliary steel for supports.
- o) It is not the intent to specify completely herein all details of design and construction of equipment or materials to be supplied or of services to be rendered.
- p) However, the equipment, materials and services shall conform in all respects to high standards of engineering design, workmanship and be capable of performing in continuous commercial operation in a manner acceptable to Client / Project Manager who will interpret the meaning of drawings and specifications and shall have the power to reject any work or material which in his judgement are not in full accordance therewith.
- q) The equipment to be supplied and erected under this specification are detailed in BOQ and these shall be in accordance with Specification and data sheets and the relevant data sheet A of data sheets section.
- r) Any item which may not have been specifically mentioned herein but are needed to complete the equipment / system shall also be treated as included and the same shall also be furnished and erected, unless otherwise specifically excluded as indicated.

4.1.1.4 The Bidder's scope also includes the following:

- a) Auxiliary steel / supporting steel for supporting the equipment, piping as well as related drilling, welding work, painting of supports etc.
- b) All kinds of supports as necessary for piping.
- c) All anchor bolts, nuts, washers and inserts to be embedded in concrete for the equipment and piping.
- d) Construction of valve chamber in case of underground pipes.
- e) Hydro testing & Flushing (All necessary equipments, connections & valves shall be in CONTRACTOR'S scope.)

4.1.1.5 For routing piping, cabling etc. breaking / making of opening in wall, etc. shall be carried out by Contractor at no extra cost.

4.1.1.6 For pipes of fire water system that enter the buildings, the following will be in scope of contractor: If the pipe has to cross the metal cladding, then a correct size opening shall be made in the cladding and after the pipe is installed, the opening shall be sealed both on inside and outside by using proper sealants as approved by engineer-in-charge. Where pipe has to cross brick / block work wall, then a correct size opening shall be made in the wall, an appropriate sleeve installed and after the fire water pipe is installed, the opening between fire water pipe and sleeve shall be sealed both on inside and outside by using proper sealants as approved by engineer-in-charge.

4.1.2 SPECIFIC REQUIREMENTS / INSTRUCTION TO BIDDERS

- 4.1.3.1 All equipment supplied shall have capacities not less than those specified in the data sheets and necessary test certificates shall be furnished in this regard. Approved makes and type of equipment/ components shall be supplied. The make, type reference of the equipment is subject to EMPLOYER's approval.
- 4.1.3.2 Grouting of all equipment and supports, supply of grounding material such as cement, sand, necessary form work etc. is Bidder's responsibility.
- 4.1.3.3 No Separate payment will be made for necessary structural supports of piping.
- 4.1.3.4 The quantities of piping & valves, specialties etc. indicated in Schedule of quantities are indicative for the purpose of Bidder's guidance and shall not be binding to limit the scope of Contractor's work. In case there is any variation (plus or minus) in the quantities actually supplied and installed from the quoted quantities, the price of the same shall be adjusted based on the unit rates furnished by the BIDDER.
- 4.1.3.5 Bidder shall note that for piping, quantities of fittings like elbows, reducers, fabricated reducers / miters, compression fittings, flanges, nipples etc. are not defined. The price for supply, fabrication and erection of necessary fittings shall be included in the unit rates for respective pipe sizes. The rates for flanges, and hardware like bolts, nuts, washers and gaskets shall be included in prices quoted for pipes, equipment, valves and specialties as applicable.
- 4.1.3.6 No separate prices are called for painting. Price for supply and application of painting shall be included in the unit prices for piping, valves and equipment, structural steel work as applicable.
- 4.1.3.7 For pipes, measurement shall be corner to corner after deducting length of valves, specialties, in-line instruments.
- 4.1.3.8 All charges for inspection, testing, radiography, dye penetrate testing, flushing, cleaning, hydro/air testing, purging with inert gases, commissioning, including consumables required for same shall be included in the unit rate for erection of piping/valves/equipment.
- 4.1.3.9 Minor civil works like wall opening, chipping of foundation, grouting of foundations shall be carried out at no extra cost.
- 4.1.3.10 In addition to the scope mentioned in Clause 4.1.1.2 above, the CONTRACTOR shall supply and erect all required temporary pipes, fittings, flanges, valves and specialties and hangers and supports for testing and cleaning operations, as a part of the erection scope of contract for each of the systems listed above. The BIDDER shall consider this requirement while quoting unit prices for erection.
- 4.1.3.11 The construction of the fire protection system requires all CONTRACTORS to adhere to good daily housekeeping practices. During construction the CONTRACTOR shall every day, keep all work and storage areas used by them free from accumulation of waste materials. Scrap/ rubbish shall be removed from the site to the satisfaction of the client. The CONTRACTOR shall maintain a crew to carry out this function without any additional payment.
- 4.1.3.12 The contractor shall prepare and submit to the EMPLOYER for approval, final piping bill of materials as actually erected for purpose of reconciliation.
- 4.1.3.13 The surplus material with the CONTRACTOR for all materials brought by him shall be taken back by the CONTRACTOR except surplus from those materials for which the EMPLOYER has given, in writing, clearance for procurement.
- 4.1.3.14 All the pipes shall conform to the relevant piping standards. The pipes shall be joined using butt welding to ANSI B 16.25.

- 4.1.3.15 Slings/ wire ropes and other lifting, hoisting or pulling slings used for lifting various loads shall be invariably tested by a test load before carrying out actual erection.
- 4.1.3.16 The Vendor shall ensure that other utilities/items and aesthetics are not damaged or disturbed due to the installation activities.
- 4.1.3.17 Caps over concealed sprinklers shall be fitted only after painting of ceiling (by others) is completed.
- 4.1.3.18 Sprinklers shall be masked off prior to painting. Any painted sprinkler or sprinkler coated with plaster of Paris is to be replaced by CONTRACTOR at no cost to the EMPLOYER.
- 4.1.3.19 Method of Testing System: The following tests shall be carried out for ensuring that the system and various components meet the system specifications

Hydrant piping	<ul style="list-style-type: none"> To withstand min. hydro-test at the pressure 1.5 times the max. working pressure i.e. $8.8 \times 1.5 = 13.2 \text{ kg/cm}^2\text{g}$ for two hours (as per clause no. 7.5.6 of TAC manual) Leak test: system to be tested at maximum operating pressure for functional test at operating pressure for 2 hours after fixing all components.
Fire water pump	Shall be capable of delivering not less than 150 % of rated capacity at a head of not less than 65 % of the rated head
Diesel Engine	Shall be capable of operating continuously on full load at the site elevation for a period of six hours.
Wrapper coating on underground pipes	Holiday testing
Other components	As per data sheet / requirements specified.

4.1.3 BIDDER'S PROPOSAL

- 4.1.4.1 To enable thorough and fast scrutiny of the BIDDER's proposal, BIDDER's are advised to respond all their technical data in the enquiry by clearly marking out their response, wherever they want to provide additional data and / or they deviate from the specified requirements. In case of full compliance, the enquiry specification and data sheets will remain unaltered. Each data sheets shall be certified by the BIDDER. This requirement is very important. Non compliance of this by the BIDDER may result in their bid being rejected.
- 4.1.4.2 Bidder shall ensure and cover all his eligible employees deputed on site under ESI act and Provident Fund Act. The contractor shall be liable to honour all labour laws as applicable in the state, also in respect of payment of minimum wages, payment of Provident Fund and ESI contribution, labour licence and any such acts which are not explicitly mentioned in the document but prevailing during the tenure of contract. The contractor should have his separate code number for compliance under ESI act and

Provident Fund Act, so as to cover all his eligible employees under the act in the said code number. The contractor shall comply with the provisions of the act, on month to month basis and shall keep the appropriate record required under the act as well as shall submit the copy of compliance to the Employer regularly.

4.1.4.3 BIDDER is advised to quote for the complete scope and partial response will not be entertained. In case of few items which do not directly fall under BIDDER's manufacturing range and / or not available from indigenous source, BIDDER should take the responsibility upon them to arrange to procure them and supply to ensure that their proposal is complete in all respects.

4.1.4.4 Ignorance of the site shall not be accepted as basis for any claim for compensation. The submission of the tender by the BIDDER will be construed as evidence that such an examination was made and any later claims / disputes in regard to price quoted shall not be entertained or considered. Bidders may visit the site, if necessary, after getting permission of client.

4.1.4 CODES AND STANDARDS

4.1.5.1 All equipment, systems and works covered under this specification shall comply with all currently applicable statutes, regulations, standards and safety codes in the locality where the equipment will be installed. All equipment and systems shall comply in all respects with requirements of codes and standards as indicated in data sheets of this specification.

4.1.5.2 Other national standards established to be equivalent or superior to the codes and standards specified are also acceptable. The BIDDER shall furnish English translation of all standards specified in this specification.

4.1.5.3 In the event of any conflict between the codes and standards referred to in the specification and the requirements of this specification, the more stringent of this requirement shall govern.

4.1.5.4 All codes and standards referred to in this specification are latest editions of respective codes and standards.

4.1.5 MAINTENANCE REQUIREMENTS

4.1.6.1 In order to carry out preventive maintenance, it should be possible to readily disassemble, repair, and reassemble the equipment system in the shortest period and to attend to any defect by a minimum disassembly.

4.1.6.2 The BIDDER shall confirm that space shown for the equipment is adequate from point of view of access, easy maintenance and for day to day operation.

a) All system must have convenient maintenance characteristics including

b) Minimum disturbance to production during preventive maintenance.

c) Easy access to replacement part which can be installed by personnel with minimum skill.

4.1.6 GUARANTEES AND PERFORMANCE REQUIREMENTS

4.1.7.1 GENERAL

The fire protection system shall perform satisfactorily to meet the guarantee requirements specified to the entire satisfaction of the CLIENT / ENGINEER and statutory requirements.

4.1.7.2 NOISE AND VIBRATION

- a) Amplitude of vibration at bearing of rotating equipment shall conform to ISO: 10816-1.
- b) Vibration isolators of proven design shall be furnished by the BIDDER for preventing the transmission of vibration from the equipment (fire water pumps, etc.) to the other neighbouring equipment and structure.

4.1.7 PAINTING

- 4.1.8.1 Painting in the immediate vicinity of any electrical and rotating equipment and / or pipe in service shall not be performed without the prior written approval of the EMPLOYER for the specific structure, equipment, or pipe to be painted.
- 4.1.8.2 The CONTRACTOR's scaffolding shall be erected, maintained and dismantled without damage to structures, machinery, equipment or obstruction to work of other CONTRACTORS.
- 4.1.8.3 All surfaces such as light gauge / glasses, required for clear visual observation shall be cleaned after paint application.
- 4.1.8.4 Special care shall be taken to avoid any paints from dropping on the machined moving parts of equipment, name plates or indicator dials of instruments and control valves. Prior to paint application or spraying paint removable adhesive tape shall be used to cover these.
- 4.1.8.5 On final completion of all work, the CONTRACTOR shall leave the entire premises within the site of his operation clean and free from all rubbish resulting from his painting operation and shall remove any paint or other blemishes caused by him on adjacent walls, windows, equipment and finished surface.
- 4.1.8.6 All piping shall be painted after hydro test only.
- 4.1.8.7 The iron and steel surfaces shall be thoroughly cleaned of all rust, scale, grease or oil by manual or power tools and then primer coat shall be applied.
- 4.1.8.8 The EMPLOYER reserves the right to inspect the cleaning down and painting operations at any stage and if required by EMPLOYER/ ENGINEER unsatisfactory surface preparation or paint application shall be emended at CONTRACTOR's expense.
- 4.1.8.9 On job site, no painting shall be carried out in a dust laden atmosphere or under unsuitable weather conditions viz. when raining or when metal surfaces are damp or when condensation is likely to affect the paint film before it is dry.
- 4.1.8.10 Surface preparation for underground and aboveground pipe shall be by thorough wire brushing and any additional cleaning as required.

4.1.8 SYSTEM DESCRIPTION

4.1.9.1 Hydrant System

The system shall be designed to operate automatically on operation of any of the hydrant valve(s). The system shall be always pressurized and will operate by a set of pumps and related instrumentation and controls. The operation of pumps shall be sequential. The jockey pump shall start and stop to maintain header pressure. In case of operation of hydrant(s), the jockey pump would be unable to maintain the pressure and the pressure drops further. At a lower predetermined pressure the motor driven pump starts. In case motor driven pump fails to start, the pressure continues falling. At a further lower predetermined pressure, the diesel engine driven standby pump shall operate. Stopping of hydrant system pumps shall be manual

4.1.9.2 Sprinkler System

The system shall be designed to operate automatically on breaking of any of the sprinkler bulbs. The operation of sprinklers in a particular zone would be indicated on the panel through instruments/appurtenance provided on the alarm valve. The system shall be always pressurised and will operate by a set of pumps and related instrumentation and controls. The operation of pumps shall be sequential. The jockey pump shall start and stop to maintain header pressure. In case of operation of sprinklers, the jockey pump would be unable to maintain the pressure and the pressure drops further. At a lower predetermined pressure the motor driven sprinkler system pump starts. In case motor driven pump fails to start, the pressure continues falling. At a further lower predetermined pressure, the diesel engine driven standby pump shall operate. Stopping of pump shall be manual.

4.1.9.3 Fire Water Pump House and Underground Fire Water Tank

- a) Fire Water Reservoir shall be of RCC underground type construction in two equal compartments along with an adjacent underground fire water pump house so that the pumps will be operating under positive suction head. Effective capacity required for exclusive use by fire protection system is 200 cubic meters.
- b) Following Fire Water Pumps shall be provided in the underground pump house.

	Name	Quantity	Parameter
	Electric Motor driven Main Pump - Horizontal Centrifugal type	01	171 m ³ /hr @ 8.8 kg/cm ² (g)*
	Diesel Engine driven Stand by Fire Pump - Horizontal Centrifugal type	01	171 m ³ /hr @ 8.8 kg/cm ² (g)*
	Electric Motor Jockey Pump – Horizontal Centrifugal type	01	10.8 m ³ /hr @ 8.8 kg/cm ² (g) *

Pump Power requirement shall be finalised by the contractor.

The jockey pump shall be used for make-up of leakages. The start-stop of jockey pump and start of fire water pumps shall be automatic by sensing of falling header pressure by individual pressure switches.

A pressure switch shall be provided on header for sensing header pressure low.

A pressure gauge shall be provided at discharge of each pump.

The system shall be pressurised at 8 kg/cm²(g). Pump shall be installed with pressure switches in the common delivery header for automatic starting in the following tentative sequence:

Sr. No.	Description	Set Pressure (in kg/cm ² g)
01.	Jockey pump – 1 start *	6
02.	Jockey pump – 1 stop *	7
03.	Main pump-start	5
04.	Standby Pump- start	4

- * The above settings are indicative and actual parameters will be finalised in the detail engineering phase. In addition to above Signals, Pump “Running” & “Fail To Start” signal shall be provided & necessary Pressure switches shall be envisaged.
- Pumps shall be capable of furnishing not less than 150% of rated capacity at a head of not less than 65% of the rated head. The shut-off head shall not exceed 120% of rated head.

4.1.9.4 Portable Fire Extinguishers

Portable fire extinguishers for the proposed facilities are included in this package. Portable fire extinguishers shall be provided as per TAC. All the extinguishers should have ISI mark. Certificates to this effect shall be furnished by CONTRACTOR. Spare quantity of 10% of all types shall be provided.

4.1.9 SUMMARY OF DATA TO BE FURNISHED ALONG WITH BID

The BIDDER shall ensure the following documentation are prepared and submitted to EMPLOYER along with the Bid:

4.1.10.1 TECHNICAL BID

- a) All data sheet from of the tender specification shall be duly filled in.
- b) Performance curves/rating charts used for selection of equipment for all the systems shall be furnished along with the bid, with the duty points duly marked on them.
- c) All sheets of bill of quantities duly filled in, signed and stamped.
- d) Electrical load list indicating rating and quantity. Bidder is not allowed to change the motor rating in the event of order placement

4.1.10.2 DETAILED ENGINEERING DOCUMENTS AFTER LOI

- a) The detailed engineering documents, hydrant piping layout drawings, Pump house Piping layout drawings etc., Piping calculation and datasheets for the execution of the job.
- b) Final data sheets.
- c) Any drawing detailed fabrication drawing which may be necessary for ring bending / fabrication etc.
- d) Any drawing which may be required to be modified / generated to suit the site condition / obtaining TAC approval.
- e) General arrangement drawings for hydrants, pumps, diesel tank valves & specialties.

4.1.10.3 FINAL DOCUMENTS

- a) Operation and maintenance manuals.
- b) Quality assurance documentation specific for the project.
- c) Final as built documentation folder containing all drawings and technical data sheets for future reference.

4.1.10 SCHEDULE OF INSPECTION / TESTING AT SITE (TO BE WITNESSED BY CLIENT)

- 4.1.12.1 The schedule of tests indicated below is indicative and not exhaustive. CONTRACTOR to carry out any other tests at site as per directions of CLIENT.

Sl No.	Name of the System/Equipment	Tests to be carried out at site
a)	Pumps	Performance Test
b)	All rotating equipment	Noise level and vibration level measurement
c)	Power consumption	For all equipment
d)	Pump control panel and logic	Operation test
e)	Piping (Sample)	Hydrostatic leak test, Wrapper coating thickness, Radiography
f)	Fire Hydrant (Sample)	Operation test
g)	Sprinkler	Operation and performance test
h)	Alarm Valve / Installation Control Valve	Operation Test
i)	Fire Extinguisher	Operation Test

4.2 FIRE PROTECTION SYSTEM-ELECTRICAL REQUIREMENTS

4.2.1 SCOPE OF WORK

4.2.1.1. Power and Control cabling from MCC to Fire Protection motors including cable carrier system.

4.2.1.2. Local Push button station

4.2.1.3. Earthing system above ground

4.2.1.4. Structural steel for supporting the panels, LPBS, Cable trays etc.

4.2.2 ELECTRICAL PANELS

4.2.1.1. The Contractor's scope includes 1 No. MCC for Fire Protection System as per Appendix - 1 of this section.

4.2.1.2. 415 Volts, 50 Hz, TPN supply at the incomer of MCC will be made available by the Employer. Further distribution of power and derivation of any other voltage shall be in Contractor's scope.

4.2.1.3. MCC incomer shall be suitable for termination of 1RX3.5CX120 sqmm, AL, XLPE
The Contractor's scope includes 1 No. MCC for Fire Protection System as per Appendix - 1 of this section.

4.2.1.4. All potential free contacts (Feedback & command from PLC) shall be wired upto Marshalling compartment of MCC.

4.2.3 LOCAL PUSH BUTTON STATIONS (LPBS)

4.2.3.1. LPBS for motors shall be provided by contractor. Necessary supporting structural steel for the same is in Contractor's scope.

- 4.2.3.2. LPBS shall be metal enclosed, weather proof, dust and vermin-proof, suitable for mounting on wall or structures. The enclosure shall be sheet steel, 2 mm thickness and shall have degree of protection not less than IP55. The enclosure shall be painted with one coat of epoxy primer and two coats of Epoxy Light Gray paint – 631 shade as per IS-5.
- 4.2.3.3. LPBS for shall be provided with 1no. recessed type start push button and 1No. Palm push, mushroom head type stop push button.
- 4.2.3.4. All push buttons shall be fitted with two (2) NO and two (2) NC contacts, rated for 10 A at 240V AC.
- 4.2.3.5. LPBS shall be suitable for bottom cable entry with stopping plugs.
- 4.2.3.6. Internal wiring shall be done with copper conductor HFFR wires shall be neatly done.
- 4.2.3.7. All spare contacts shall be wired upto terminal block.
- 4.2.3.8. Distance between cable gland plate and terminal block shall be minimum 75mm for ease of termination.
- 4.2.3.9. Two (2) Nos. earthing terminals shall be provided for external earthing. Earthing continuity bonds shall be provided.

4.2.4 CABLING SYSTEM

- 4.2.4.1. For MCC, Power supply will be made available at incomer with the help of 1.1 kV, XLPE Power Cables by others. Further Power and control cabling from MCC to motors shall be in the in scope of Contractor. Incoming Cable sizes will be indicated to successful bidder during execution based on total load of each plant.
- 4.2.4.2. FPS MCC shall be installed in Pump House.
- 4.2.4.3. MCC shall be provided with Top Cable entry. Anchor Fasteners, Bolts and other necessary supporting structure required for Panel installation shall be provided by bidder.
- 4.2.4.4. Contractor shall furnish Cabling layout & Cable Schedule for each Area.
- 4.2.4.5. For overhead cable trays, foundation (if required) for cable tray supporting structure will also be provided by Bidder.

LV Power Cables shall be 1.1 kV grade stranded copper conductor (up to 6 sq. mm) and stranded aluminium conductor (above 6 sq. mm) multi core, XLPE insulated, extruded PVC inner sheathed, GI wire / strip armoured, and extruded FRLS PVC outer sheathed, as per IS:7098 (Part- 1).
- 4.2.4.6. Control Cables shall be 1.1 kV grade stranded copper conductor (of minimum 2.5sq.mm.), XLPE insulated, extruded PVC inner sheathed, GI wire / strip armoured, extruded FRLS PVC outer sheathed as per IS:7098 (Part-1).
- 4.2.4.7. Minimum 1 core shall be kept spare in control cable.
- 4.2.4.8. Cable trays shall be Hot dipped Galvanised Iron (85 micron galvanising) with accessories such as coupling plates (with minimum 8 nos. holes), bends, tees, reducers, coupling nut-bolts etc. of following width. All the hardwares used for cable tray jointing, cable supporting & clamping shall be of SS304 material.

4.2.4.9. Nylon ties shall not be used for clamping cables, GI strip with SS304 hardware shall be used.

a) While sizing of Cables, Bidder shall consider voltage drop of 1.0% (max.) from MCC to Motor.

b) Cable sizes indicated in data sheets of low voltage induction motor are for General Guidelines only. Contractor shall provide cable sizing calculation based on design criteria mentioned above.

4.2.5 EARTHING SYSTEM

4.2.5.1. Earthing below ground shall be by others. Earthing above ground i.e. equipment earthing upto earthing bus shall be in the scope of Bidder.

4.2.5.2. Earthing shall be of GI.

4.2.5.3. Earthing connection at equipment shall be of bolted type.

4.2.5.4. 1 Run of 50x10mm GI Strip shall be provided by contractor along Cable Tray and shall be connected at suitable point to Earth Grid.

4.2.5.5. Bidder shall furnish the Earthing layout along with calculations (below as well as above ground).

4.2.6 LV MOTORS

4.2.6.1. Motors shall be suitable for 415 V, 3 phase, 50 Hz supply, squirrel cage type.

4.2.6.2. Motors shall be squirrel cage type, energy efficient (IE-3 class as per IS-12615, 2011) squirrel cage induction motors having TEFC, IP-55 enclosure (including terminal boxes and bearing housing) with Class-F insulation (and temperature rise limited to Class B) conforming to IS 325.

4.2.6.3. Motors shall be energy efficient (IE-3) type.

4.2.6.4. Motors will be with Direct On Line starter (DOL).

4.2.6.5. For other details, refer specification No. Data sheets A1 of low voltage induction motor.

4.2.6.6. Bidder shall follow below mentioned values of Efficiency as per ECBC.

Motor Size (kW)	Efficiency (%)	
	2 Pole	4 Pole

Motor Size (kW)	Efficiency (%)	
	2 Pole	4 Pole
1.1 (1.5 hp)	82.2	83.8
1.5 (2 hp)	84.1	85
2.2 (3 hp)	85.6	86.4
3.0 (4 hp)	86.7	87.4
4.0 (5.5 hp)	87.6	88.3
5.5 (7.5 hp)	88.5	89.2
7.5 (10 hp)	89.5	90.1
11.0 (15 hp)	90.6	91
15.0 (20 hp)	91.3	91.8
18.5 (25 hp)	91.8	92.2
22.0 (30 hp)	92.2	92.6
30.0 (40 hp)	92.9	93.2
37.0 (50 hp)	93.3	93.6
45.0 (60 hp)	93.7	93.9
55.0 (75 hp)	94	94.2
75.0 (100 hp)	94.6	94.7

4.2.6.7. For preferred makes refer Appendix-2 of this section.

4.2.7 TERMINAL POINTS (BATTERY LIMIT)

4.2.7.1. 415 Volts, 50 Hz, TPN supply at the incomer of MCC shall be made available by the Employer. Further distribution of power and derivation of any other voltage shall be in Contractor's scope.

4.2.7.2. Termination of incomer and outgoing cables is in scope of contractor.

4.2.7.3. Earthing above ground shall be considered in contractor's scope as per clause no. 4.2.5

4.2.7.4. APPENDIX - 1

FPS MCC (Loc: Pump House)

Sl. No.	Name of the equipment	Feeder Type	Motor Rating (kW)
1)	Incomer	MCCB	400A
2)	Fire Protection Main Pump	STAR/DELTA STARTER	70
3)	Fire Protection Jockey Pump	DOL	10
4)	Socket in MCC	MCCB+63A Socket	63A

Note – kW Rating & no. of feeders indicated here are preliminary & shall be confirmed by the bidder.

4.3 FIRE PROTECTION SYSTEM-INSTRUMENTATION AND CONTROL (I&C) SYSTEM REQUIREMENTS

4.3.1 EQUIPMENT & SERVICES TO BE PROVIDED BY THE BIDDER

4.3.1.1. This specification covers the general requirements for design, preparation of detailed drawings, supply of material, manufacture, testing, inspection at BIDDER'S works, packing, forwarding, transportation, transit insurance, delivery at site, erection/installation, testing, commissioning at site and carrying out performance / acceptance tests of the Instrumentation & Control System for Fire Protection System as per specifications in this section, enclosed data sheets, drawings and other documents.

4.3.1.2. The following shall be in the scope of the BIDDER:

4.3.1.3. Supply, erection & commissioning of instruments as per P&ID for following systems:

- a) Hydrant System
- b) Sprinkler system
- c) The instruments shown on P & ID are of minimum requirements. However BIDDER shall provide all instruments required for proper functioning of the systems.

4.3.1.4. Supply, erection & testing, commissioning of Fire Protection Panel and completely wired Pressure switches to Fire Protection Panel. Panel shall be located in Pump house along with all required accessories as per specification. The cabling required up to Fire Protection panel from instruments is in the BIDDER's scope

4.3.1.5. Contractor shall supply & lay the following cables:

- a) All cables between the field instruments, junction boxes, control panel, MCC & any other equipment with termination & cable gland at both ends along with all cable laying accessories.
 - b) Power supply cables as required for the instruments & panels. 230 V AC power supply shall be made available by Bidder. Bidder shall supply, lay & terminate the power supply cables from that point to the respective system panels for I&C system. Power supply cables for further distribution of power supply within the panel & from panel to field shall be provided by Bidder.
 - c) Cable trays / GI /PVC conduits for all the above cabling. The cable trays in the outdoor areas shall be provided with covers.
- 4.3.1.6. All erection hardware including structural steel for erection of all field instruments, cable trays/ GI / PVAC conduits, panels etc. shall be provided by the BIDDER. BIDDER shall supply all necessary erection hardware required for proper installation of the instruments
- 4.3.1.7. Earthing for all field instruments, panels, PDBs etc. shall be in the scope of contractor.
- 4.3.1.8. Bidder's scope of work shall include complete loop checking of all measurement & command chains.
- 4.3.1.9. Integration & commissioning of the complete system.
- 4.3.1.10. Minor civil work such as wall opening & sealing it back after laying of cable trays / conduits, pedestals for stanchions, grouting, anchor fasteners for supporting etc. are included in scope of bidder
- 4.3.1.11. Site Acceptance tests (SAT) to meet the design specifications & functional requirements as specified.
- 4.3.1.12. Assumptions to cover lack of information are not allowed. Bidder is obliged to obtain reliable information from EMPLOYER/ PROJECT MANAGER.
- 4.3.1.13. The compliance with this specification does not relieve the Bidder from his responsibility towards contractual obligations with regard to completeness, satisfactory operation and easy maintenance of the unit
- 4.3.1.14. Supply & erection of GI / PVC conduits as required for cabling.
- 4.3.1.15. The BIDDER's scope of work shall include trial runs, start up, commissioning and process trials of systems covered in this specification.

4.3.2 DESIGN CRITERIA

- 4.3.2.1. All instruments shall be suitable for use in hot, humid, tropical & dusty climate.
- 4.3.2.2. Field mounted electrical and electronic instruments shall be weatherproof to IP-65. All instruments of submersible type if any shall be protected to IP-68.
- 4.3.2.3. Wherever the service is hazardous, the field transmitters shall be intrinsically safe. For switches, solenoid valve & junction boxes suitable ex-proof enclosure shall be

provided in hazardous areas. For intrinsically safe instruments suitable barriers shall be provided in relay control cabinet by BIDDER.

- 4.3.2.4. All panels, control desks & enclosures shall comply with the requirements of protection classes as indicated below

In-door Air-conditioned (A.C.) areas	IP 20
In-door Non A.C. areas	IP 42
Outdoor areas	IP 65

- 4.3.2.5. The field junction boxes for indoor application with IP55 and outdoor JB with IP65 shall be provided.
- 4.3.2.6. All wetted parts shall be of minimum SS 316. However, based on the process application, suitable superior material shall be provided to match the process.
- 4.3.2.7. All instruments and control devices located on control panels shall be of miniaturised design, suitable for modular flush mounting on control panels with front draw out facility and flexible plug-in connections at the rear.
- 4.3.2.8. The I&C system shall be designed by selecting high-grade components of proven quality and proper design of system electronics. The system shall be highly reliable with high-integrity and high MTBF system.
- 4.3.2.9. All instruments, control systems and accessories furnished under this specification shall be from the latest proven product range of a qualified manufacturer whose successful performance has been established by a considerable record of satisfactory operation in utility power stations.
- 4.3.2.10. The normal working range of all indicating instruments shall be between 30% and 80% of the full range.
- 4.3.2.11. For pressure switches and temperature switches, the set points shall fall within 30% to 70% of the scale range selected.
- 4.3.2.12. For level measurement, the maximum of the range will cover the overflow point or six inches from the top of the tank and the minimum of the range will be six inches above the bottom of the tank. Also, the gauge glasses will be stacked with overlap to cover permissive, alarm and trip levels.
- 4.3.2.13. The performance of all instruments shall be unaffected for the variation in voltage and frequency of the power supply.
- 4.3.2.14. Provision shall be made for external adjustment of span and zero for all instruments for calibration.
- 4.3.2.15. All the hardware/software shall be latest and field proven as available in the market.
- 4.3.2.16. All requirements of auxiliary equipment for instruments and control devices including thermo wells, resistance elements and transmitters, special wiring and piping accessories, air filter and pressure regulators, condensation pots and all other special devices required for installation in instrument piping and wiring system shall be furnished complete as required for each individual element, instrument or system unless specifically stated otherwise in this specification.

- 4.3.2.17. Tag numbering philosophy would be uniform for the entire plant. There would be a single, unique tag for a given equipment / signal.
- 4.3.2.18. All parts subject to high pressure, temperature or other severe duty shall be of materials and construction suitable for the service conditions and long operating life.
- 4.3.2.19. Components of instruments, control devices, accessories, piping etc. which contact with steam, condensate or boiler feed water shall be manufactured from copper free materials which do not react with media at operating parameters.
- 4.3.2.20. Instruments for location in outdoor/indoor/air-conditioned areas shall be designed to suit the environmental conditions and shall be suitable for continuous operation in the operating environment without any loss of function or departure from the specification requirements covered under this specification.
- 4.3.2.21. The power supply for the instrumentation & control system shall be 24 V DC, unless otherwise specified.
- 4.3.2.22. IBR certification wherever applicable shall be provided with the instruments.
- 4.3.2.23. For interlock and protections dedicated switches shall be provided. All trip condition shall be preceded by pre warning.
- 4.3.2.24. 230 V AC power distribution board (PDB) / UPS distribution board in the control rooms.
- 4.3.2.25. Earthing pits.

4.3.3 SPECIFIC REQUIREMENTS / INSTRUCTION TO BIDDERS

- 4.3.4.1. This is a unit rate contract. Price shall be quoted as per the specifications in section. The quantities of cables, conduits, trays etc. is estimated based on the Plot plan drawing. Bidders are advised to go through the tender document carefully and suggested that clarifications, if any, are obtained from Department before submission of their quotation.
- 4.3.4.2. The construction of this facility requires that, all BIDDERS adhere to good daily housekeeping practices. During construction the BIDDER shall every day, keep all work and storage areas used by them free from accumulation of waste materials. Scrap / rubbish shall be removed from the site to the satisfaction of the EMPLOYER. The BIDDER shall maintain a crew to carry out this function without any additional payment.
- 4.3.4.3. It is not the intent to specify completely herein all details of design and construction of equipment or materials to be supplied or of services to be rendered.
- 4.3.4.4. However, the equipment, materials and services shall conform in all respects to high standards of engineering design, workmanship and be capable of performing in continuous commercial operation in a manner acceptable to EMPLOYER who will interpret the meaning of drawings and specifications and shall have the power to reject any work or material which in his judgement are not in full accordance therewith.
- 4.3.4.5. Any item which may not have been specifically mentioned herein but are needed to complete the equipment / system shall also be treated as included and the same shall also be furnished and erected, unless otherwise specifically excluded as indicated.

- 4.3.4.6. To enable thorough and fast scrutiny of the BIDDER's offer, BIDDERS are advised to respond all their technical data in the enquiry by clearly marking out their response, wherever they want to provide additional data and / or they deviate from the specified requirements. In case of full compliance, the enquiry specification and data sheets will remain unaltered. Each data sheet & write up in specification shall be signed and stamped by the BIDDER. This requirement is very important. Non compliance of this by the BIDDER may result in their bid being rejected.
- 4.3.4.7. BIDDER is advised to quote for the complete scope and partial response will not be entertained. In case of few items which do not directly fall under BIDDER's manufacturing range and / or not available from indigenous source, BIDDER should take the responsibility upon themselves to arrange to procure them and supply to ensure that their offer is complete in all respects.

4.3.4 CODES AND STANDARDS

- 4.3.5.1. All equipment, systems and works covered under this specification shall comply with all currently applicable statutes, regulations, standards and safety codes in the locality where the equipment will be installed.
- 4.3.5.2. In particular, the following standards are applicable (latest editions)

ANSI :American National Standards Institute

1.1.1. Control Valve Seat Leakage classification.

ASME : American Society for Mechanical Engineers

BS : British Standards

BS-5308 Part-I Specification for Polyethylene insulated cables.

DIN-43760 Temperature Vs Resistance curves for RTD.

IEC : International Electro technical Commission

IEC 79 Electrical Apparatus for Explosive Gas atmosphere

IEC-332 Test on bunched wires or cables.

IEC 529 Classification of degree of protection provided by enclosures

IEC 584-2 Thermocouple Tolerances

IEC 751 Industrial RTD Sensors.

IEC 801 Electromagnetic compatibility for industrial for industrial Process measurement and control.

ISA : Instrument Society of America

S-5.2 Binary Logic Diagrams for Process Operations.

S-7.3 Quality standard for instrument air

S-75.01 Flow equations for Control Valve Sizing

ISO : International Organization for Standardization.

ISO-5167 Measurement Of fluid flow in closed conduits

NEC : National Electric Code

NEMA : National Electrical Manufacturer's Association

ICS-6 Enclosures for industrial control system

IS:13947. Low voltage switchgear and control gear : General rules
Part-1

IEC 326.

Printed Circuit Boards

- 4.3.5.3. Other national standards established to be equivalent or superior to the codes and standards specified are also acceptable. The BIDDER shall furnish English translation of all those standards apart from those mentioned in this specification.
- 4.3.5.4. In the event of any conflict between the codes and standards referred to in the specification and the requirements of this specification, the more stringent of these requirements shall govern.
- 4.3.5.5. Unless indicated otherwise, all codes and standards referred to in this enquiry specification shall be understood to be the latest version on the date of offer made by the Bidder.

4.3.5 MAINTENANCE REQUIREMENTS

- 4.3.6.1. In order to carry out preventive maintenance, it should be possible to readily disassemble, repair, reassemble the I&C equipment in the shortest period and to attend to any defect by a minimum disassembly.
- 4.3.6.2. All system must have convenient maintenance characteristics including :
 - a) Minimum disturbance to production during preventive maintenance.
 - b) Easy access to replacement part which can be installed by personnel with minimum skill.

4.3.6 I&C SYSTEM CONFIGURATION

4.3.7.1. SPRINKLER SYSTEM

- a) Instruments shall be provided for the system as per P&ID & data sheets in as per specification.
- b) Alarm from these instruments shall be annunciate in Window Annunciator located in Fire Fighting Panel.

4.3.7.2. HYDRANT SYSTEM

- a) Instruments shall be provided for the system as per P&ID & data sheets in specification.
- b) Alarm from these instruments shall be annunciate in window Annunciator located in Fire Fighting Panel.

4.3.7.3. JUNCTION BOX

- a) All the cables shall be wired to Fire Fighting Panel through Junction Boxes.

4.3.7.4. FIRE PROTECTION SYSTEM CONTROL PANEL

- a) A relay based Fire Protection Panel shall be provided for local operation and monitoring at fire water pump house. The panel shall house the logic of operation and Annunciation of Fire water pumps. Auto manual switches and push buttons

will be provided on panel for local operation of pumps. The annunciator shall be microprocessor based, split type with alarm windows mounted on front door and electronic components inside the panel. Potential free contacts shall be wired up to the terminals inside fire protection panel for each of the alarm. The control supply for the panel shall be 24V DC. The panel will be provided with 230V AC from reliable supply from UPS, AC to DC converter in redundant mode will be provided in the panel.

4.3.7.5. The operation in auto & manual modes shall be as below:

a) Auto mode

- In the auto mode, the pumps shall be started / stopped as per the table given in P&ID.

b) Jockey Pumps

- The jockey pump shall start/stop automatically based on the pressure in the delivery header P&ID. Alarms shall be provided for indication 'trip' & 'failed to operate' status of jockey pump.

c) Main Fire Water Pumps

- The main fire water pumps shall start at the pressures in the hydrant header as given in P&ID. If the main fire water pump fails to start, the system pressure will fall further. When the reaches header as given in P&ID, the standby fire water pump shall start automatically.
- The main & standby engine driven fire water pumps shall be stopped manually by pushbuttons on the MCC even in the auto mode.
- Alarm shall be generated at delivery header pressure as given in P&ID to alert the operator to stop the fire water pump.
- Alarms shall be provided for indication of running, trip & failed to operate status of each fire water pump (main & engine driven) and trip & failed to operate status of jockey pump. The potential free contact from pressure switches provided in the discharge of each pump shall be used for indication of 'Pump running.
- Provision for Potential Free contacts shall be provided in fire Protection Panel for wiring the Pump trip signal of Fire water Pumps to DDC (If any).

d) Manual mode

- In the manual mode, the fire water pumps & jockey pumps shall be started/stopped using pushbuttons provided on the MCC.

- 4.3.7.6. The control voltage shall be 24 VDC. The power supply (230 V AC) shall be made available in the panel by the bidder from the MCC.
- 4.3.7.7. 2 nos of level switch shall be considered for Fire Water storage tank which will generate potential free contact for Hi & Low level alarm in relay based Fire Protection Panel.
- 4.3.7.8. Level indicator or Gauge shall be considered for fire water storage tank for local monitor purpose.
- 4.3.7.9. The cables to be considered are armored cables.
- 4.3.7.10. Cables inside Pump house shall be laid over perforated trays.

4.3.7 SPECIFICATION FOR THE ALL THE FIELD INSTRUMENTS SHALL BE AS GIVEN BELOW

4.3.8.1. Pressure Gauges

Sr.No	Description		Employer's requirement
1	Type	:	Direct Reading
2	Casing	:	SS 304
3	Glass	:	Toughened borosilicate shatterproof
4	Dial size	:	150 mm
5	Wetted Parts (including accessories)	:	SS 316
6	2-valve manifold	:	SS 316
7	Diaphragm seal	:	SS 316 (with suitable coating of material if required)
8	Pointer	:	Aluminium
9	Movement & socket	:	SS 316
10	Accuracy	:	± 1.0 % of full scale
11	Process Connection	:	Bidder to State
12	Over range protection	:	25% above maximum pressure
13	Accessories	:	<ul style="list-style-type: none"> • Syphon for services above 75oC • Snubber for pump discharge applications • Chemical diaphragm for corrosive fluid

		lines (acid, alkali etc.), in discharge of sludge transfer pumps & in oil. • 2-valve manifold (2-valve manifold & snubber is not be required for diaphragm seal application.) • SS name plate.
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4.3.8.2. Pressure Switch

Sr.No	Description		Employer's requirement
1	Type	:	Non-indicating type
2	Casing	:	Aluminium casing
3	Wetted Parts (including accessories)	:	SS 316
4	Repeatability	:	+ 1.0 % of full scale reading
5	Micro switch contacts	:	2 Nos. SPDT contacts rated 5A at 240V AC.
6	Over range protection	:	25% above maximum pressure
7	Accessories	:	Syphons for services above 75oC, snubbers for pump discharge applications and chemical diaphragm for corrosive & oil services, 2-valve manifold and SS name plate

4.3.8.3. Solenoid Valve

Sr.No	Description		Employer's requirement
1	Type	:	Direct operated (rated for insulation class "F")
2	Power supply	:	24V DC
3	Size	:	Full port
4	Material Construction of	:	Body – Brass Internals - SS 304
5	Accessories	:	SS Nameplate, Free wheeling diode is required across the solenoid
6	Applications	:	Three (3) way solenoid valve shall be provided single acting spring return cylinder for pneumatically operated on-off valves.

7	Notes: Terminal blocks and Manual actuator shall be provided in the solenoid valves.
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4.3.8.4. Level Gauge / Indicator – Float & Cord

Sr. No.	Description	Qty.	Employer's requirement	
	GENERAL			
1.	Manufacturer			
2.	Model No.			
	FEATURE			
3.	Calibrated scale board		Required	
4.	Colour of numerals		Black	
5.	Accuracy		± 10 mm	
6.	Enclosure		IP 65 or equal	
7.	Mounting		Top	
8.	Height of numerals		40 mm high minor marking at every 100 mm; 70 mm high major marking at every 1000 mm	
	MATERIAL OF CONSTRUCTION			
9.	Float		SS 316	
10.	Float cable		SS 316	
11.	Anchor		SS 316	
12.	Spring assembly		CS with cadmium plating	
13.	Board		Aluminum epoxy painted	
14.	Guide wires		SS 316	
15.	Elbows		Aluminum epoxy painted	
16.	Flanges		SS 316	

	CONNECTION & DIMENSIONS			
17.	Type		Flanged	
18.	Flange size		4"	
19.	Flange rating		#150 S. O. RF	
20.	Name plate/ metal tag		Fixed SS304	
	Installation hardware		Required	

4.3.8.5. Float Switch

Sr. No.	Description	
1.	Manufacturer :	*
2.	Model no. :	*
3.		
4.	FEATURES	
5.	Calibrated scale board	
6.	Colour of numerals :	
7.	Height of numerals :	
8.	Accuracy : +/- 5 mm <input checked="" type="checkbox"/> +/- 10 mm <input type="checkbox"/>	
9.	Range :	
10.		
11.	MATERIAL OF CONSTRUCTION	
12.	Float : SS 316 <input checked="" type="checkbox"/> <input type="checkbox"/>	
13.	Float cable : SS 316 <input checked="" type="checkbox"/> <input type="checkbox"/>	
14.	Anchor : SS 316 <input checked="" type="checkbox"/> <input type="checkbox"/>	
15.	Spring assembly : spring steel <input checked="" type="checkbox"/> CS with cadmium plating <input type="checkbox"/>	
16.	Board : Aluminum epoxy painted <input checked="" type="checkbox"/> Aluminum polyurethane painted <input type="checkbox"/>	
17.	Guide wires (refer note 4 & 5) : SS 316 <input checked="" type="checkbox"/> <input type="checkbox"/>	
18.	Elbows : : Cast Aluminum Aluminum epoxy painted <input checked="" type="checkbox"/> Aluminum polyurethane painted <input type="checkbox"/>	
19.	Pulley: SS316 <input checked="" type="checkbox"/> Aluminum <input type="checkbox"/>	

20.	Pipe enclosing float cable: GI <input type="checkbox"/> SS 316 <input type="checkbox"/>	
21.	CONNECTIONS & DIMENSIONS	
22.	Type : flanged	
23.	Flange size :	
24.	Flange rating	
25.		
26.	ACCESSORIES (REFER NOTE 3)	
27.	Mounting brackets	
28.	Name plate / metal tag	
29.	Gaskets, bolts, nuts	
30.	All installation hardware	
31.		
32.	CODES & STANDARDS	
33.	Refer note - 2	
34.		
35.	TESTS	
36.	Performance :	
37.	Calibration :	
38.	Hydro test for the float :	

	DRAWINGS/DOCUMENTS	
1.	Vendor shall submit data sheets, catalogue and erection sketch for review and comments by Employer/Project Manager.	
2.	Vendor shall submit instruction manual for records.	

	TEST CERTIFICATES	
1.	Vendor shall submit all routine test certificates for Employer/Project Manager's review.	

NOTES :

- 1.0 *: bidder to state / furnish details; 3: required; – not required.
- 2.0 The bidder shall indicate all applicable codes & standards.
- 3.0 All accessories shall be supplied as applicable.
- 4.0 Sufficient float & guide wire to be supplied on single length to cut at site as per requirement.
- 5.0 Option of counter weight instead of anchoring of guide wire at bottom is decided based on site condition of the Tanks
- 6.0 Refer follow-up sheets for service and application details.

4.3.8.6. Junction Boxes

Sr. No.	Description	Qty.	Employer's requirement	
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Sr. No.	Description	Qty.	Employer's requirement	
	GENERAL			
1.	Manufacturer			
2.	Model No.			
	FEATURE			
3.	Mounting		Wall/ column	
4.	No. of terminals		32 (2x16)	
5.	Terminal type		Screwed	
6.	Terminal size		Suitable for 2.5 sq. mm. wire	
7.	Mounting plate		Required	
8.	Cable entry		Bottom	
9.	Gland plate		Removable	
10.	Door		Single lockable door with gasket	
11.	Lock & key		Required	
12.	Sheet thickness		3 mm	
13.	Painting		Inside: glossy white; Outside: RAL 7032	
14.	Protection class		Weather proof to IP 65	
	MATERIAL OF CONSTRUCTION			
15.	Enclosure		MS with epoxy painting	
16.	Gasket		Neoprene	
17.	Cable entry sealing		Fire proof compound	
18.	Name plate/ metal tag		Fixed SS304	

Sr. No.	Description	Qty.	Employer's requirement	
19.	Installation hardware		Required	

4.3.8.7. Power Supply

230 V AC power supply for the I&C system shall be available from UPS. All field instruments/ valves shall operate on 24 V DC power supply. Two-wire field instruments shall be system powered (24 VDC) from the control system. The distribution of power in field, if required for the instruments/valves, shall be through a designated field mounted junction box (with fused terminals).

4.3.8.8. Instrumentation and Control Cables

- (a) All instrument cables for control and indication shall be flame retardant, Low smoke (FRLS) and tested in accordance with IEC 60332 Part 3 and Cable design shall be as per EN 50288-7.
- (b) The basic specification of the conventional cables shall be as follows:

Conductor material	-	Tinned copper, with minimum 7 strands
Conductor size	-	1.0 mm ² for signal cable as minimum. 1.5 mm ² for control cable as minimum 1.5 mm ² for power cables as minimum Other sizes based on the load requirement
Core / Pair	-	1 Pair, 2 Pair, 6 Pair, 12 Pair for signal 1 Triad, 8 Triad for RTD signals 2 Cores, 3 Cores (Power), 6 Cores, 12 Cores, 24 Cores, 36 Cores for control cable
Insulation	-	Polyethylene
Voltage grade	-	660 / 1100 V
Inner sheath	-	PVC, black
Screening	-	Aluminium Mylar tape
Coverage	-	100%, Overlap 25%
Drain wire	-	Copper, 0.5 mm ²
Armouring/ Braided	-	GI wire /strips

Outer sheath	-	FRLS PVC for 90°C Blue (IS), Grey (Non IS / Exd), Black (Power)
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(c) Cables for earthing

1100 V, FRLS, PVC insulated, Green color, stranded copper cable.

- (d) All multipair & multicore cables shall be provided with 20% (of used pairs/cores) spare pairs & cores for future use.

4.3.8.9. CABLE TRAYS AND CABLE GLANDS

(a) Cables Glands

Cable entries in field instruments & panel shall be using cable glands. The cable glands shall be of double compression type with high quality neoprene gaskets. Cable glands shall be of brass with nickel plating.

(b) Cable trays

Cable trays shall be perforated of hot dipped galvanized steel. I&C cables (24 V DC) and power cables (230 V AC) shall be routed through different cable trays to avoid electromagnetic interference. Minimum 300 mm distance shall be maintained between I&C cables /24 V DC power supply cables and 415 V AC/ 230 V AC power cables. The thickness of the cable trays shall be 2mm while that of the tray covers shall be 1.5mm

4.3.8.10. FIRE PROOF SEALING OF CABLE PENETRATION

Cables/ cable tray openings in walls and floors or through pipe sleeves from one area to another or one elevation to another will be sealed by a fireproof sealing compound. The fire-proof sealing compound will effectively prevent the spread of fire from the flaming to non-flaming side, in the event of fire.

4.3.8.11. WIRING

All inter cubical and internal wiring for all panels/ junction boxes/ power distribution boards shall be carried out with 1100V grade, stranded tinned copper conductors with insulation. The minimum size of the stranded copper conductor used for the panel wiring shall be 1.0 mm² for analog signals and 1.5 mm² for 24 V DC control commands. For power supply, the conductor size shall be provided as per the load rating (min. 2.5 sq. mm for 230 V AC and 1.5 sq.mm. for 24 V DC). Control & Power wiring shall be segregated and routed in PVC troughs. Different colour wires shall be used for different voltages.

Engraved core identification plastic ferrules, marked to correspond with the panel-wiring diagram shall be fitted at both ends of each wire. Cross ferruling shall be done.

For termination of cables emanating/entering the panels & junction boxes etc. Terminal blocks shall be provided. For 24 V DC power distribution to panels/ junction boxes, terminal blocks shall be provided for cables emanating/entering the panels.

For 230 V AC PDBs & sub-PDBs, normal terminal blocks are acceptable.

All spare contacts and spare terminals of the panel mounted equipment and devices shall be wired to the terminal strips.

4.3.8.12. CABLE TERMINATIONS

Suitable termination accessories shall be provided for terminating on the terminal strips in junction boxes, consoles, panels, power distribution boards etc. All necessary cable terminating accessories such as removable gland plates, compression glands, supporting clamps and brackets, wiring troughs and gutters, etc. shall be included in the BIDDER's scope of supply. Cable entry into the junction boxes, consoles, panels, power distribution boards etc. shall be using double compression Nickel plated brass.

Disconnect type terminals with fuses with visual indication of fuse down shall be provided at each digital input & output terminal.

Disconnect type terminals shall be provided for all inputs/ outputs to isolate field input and output for maintenance purpose.

4.3.8.13. RELAYS

All industrial relays used shall have 2 NO + 2 NC contacts.

Whenever relays are used (if applicable) to interface process input/outputs, 20% additional relays shall be provided. In addition, 20% spare space shall be provided in panels/junction box to install 20% additional relays or other items in future.

4.3.8.14. LABELS

All front mounted equipment, as well as equipment mounted inside the panels/junction boxes shall be provided with individual labels with equipment designation engraved. These shall be phenolic overlays (1.6 mm thick) with black background and white lettering and shall be fixed to the panel by stainless steel screws (counter sunk). The panels/junction boxes shall also be provided at the top with a label engraved with the designation. Lettering for panel/control desk/junction box designation shall be 6 mm. The minimum lettering size for instrument/device labels shall be 3mm. The lettering on the labels shall be subject to EMPLOYER'S approval. Labels of internally mounted equipment shall be clearly visible.

4.3.8.15. EARTHING

Each panel, junction box & power distribution board shall be provided with a safety ground bus & system ground bus made of copper securely fixed along the inside base of the panels. These buses shall be typically of 25 mm wide and 6 mm thick of copper. The safety ground bus shall be properly secured to the plant safety earthing. All metallic cases/frames of relays, instruments, other panel mounted equipment shall be connected to the safety ground bus and shields & drain wires of signal/control cables shall be connected to the system ground bus by independent copper wires of not less than 2.5 sq. mm. The system ground bus shall be electrically isolated from AC mains earthing bus. The insulation colour code for earthing wires shall be green with yellow bands.

4.3.8 TENDER EVALUATION

The BIDDER shall comply with all systems / parameters wherever they are specified in data sheets of specification. No credit will be given during tender evaluation, if parameters better than those specified are offered by the BIDDER.

4.3.9 SUMMARY OF DATA TO BE FURNISHED ALONG WITH BID AND AFTER PLACEMENT OF ORDER

The BIDDER shall ensure the following documentation are prepared and submitted to EMPLOYER for his review / record.

4.3.10.1. Technical Bid

- a) Specification, each data sheet & write-up in specification shall be signed / filled and stamped by the BIDDER indicating compliance to the specifications.
- b) The following drawings/ documents shall be submitted:
 - Dimensional Drawings of Junction boxes, Window annunciator panel along with BOQ.
 - Instrument list indicating, Make, Model No., Service, Type of Instrument.
 - Engineering activity and manufacturing schedule giving activity wise breakup to meet the delivery schedule.

4.3.10.2. Final Documents

- a) Operation and maintenance manuals.
- b) Quality assurance documentation specific for the project.
- c) Final as built documentation folder containing all items for future reference.

4.3.10 DATA AND DRAWINGS BY BIDDER (AFTER THE AWARD OF CONTRACT)

The BIDDER shall submit the following drawings / documents after award of contract. BIDDER shall adhere to the delivery schedule as submitted along with the BID. BIDDER shall also refer to data sheets in Data sheets for list of deliverables to be submitted for various instruments/ panels.

<u>Sl. No.</u>	<u>Details</u>
(a)	PERT/Bar chart for the design, manufacturing, erection, commissioning, trial operation and performance testing of the system offered.
(b)	System Functional Write-up.
(c)	Unpriced purchase order copy for various bought out /sub contracted equipment / services.
(d)	Letter from Sub BIDDER(s) showing order acceptance and adherence to project schedule.
(e)	Junction Box list with data sheets, Internal G.A. drawings, internal wiring drawings & BOQ, quantity & model no. of all instruments/ items mounted in the junction boxes. Window annunciator panel list with data sheets, Internal G.A. drawings, internal wiring drawings & BOQ, quantity & model no. of all instruments/ items mounted in the junction box.
(f)	Heat load and Power consumption for all I&C loads.
(g)	Instrument list with tag numbers, Makes and Model nos., Service, Type of instrument.
(h)	Data sheets & catalogues for all instruments (including panel mounted instruments), installation sketches along with erection bill of quantities for all field mounted instruments and loop diagrams.

<u>Sl. No.</u>	<u>Details</u>
(a)	Data Sheets & catalogues for I&C cables & power cables.
(b)	QAPs for all items like field & panel mounted instruments, valves, panels, junction boxes, cables etc.
(c)	Earthing diagrams.
(d)	Cable Schedules and Interconnection cable schedules.
(e)	‘As Built’ drawings.
(f)	Instruction manual for installation and start-up.
(g)	System operation and maintenance manual.

4.3.11 TESTING, INSTALLATION, COMMISSIONING AND ACCEPTANCE

4.3.12.1. General

On the basis of guidelines specified in this specification Bidder shall submit their own testing, installation, commissioning and acceptance procedure. The procedure shall include purpose of test, test definition, results expected and acceptance criteria.

4.3.12.2. Site Acceptance Tests (SAT)

Full integrated site acceptance test shall be performed before hand over of total system to the EMPLOYER. The test shall demonstrate functionality of the entire I&C system supplied & erected by the BIDDER. The BIDDER shall provide all personnel, test facilities, equipment and tools etc. for the same. All test instruments shall have calibration certificates from approved test house, valid for minimum 6 months. A test procedure is required for approval 2 weeks prior to the schedule start.

4.3.12.3. Instrumentation Testing Requirements

- a) Tests on cable
 - Check details are in accordance with the specification.
 - Check for physical damage.
 - Megger test between each core and armour/sheath.
 - Continuity check including screen continuity
 - Terminations in the Panels/ junction boxes/ battery with battery charger supplied & erected by the BIDDER.
- b) It shall be ensured that erection of junction boxes are as per approved layout drawings. Checking for tagging/identifications of all the panels /junction boxes shall be done. Checks for continuity and termination of all power signal

& control cables as per approved drawings shall be carried out. All the panels & junction boxes supplied & erected by the BIDDER shall be checked at site by carrying out the following tests:

- Visual & Mechanical testing.
- Power up tests on battery with battery charger, checking input & output voltages
- Checks on incoming voltage and power distribution in the various panels & junction boxes by switching on MCCBs/MCBs one after the other.
- Power up tests on the DC power supply system, checking input & output voltage
- Tests on electrical installation
- Checking of closing, tripping, supervision and interlocking of control devices.
- Checking operation of all alarm circuits.

c) Instrument Calibration.

- The services of factory trained instrumentation technicians, tools and equipment for field calibration of each instrument to its specified accuracy in accordance with the manufacturer's specifications and instructions for calibration shall be provided.
- Each instrument shall be calibrated at 0 percent, 25 percent, 50 percent, 75 percent and 100 percent of span using test instruments to simulate inputs and read outputs that are rated to an accuracy of at least 4 times greater than the specified accuracy of the instrument being calibrated.
- Such test instruments shall have accuracies traceable to the National Bureau of Standards as applicable.
- A written report on each instrument in the format required by the Employer shall be provided to the Employer certifying that it has been calibrated to its published specified accuracy. This report shall include a listing of the published specified accuracy and permissible tolerance at each point of calibration. The report shall be certified by the Engineer.

d) System Validation

- The services of factory trained and field experienced instrumentation engineer(s) shall be provided to validate each system and verify that it is operational and performing its intended functions as per specifications.

- Each system shall be validated by simulating inputs at the first element in loop (i.e. sensor) of 10 %, 50 % and 90 % of span, or on/off and verifying loop output devices (i.e. indicator, alarm etc.).
- During system validation, provisional settings shall be made on levels, pressure, temperature, alarms etc.
- Correct operation of controllers shall be verified by observing that the final control element moves in the proper direction to correct the process variable as compared to the set point.
- All logic sequences shall be verified to operate in accordance with the specifications.
- All defects and malfunctions disclosed by tests shall be corrected immediately. New parts and materials shall be used as required and approved and tests shall be repeated.
- A report certifying completion of validation of each instrument system indicating the errors observed during the validation and any provisional settings made to devices shall be provided. The report shall be made in the format required by the Employer and shall be certified by the Employer when he approves it.

e) Final Operational Testing and Acceptance.

- Upon completion of instrument calibration and system validation, all systems shall be tested under process conditions.
- The testing shall include, but not limited to all specified operational modes, taking process variables to their limits (simulated or process) to verify all alarms, failures, interlocks and operational interlocks between systems and/or mechanical equipment.
- Any defects or malfunctions shall be immediately corrected using approved methods and materials and the tests shall then be repeated.
- Upon completion of final operational testing, a report shall be submitted, indicating that the total control system provided meets all the functional requirements specified herein. This report shall be made in the format required by the Employer. The Employer shall certify this report when he approves it and it shall constitute final acceptance of the control system.

4.3.12.4. Commissioning

- a) Commissioning Procedure shall be carried out in a methodical sequence as follows

- Start-up,
 - Initial running,
 - Operability adjustment,
 - Stable operation
 - Final adjustment
- b) The BIDDER shall check the operating conditions of the Plant by constantly monitoring operating data.
 - c) The BIDDER shall specify for each discrete part of the Plant the operational data to be recorded and the manner in which the data is to be taken.
 - d) All the operating data shall be recorded, evaluated and submitted to the Employer.

4.3.12 SPARE PHILOSOPHY

- 4.3.13.1. Spare shall include spare parts, special tools and tackles, including tool box, as required for pre-commissioning & commissioning, start-up and interim operation, day-to-day maintenance, any premature failures for the facilities and first one years operation.
 - a) Start-up and Commissioning spares
 - b) Mandatory spares
 - c) One-year operational spares
 - d) Special tools and equipments (if required)
- 4.3.13.2. Following spare philosophy shall be followed for field instrument:
 - a) Local gauges, instruments, switches, lamps etc. – 10% of each type/model or 1 No. minimum whichever is higher
 - b) All electronic items/ transmitters – 10% of each type/model or 1 No. minimum whichever is higher
- 4.3.13.3. Following spare philosophy shall be followed for the control system:
 - a) For relays and passive components in panel, minimum 20% spare components shall be provided.
 - b) In addition, 20% spare space shall be provided in panels/junction box / cabinets to install relays or other items in future.

4.4 DATASHEETS

4.4.1 DATA SHEETS FOR HORIZONTAL CENTRIFUGAL PUMPS

4.4.1.1. DATA SHEET A

	1. Designation: Refer Table-1		25. Drive transmission :
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			Direct / Gear / Pulley
General	2. Number Required : Refer Table-1		26. Seal : Gland Packing /
	3. Tag Numbers : - Refer Table-1	construction features(continued)	Mechanical Seal
	4. Location : Indoor / Outdoor		Single / Double
	5. Operation : Continuous /		27. Pump Driver : [Refer Table-1]
	Intermittent As And When Required		Motor As Per Data Sheets Of Low Voltage Induction Motor
	6.		Steam Turbine As
	7. Liquid Pumped :Fire Water		Diesel Engine As Per Specification
	8. Temperature : Ambient		By Employer / Vendor
	9. Specific Gravity : 1		28. Nozzle orientation:
Design Data	10. Viscosity: Kg/M/S		Side Suction Side Discharge /
	11. % Solid By Weight : NIL		End-Suction Top-Discharge Back Pull-Out Type
	12. Maximum Size Of Solid : mm		Top Suction Top Discharge
	13. Design Capacity : Refer Table-1		29. Flange drilling standard :
	14. Minimum Suction Head : 0 Mle		ANSI B 16.5, 150#
	15. Maximum Suction Head : Mle		30. Flange Face : FF
	16. minimum discharge head:		31.
	17. Differential Head : Refer Table-1	materials of construction	32. Casing :CI IS 210 GR. FG 260
	18.NPSH Available: Flooded Suction		33. Impeller : Bronze To Is 318 Gr 2
	19.Design Code : IS:5120 (Refer Note-4)		34. Shaft :AISI 410 ASTM A 276
Construction Features	20. Type Of Pump : : Refer Table-1		35. Shaft sleeve : ASTM A 276 GR. 410 hardended and tempered
			36.Casing Ring : bronze to IS 318 GR 2
	21.Impeller: open/semiopen /closed		37. Impeller Ring :NA
	22. volute :As Per Mfr's Standard		38. Stuffing Box Packing :Graphite
	Single / double / diffuser		39. Base plate : CS IS 2062 GR. A
	23. Shaft : coupled / monoblock		40. Companion Flanges :For Size
	24. Coupling : flexible /spacer		≤150 ASTMA 105; ≥150 IS 2062-

			1992
	41. Companion flanges with nuts,	spares and maintenance tools and tackles	57.
	Bolts, Gaskets : Yes/ No		58.
	42. Common Base Plate : Yes/ No		58.1
	43. Foundation Bolts : Yes/ No		58.2
	44. Coupling : Yes/ No		58.3
	45. Coupling Guard With Bolts : Yes		58.4
Accessories	46. Drip Tray : yes/ no	performance guarantee	59. Capacity :
	47. lantern ring : yes/no		+ (-) nil refer table-1 m ³ /hr
	48. Bearing temperature gauges :		60. Differential head :
	yes/no		+ (-) nil refer table-1 mlc
	49. Priming tank with accessories :		61. Power Consumption :
	yes/no		+NIL (-) (*) kw
	Capacity : M ³	Cost Loading And Penalty	62. power consumption :
	50. Foot Valve : Yes/No		rs. _____ / kw
	Size And Number : mm NB And		63.
	51. Strainer: Yes/No		64.
	52. Suction Pressure Gauge : Yes/No		65.
	53. Discharge Pressure Gauge: Yes/No	Tests And Inspection	66.
	54. motor starter : yes/no		
	55. Recommended Spares : yes/ no		(see note 1)
	56. Painting : Epoxy / Synthetic		67. Hydrotest Duration :
	enamel yes/ no		68.

TABLE-1**DETAIL OF PUMPS**

SL. NO. IN DATA SHEET	DESCRIPTION	UNITS	PUMP-1	PUMP-2	PUMP-3
1.0	Designation		Fire water main pump [refer note-2]	Fire water stand by pump [refer note-2]	Jockey pump [refer note-5]
2.0	Tag Numbers	-	P-1	P-2	P-3
3.0	Number Required	Nos.	1	1	1
4.0	Design Capacity	M ³ /Hr	171	171	10.8
5.0	Differential Head	Mwc	88	88	88
--	Maximum Speed	Rpm	1500	1500	2900
6.0	TYPE OF PUMP		End-Suction Top-Discharge Back Pull-Out Type	End-Suction Top-Discharge Back Pull-Out Type	End-Suction Top-Discharge Back Pull-Out Type
7.0	Drive Data/ Prim Mover		Motor	Diesel Engine	Motor

NOTES

1. Additional tests indicated as 'B' in shops inspection requirements shall also be carried out when it is applicable.
2. pumps shall be capable of furnishing not less than 150% of the rated capacity at a head not less than 65% of the rated head. the shut-off head shall not exceed 120% of the rated head
3. * value / capacity to be indicated by bidder
4. negative tolerance on capacity, head & efficiency is not acceptable.
5. for vertical inline jockey pumps moc shall be as follows:-
base/adaptor -grey cast iron, impeller / intermediate chamber -AISI-304, shaft-AISI-316

4.4.1.2. SCOPE

This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at manufacturer's works and delivery at site of Horizontal Centrifugal Pumps.

4.4.1.3. CODES AND STANDARDS

The design, materials, construction, manufacture, inspection, testing and performance of horizontal centrifugal pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to latest applicable Indian or equivalent standards. Other international standards are also acceptable, if these are established to be equal

or superior to the listed standards. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

4.4.1.4. DESIGN REQUIREMENTS

- a) Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division. Components of identical pumps shall be interchangeable.
- b) Flow rate versus head curve shall have stable and continuously rising characteristics towards the shut-off head. In case of unstable (drooping) characteristics the duty point shall be well away from the unstable region. Besides the actual flow rate versus head curve, curves for minimum and maximum impeller diameters shall also be shown.
- c) The shut-off head shall be at least 110% of the differential head.
- d) The required NPSH at duty point shall be at least one (1) metre less than the available NPSH.
- e) The rating of the pump driver shall be the larger of the following:
 - The maximum power required by the pump from zero discharge to run-out discharge at site climatic conditions.
 - 110% of the power required at the duty point at site climatic conditions.
- f) The corrosion allowance for pressure parts shall be 3 mm.
- g) Pumps shall run smooth without undue noise and vibration. Noise level produced individually or collectively shall not exceed 85 dB (A) measured at a distance of 1.86 metres from the source in any direction. The overall vibration level shall be as per zones A and B of ISO 10816-1
- h) In case of fire water pumps, pumps and drivers with all the accessories shall meet the requirements of Tariff Advisory Committee (TAC) or any other standard as called for in data sheet A. Pump type shall be as accepted by TAC accredited Agency.

4.4.1.5. CONSTRUCTION FEATURES

- a) In addition to static balancing, impeller and balancing drum shall be balanced dynamically at or near the operating speed.
- b) Pump shall be provided with renewable type casing ring. Pump having capacity 1,000 M³/Hr and above shall be provided with impeller ring in addition to casing ring. The hardness of impeller ring shall be 50 BHN higher than that of casing ring.
- c) Pump casing shall be provided with drain and vent connection with plugged or valve connection.
- d) Bearing shall be oil-lubricated or grease-lubricated and shall have a life of 40,000 hours of working. In case of oil-lubricated bearing, constant oil leveller with magnetic drain plug shall be provided.
- e) Replaceable shaft sleeves shall be provided to protect the shaft where it passes through stuffing box.

- f) Stuffing box shall be of such design that it can be repacked without removing any part other than the gland and lantern ring.
- g) Mechanical seals shall be provided if called for in data sheet - A. If required, a flushing line shall be furnished, complete with strainer and orifice, from the pump discharge to the sealing face. When pumping liquid is not suitable for this purpose, a flushing connection shall be provided so that it can be connected to an external source. Auxiliary piping and plan shall be in accordance with appendix - D of API 610.
- h) The allowable loads on the pump nozzles shall be at least twice the values listed in the relevant tables of API 610 without reference to any other criterion. The base plate shall be designed to cater to the above increased loads.
- i) In addition to accessories listed in data sheet A, any other accessories required for safe and efficient operation of pump shall be provided.
- j) All incidental piping and valves required for sealing, lubrication and cooling for stuffing box packing and/or bearing of pump shall be furnished by the VENDOR.
- k) Leakage from the pump shall be led to the nearest surface drain by OTHERS. Pump VENDOR shall provide necessary arrangement like drip tray, base plate drain connection etc.
- l) All pumps, except for back-pull out type, shall be provided with flexible coupling. Back-pull out type pumps shall be provided with spacer type coupling.
- m) Coupling guard made of expanded metal and bolted to the base plate shall be furnished for all coupled pumps.
- n) In addition to accessories listed in data sheet A, any other accessories required for safe and efficient operation of pump shall be provided.
- o) All incidental piping and valves required for sealing, lubrication and cooling for stuffing box packing and/or bearing of pump shall be furnished by the VENDOR.
- p) Leakage from the pump shall be led to the nearest surface drain by OTHERS. Pump VENDOR shall provide necessary arrangement like drip tray, base plate drain connection etc.

4.4.1.6. TESTS AND INSPECTION

- a) Hydrotest pressure on casing shall be 1.5 times maximum discharge head or twice differential head whichever is higher. (Maximum discharge head = shut-off head + maximum suction head). Unless otherwise stated in data sheet A, the hydrostatic tests on the casing shall be conducted for a minimum duration of 30 minutes.
- b) The pumps shall be tested as per IS 5120, at rated speed at MANUFACTURER's works to measure capacity, total head, efficiency and power. The negative tolerance on efficiency shall be limited to 2.5% and not 5% as indicated in IS 5120. These tests shall form the basis for acceptance of pumps except for vibration and noise. The pumps shall be tested over the range covering from shut-off head to the maximum flow. The duration of the test shall be minimum one (1) hour. Minimum five (5) readings approximately equidistant shall be taken for plotting the performance curves.

- c) After installation, the pumps shall be subjected to testing at site also. If the site performance is found not to meet the requirements regarding vibration and noise as specified, the equipment shall be rectified or replaced by the VENDOR, at no extra cost to the EMPLOYER.

4.4.1.7. PERFORMANCE GUARANTEE

- a) Performance parameters to be guaranteed by the VENDOR and tolerances permitted shall be as indicated in specification and/or data sheet A. BIDDER shall confirm acceptance of these by indicating values in data sheet B. Pump or any portion thereof is liable for rejection, if it fails to give any of the guaranteed performance parameters.

4.4.2 DATA SHEETS FOR DIESEL ENGINE AND ACCESSORIES

4.4.2.1. DATA SHEET A

1.0	<u>GENERAL</u> Make and model No.		
2.0	Nos. Required		1
3.0	Mode of operation		Continuous Duty Type
4.0	Diesel engine type		Radiator cooled
	<u>DESIGN DATA</u>		
5.0	<u>Site Conditions</u>		
	(a) Maximum ambient temperature	° C	35.6
	(b) Relative humidity at maximum ambient temperature	%	45
	(c) Altitude above mean seal level	Meters	921 M above MSL
	(d) Air temperature at the inlet of charge air cooler	° C	*
6.0	<u>Design Fuel Oil</u>		
6.1	Designation		High Speed Diesel
6.2	Standard		IS 1460-2005
6.3	Maximum engine speed	RPM	To Suit Fire Pump
6.4	Type of drive between diesel engine and driven equipment		Direct/gear/belts/other s
6.5	Maximum noise level	db (A)	85 at 1.0 M from

			Eqpt. Outline
6.6	Engine Air Data (Primary)		*
7.0	<u>SECONDARY COOLING WATER DATA</u>		Not Required
7.1	Designation		
7.2	Pressure at EMPLOYER's terminal point	Kg/cm ² (g)	
7.3	Temperature at EMPLOYER's terminal point (max.)	° C	
7.4	Total hardness	ppm	
7.5	Turbidity	ppm	
7.6	Chlorides (as CaCO ₃)	ppm	
8.0	Engine starting system		
9.0	Period for taking load from start impulse	Seconds	
	<u>SCOPE OF SUPPLY</u>		
10.0	Diesel engine		Yes
11.0	Driven equipment		Yes
12.0	Control panel		Yes
13.0	<u>Fuel Oil system</u>		
13.1	Day tank		Yes
13.2	Fan for Radiator		Yes
13.3	Hand operated transfer pump		No
13.4	Flexible hose on suction and discharge of hand operated transfer pump		No
13.5	AC motor driven priming pump with clock timer		*
13.6	Thermostatic heater		*

13.7	1 X 100 % Duplex filter or 2 x 100 % Simplex filters		*
13.8	Interconnecting fuel oil piping between engine, duplex filters and day tank with necessary valves, fittings and other specialities		*
13.9	Interconnecting piping from transfer pump to day tanks and suction piping for transfer pumps together with necessary valves, fittings and other specialities.		
14.0	<u>Air cooled Radiator System</u>		
14.1	Engine driven circulating Fan		Yes
14.2	Heat exchanger secondary cooling water cooled		No
14.3	Air cooled radiator		Yes
14.4	Complete jacket water interconnecting piping with valves, fittings etc.		No
14.5	Engine driven fan with guard		Yes
14.6	Air duct		No
15.0	<u>Secondary Cooling Water System</u>		
15.1	Complete interconnecting raw water piping with valves, fittings and specialities		No
16.0	<u>Engine Starting System - Electrical</u>		
16.1	Starter motor		Yes
16.2	Starter battery and battery charger		Yes(2×100% batteries)
17.0	<u>Engine Exhaust Gas System</u>		
17.1	Silencer		Yes

17.2	Complete exhaust gas piping with lagging, fittings, supports, expansion joints (i.e. bellows) etc.		Yes – To be led with hood & bird mesh outside Raw/Fire water Pump house building with min. 1 mtr. above the bldg.
18.0	Instrumentation as per write up		Yes
19.0	Base frame for engine and driven equipment		Yes
20.0	Holding down bolts and foundation bolts		Yes
21.0	Coupling between engine and driven equipment		Yes
22.0	Clutch between engine and driven equipment with engaging assembly		No
23.0	Coupling guard for coupling between engine and driven equipment		No
24.0	Painting at shop		Yes
25.0	Maintenance tools and tackles for entire plant		Yes
	<u>Construction Features</u>		
26.0	Fuel oil day tank capacity (Cylindrical)		Min. 6 hrs of engine rating
27.0	Air compressors		Not applicable
28.0	Starting battery type		Lead acid/alkali/other/ not applicable/ VRLA maintenance free
29.0	Type of base frame for engine and drive equipment		Mild Steel
	<u>Tests</u>		
30.0	Shop testing of fully assembled engine		Required
31.0	Final testing of complete diesel engine set plant at site prior to take over by the EMPLOYER		Required/ not required
	<u>Codes And Standards & Start Up And Essential Spares</u>		
32.0	ISO 3046		
			Refer note 1

Notes:

1. The following spare parts which will be adequate to the requirement of one engine shall be supplied with the engine (only one common set for the quantity of engines mentioned in specifications):
 - a) Two sets of fuel filters, elements and seals.
 - b) Two sets of lubricating oil filters, elements and seals.
 - c) Two sets of belts (where used).
 - d) One complete set of engine-joints, gaskets and hoses,
 - e) Two injector nozzles.
 - f) One complete set of piston rings – for all cylinders of the engine.
 - g) One inlet valve and one exhaust valve.
2. Starter battery for manual and automatic start of engine (one for each) and one common 2- rate trickle charger & the same should be capable to charge two batteries simultaneously. Battery capacity shall be adequate for ten consecutive starts without recharging with a cold engine under full compression.
3. The capacity of the diesel engine shall be as per IS 12469 for fire water pumping requirements. Necessary calculations along with pump curves shall be submitted to establish the same.
4. * - Bidder to fill
5. Fuel Oil Day Tank capacity mentioned in cl. No. 3.2 of Data sheets document shall be read as 6 hrs.

4.4.2.2. SCOPE

This specification covers the design, manufacture, construction features, erection supervision, delivery to site, commissioning, and performance testing of diesel engine along with accessories.

4.4.2.3. CODES & STANDARDS

The design, manufacture and performance of Diesel engine shall comply with all currently applicable statutes, regulations and safety codes in the locality where the Equipment will be installed. The equipment shall also conform to the latest applicable Indian/British/USA / ISO Standards. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility. In particular, the equipment shall conform to the latest editions of the standards followed.

4.4.2.4. DESIGN REQUIREMENTS

a) DIESEL ENGINE

- The diesel engine shall be radiator cooled and shall be furnished with at least the minimum equipment according to standard practice. The power rating, required auxiliaries, guarantees of fuel consumption, parallel operation, governor performance and torsional vibration shall be in accordance with ISO: 3046.
- The engine shall be provided with an exhaust gas turbocharger having a charge air cooler, integral intake air filter and silencer.

b) FUEL OIL SYSTEM

- An overhead 'Day' tank of about 10hours rated capacity or capacity which meets the Petroleum rules which ever is less shall be installed. The 'Day' tank shall be provided with a suitable electrical sensing device to signal 'low' oil level in the tank. A mechanical oil level indicator shall also be provided to indicate low and high levels. This tank shall in particular, conform to the requirements of IS:803 and API:650. A hand operated / motor operated transfer fuel pump with hoses / piping and other accessories shall be provided to transfer fuel oil to the day tank.
- Thermostatically controlled heaters shall be provided for heating the fuel oil, if ambient conditions warrant the same.

c) LUBE OIL SYSTEM

- Automatic pressure lubrication shall be provided by engine driven gear type pump. The system should be complete with an oil cooler and 1 x 100 % duplex fine-mesh filters or through 2 x 100% capacity individual filters. Differential pressure gauge across the filters or pressure gauges on either side of the filters shall be provided to monitor the cleanliness of the filters.
- The oil cooler shall be either air or water cooled and shall be equipped with the necessary bypass to bypass the cooler during start up until the oil temperature reaches the pre requisite value.
- Thermostatically controlled heaters shall be provided for heating the lube oil, if ambient conditions warrant the same.
- A DC motor driven standby lube oil pump shall be provided, if specified, to supply lube oil to the engine and turbo-charger on failure of the engine driven oil pump and/or during coasting down period of the engine.
- An AC motor driven intermittent operation pre lube oil pump shall be provided. This pump in conjunction with a suitable clock timer shall supply

lube oil intermittently to the engine when the engine is not in operation to keep the system primed with lube oil for remote and quick starting at any instant. A suitable pressure relieve valve protective device shall also be provided.

- For the charge air cooler and lube oil cooler, the air flow to the charge-air cooler shall be thermostatically controlled.

d) ENGINE STARTING SYSTEM

- Starting of the diesel engine shall be either by compressed air or by electric starting system as specified in Data Sheet-A.
- Electric Starting System
- The electric starting system shall comprise of starter motor, starter batteries and battery charger and all the required instruments and accessories. If automatic starting is specified in Data Sheet, facility shall also be provided for manual starting of the engine. Necessary auto / manual selector switch shall be provided on the diesel engine control panel. Suitable hydrometer shall be provided for testing the specific gravity of the battery electrolyte. A voltmeter should be provided and installed so that the voltage of the batteries may be ascertained.

e) AIR INTAKE AND EXHAUST SYSTEM

- The VENDOR shall provide an air intake filter and silencer (if required). Air will be taken from the diesel engine room.
- The exhaust shall consist of an exhaust driven turbocharger with lagged piping interconnecting cylinder head outlets with the turbocharger inlet. Exhaust manifold shall be of fabricated steel and it shall be suitably lagged. Exhaust gas from the turbocharger shall be led through an exhaust gas silencer. The exhaust gas silencer, necessary pipes, adapters, etc. shall be provided by the VENDOR
- The exhaust gas pipe shall be led to the atmosphere at a minimum of 3 meters above the building where the diesel engine is installed. The exhaust pipe shall be insulated for personal protection upto a safe height.

f) GOVERNING SYSTEM

- The governor shall be Woodward type EGB-10 or approved equal. The governor characteristics shall comply with the requirements of 'Class A 1-governing' of ISO 3046.

- The governor shall have the following features :
- The governor shall be provided with an electrically operated speeder gear for remote adjustment of generator frequency, suitable for operation on DC voltage indicated in Data Sheet-A.
- An overspeed trip mechanism shall be provided to automatically shut off fuel in case the set speed reaches about 110% of rated speed. The values at which the mechanism trips the engine shall be adjustable.
- An engine mounted emergency stop push button shall be provided which, when operated will trip the engine.

g) CONTROL SYSTEM FOR DIESEL ENGINE

- Unless otherwise specified in Data Sheet-A, tripping of the diesel set for a normal shut down will be done manually, by means of push buttons.
- It should be possible to shut down the diesel engine either through the local push button on the diesel control panel or through the remote push button. The trip impulse should directly go to the engine shut down device without passing through the local/remote selector switch.
- The diesel engine shall be tripped automatically under the following abnormal conditions :
 - ✓ Over speed of diesel engine set as sensed by over speed trip device.
 - ✓ Low lubricating oil pressure after engine has attained 90% speed.
 - ✓ Incomplete start after a preset time
 - ✓ DC control supply failure
 - ✓ Emergency stop
 - ✓ Generator fault
 - ✓ Any other tripping condition required for the safe operation of the engine.

h) CONTROL PANELS

- Suitable control panel comprising of necessary auxiliary relays, pushbuttons, DC voltmeters, DC ammeters, DC motor starter, control switches, etc. with complete panel internal wiring shall be provided by the VENDOR. Once the start push button is pressed or starting impulse is given (in the case of automatic starting), complete starting sequence shall be automatically

disengage and stop after the engine picks up speed. When the engine stops all the controls shall automatically be reset to its normal starting operation.

- Annunciators shall be supplied by the VENDOR and mounted on each diesel control panel to give visual and audible indication for the following conditions.
 - ✓ High lubricating oil temperature
 - ✓ Low lubricating oil pressure and trip of the engine.
 - ✓ Fuel oil day tank level low
 - ✓ Engine overspeed and trip
 - ✓ Failure to start
 - ✓ Standby lube oil pump in operation (if provided)
 - ✓ Lubricating oil priming pump (if provided) in operation
 - ✓ Fuel oil priming pump(if provided) in operation
 - ✓ Low DC voltage
 - ✓ Starting air pressure low (alternatively, if provided)
 - ✓ DC control supply failure
 - ✓ Four (4) Nos. spare windows shall be provided
- Each annunciator system shall be provided with :
 - ✓ One push button for acknowledging the audible alarm(visual indication shall persist)
 - ✓ One push button for resetting the visual indication after the fault has been cleared.
 - ✓ One push button for testing the illuminated transparencies.
- On the occurrence of a fault the audible alarm shall sound and the appropriate window shall light up. The audible alarm will be silenced by pressing the 'acknowledge' push button. The visual indication shall, however, persist until the relevant fault contact has reset after which the visual indication can be reset by the 'rest' push button.
- After acknowledgement of one trouble by the 'acknowledge' push button, the alarm circuit shall be ready to operate for another fault.

- The VENDOR shall provide all the sensing devices at the diesel engine for the above alarms and accessory relays at the control panel. These shall be suitable for operation on ungrounded DC system. The DC supply will be made available at the control panel by the EMPLOYER. Suitable name plates shall be provided for each window.

i) MOTORS

Drive motors shall conform to the companion specification data sheets of low voltage induction motor.

j) POWER AND CONTROL CABLES

The VENDOR shall include in his scope of supply all auxiliary wiring between the diesel engine and control panels.

k) INSTRUMENTS FOR ENGINE

The following instrumentation shall be provided:

Dial type thermometers shall be provided as follows :

- Lube oil outlet temperature from bearing.
- Lube oil temperature at lube oil cooler inlet/outlet
- Pressure gauges shall be provided as follows :
- At the discharge of all auxiliary pumps provided with the diesel engine.
- At the lube oil cooler outlet
- On air receiver

Differential pressure gauges across lube oil and fuel oil filters or separate pressure gauges on either side of the filter.

Pressure switches shall be provided for automatic starting of the DC motor driven standby lube oil pump on low lube oil pressure.

Pressure switches shall be provided for lube oil system to give on alarm if the pressure falls below a preset value and subsequently trip the unit when the minimum safe pressure limit has been reached.

A thermostat shall be provided at the lube oil outlet from engine bearing for alarm on high oil temperature.

Tachogenerator Primary sensing devices, control valves, controller etc. for :

- Lube oil temperature and pressure
- Fuel oil day tank low level

Leads from all the sensing devices and instruments to which the EMPLOYER's cables (from the engine to the diesel control panel) will be connected shall be neatly brought to terminal blocks.

The terminal block shall be properly identified.

1) PIPING, VALVES AND FITTINGS

All necessary interconnecting piping, valves and fittings, supports, filters and strainers shall be provided for lube oil, fuel oil and starting air systems. Terminal points shall be as indicated in specifications. The piping shall be designed, fabricated and tested in accordance with ANSI. B 31.1- Pressure piping code or approved equivalent.

4.4.2.5. ITEMS OF GUARANTEED PERFORMANCE

The following items of performance shall be guaranteed by the VENDOR in respect of the diesel engine units and the auxiliaries, when operating under the specified site conditions.

- Net electrical output at engine shaft
- Fuel oil consumption at full load
- Lubricating oil consumption at full load
- 10% overload for one hour without overheating or showing signs of undue stress and within specified frequency variation.
- Vibration and noise levels
- Governor response, overspeed trip and overspeed capability.

The VENDOR shall indicate the standards according to which tolerances on the performance figures will be applicable.

4.4.2.6. SHOP TESTS

The VENDOR shall perform all the following shop tests to ensure that the equipment conforms to the specifications and meets the performance guarantees.

a) Tests on the diesel engine shall include, but not be limited to, the following :

- One (1) hour at 50 % load
- One (1) hour at 75 % load

- Four (4) hours at full load followed by one (1) hour continuous load of 110%.
 - Specific fuel oil consumption measurement at various loads.
 - Vibration levels
 - Noise levels
- b) The Vendor shall perform hydraulic tests at 1.5 times the design pressure on all pressure parts.
- c) Readings shall be recorded at intervals of 15 minutes during the test period of diesel engine. The Vendor shall provide necessary calibrated instruments for the measurement of pressures, temperatures and flow of fuel oil, lubricating oil, jacket water etc, The tests shall be performed in accordance with ISO 3046.
- d) The VENDOR shall clearly indicate if he is not in a position to carry out any of the above tests.
- e) Copies of the test certificates and record of tests shall be submitted to the EMPLOYER for approval.
- f) In the event, the VENDOR cannot perform any or all of the tests mentioned above or the EMPLOYER cannot witness such shop tests if performed by the VENDOR, the VENDOR shall perform all the tests mentioned above at the site subject to EMPLOYER'S acceptance after installation and during commissioning.

4.4.2.7. PAINTING

- a) Machined and finished surfaces shall be protected against formation of rust and corrosion by application of suitable rust inhibitors.
- b) All steel surfaces which are to be painted shall be thoroughly cleaned, degreased and given one shop coat of primer, prior to assembly.
- c) All castings shall be sand blasted, degreased and cleaned before painting.

4.4.2.8. COMMISSIONING

The VENDOR shall perform the following tests at site, but not limited to the following to the satisfaction of the EMPLOYER :

- a) Specific Fuel Oil Consumption test
- b) Lube Oil Consumption test
- c) Vibration
- d) Noise level
- e) Automatic starting up
- f) Governor response

4.4.3 DATA SHEET FOR HYDRANT VALVE

DATA SHEET A

General	1. Type: Single headed-63 mm size conf	Materials of construction (contd.)	17. Hand wheel: es as per is 1030 or CI
	to IS 5290 type a with/ without		as per IS 210
	stand post of 80 mm nb		18. Seat washer:
	2. Type: double headed conf to is:5290		rubber as per IS 937 or leather
	— type b / two valves as above		as per is 581
	3. Lug type: pull out/ twist		19. Gland packing: asbestos free thread
	4. Flange drilling standard: ANSI		as per IS 4687 /
	B16.5 / is: _____ /		20. Spring: phosphor bronze wire
	5. Companion flange at stand post		as per is 7608 for cu alloy hydrant
	required: yes/no		Valve or SS wire as per IS 6528 for
	6. Size: 63 mm		al alloy/ SS hydrant valve
	7. Scope includes stand post - yes/no		21. Blank cap: ABS plastics
	8. Stand post size: 80 mm/ 100 mm		22. Stand post: same as firewater pipe
	9. Water: ordinary/ sea water		23. Companion flange at stand post:
Materials of construction	10. Hydrant valve shall bear ISI mark		Astm a 105
			24.
	12.		25.
			26.
	14. Valve body, bonnet, stop valve,		27.
	Checknut and instantaneous female		28.
	Outlet		29.
	14.1 leaded tin bronze as per gr 1tb2		30.
	— of is 318 ————— or	Pai ntin b	31. Valve top except face of flange

	14.2 al alloy as per designation		and instantaneous outlet:
	4225, 4450, 4600 of is 617 or		PO FIRE RED, shade no. 536 of IS 5
	14.3 SS as per grade 1/4 of IS 3444		32. Hand wheel: black as per IS 2932
	15. Valve spindle: brass rod as per is	Spares and maintenance tools and tackles	33.
	— 319 or is 320 for body of leaded tin		34.
	bronze or SS as per IS 6603 for body		34.1
	of al or ss		34.2
	16.		34.3
Tests and inspection	35. Test pressure for:	Approved sub-vendors	41.
	35.1 Water tightness: 14 kg/cm ² g		42.
	35.2 Valve body and gland: 21 kg/cm ² g		43.
	36. Flow test: 900 lpm @ 7.0 kg/cm ² g		44.
	37. As per shop inspection and testsand/or		45.
			46.
	as per specification and tac regulations		47.
	(note 1)		48.
	38.		49.
	39.		60.
40.	51.		
<u>Note</u>			
1.	Additional tests indicated as 'b' in shops inspection requiremets shall also be carried out when it is applicable.		
2.	Hydrant valve shall be ISI marked.		

4.4.4 DATA SHEET FOR BRANCH PIPES AND NOZZLES

DATA SHEET A

General	1. Standard: IS 903	Spares and maintenance tools and tackles	13.
	2.		14.
	3.		14.1
	4.		14.2
Is of construction	5.1 cu alloy as per sand castings:		14.3
	Gr hb2 of is 318 or gr hb1 of is 304		14.4

	Die casting: gr 3 of is 292	Tests and inspection	14.5
	Hot forgings: is 291		15. Test pressure: 21 kg/cm ² g
	Gravity die castings: is 1264		16. As per shop inspection and tests
	- or -		
	5.2 al alloy as per die castings:		
	Designations 4450, 4600 of is 617		17.
	-or-		18.
	5.3 SS as per grade 1 - or 4 of IS 3444		19.
			20.
	6. Washer: type b of IS 937	21.	
	7. Nozzle spanner: gr 35c4 or 40c8 of	22.	
	IS 1570 (Part 2/Section 1) – with	23.	
	Plating of chromium or zinc	24.	
Dimensions	9. Branch pipe inlet size: 63 mm	25.	
	10. Nozzle bore: 20 / 25 / 30	26.	
	11.	27.	
	12.	28.	
<u>Notes</u>			
	1. The branch pipe with nozzle shall be isi marked.		

4.4.5 DATA SHEET FOR FIRE HOSES WITH COUPLING

DATA SHEET A

Standards	1. Hose: IS 636 -type a or type b or is: 8423	Dimensions	7. Diameter: 63 mm
	— is: 14933 — type a or type b or is: 4927		8. Length for: (type of hydrant)
	2. Delivery coupling:		8.1 (internal / fire escape): 7.5 m / 15 m (note 2)
	instantaneous spring lock type		8.2 (external hydrant): 15 m
	as per IS 903 (note 1)		9.
	3.		10.
Materials of construction	4. Hose: controlled percolating fire hose pipe	Spares	11.
	5. Delivery couplings:		11.1
	5.1 cu alloy as per sand castings:		11.2

	gr ltb2 of is 318 or gr ltb1 of is 304		11.3
	die castings: gr 3 of is 292		11.4
	hot forgings: deb 1 of is 291	Tests and inspection	12. Hose proof pressure: 21.4 or 35 kg/cm ² (g)
	gravity die castings: is 1264		13. Hose burst. Pressure: 35.7 or 50 kg/cm ² (g)
	—or—		14. Coupling hydrotest: 21 kg/cm ² (g)
	5.2 al alloy as per die castings:		15. As per shop inspection and tests and/or
	is designations of 4450, 4600 of is 617		
			and TAC guidelines (see note 3)
	- or -		Approved sub-vendors
	5.3 SS as per IS 3444 grade 1 / grade 4	17.	
		18.	
	6.	19.	
<u>Notes</u>			
1.	Each hose shall have one male half coupling at one end and one female half coupling at the other end. The couplings shall be joined with hosepipe as per the procedure detailed in tac fire protection manual.		
2.	For tg hall, boiler house and mill bays of a power plant and basements 15 m long hoses shall be used.		
3.	The fire hose as well as coupling shall be isi marked.		
4.	Additional tests indicated as 'B' in shops inspection requirements shall also be carried out when it is applicable.		
	.		

4.4.6 DATA SHEET FOR FIRE HOSES CABINETS

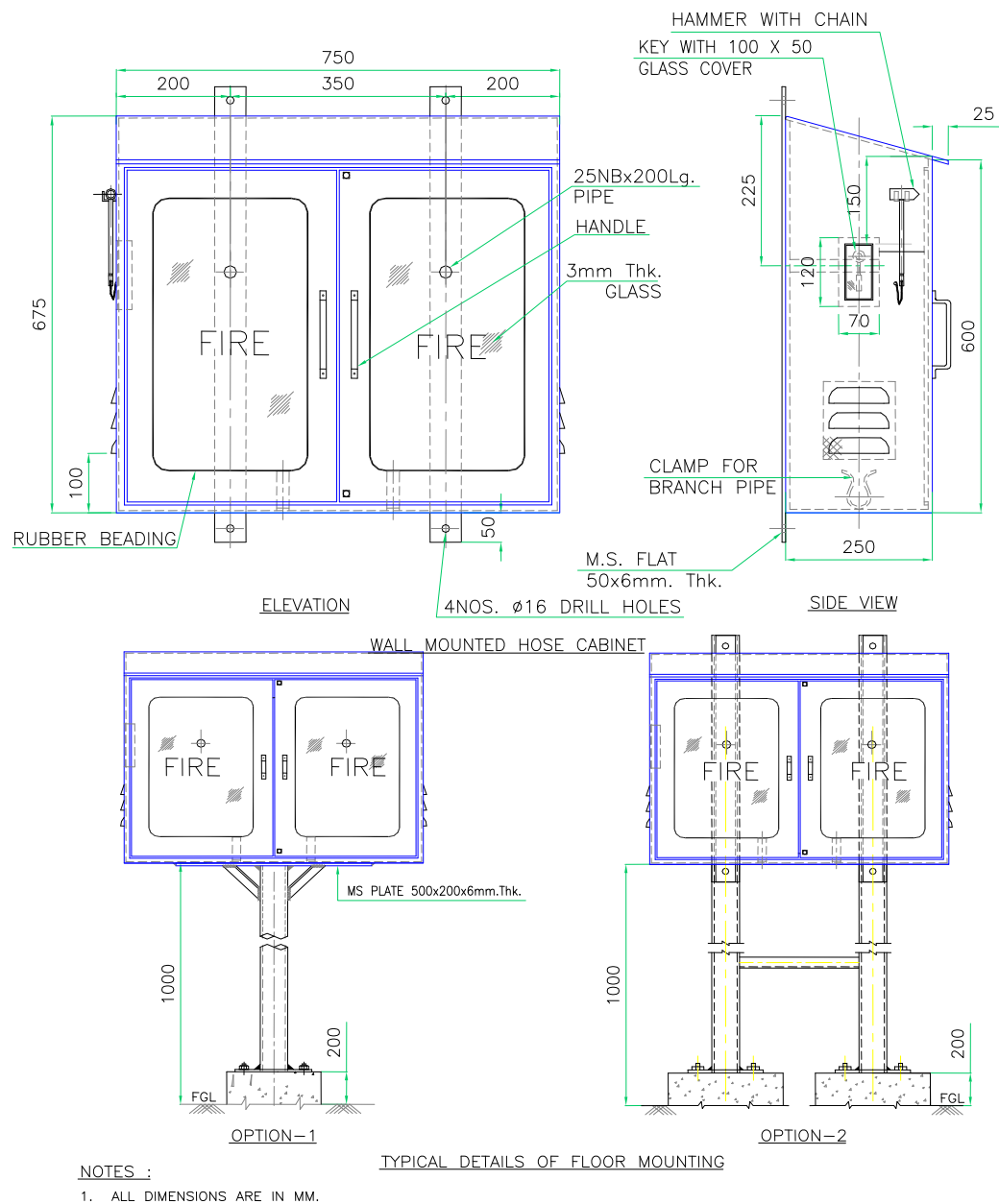
DATA SHEET A1

General	1.	wall / floor mounted hose	Construction features (contd.)		Support legs complete with
		Cabinets suitable for 2 nos.63 mm			Foundation bolts, nuts etc.:
		Dia x 15 m / 7.5 m long hoses and			Yes / no
		Accessories : (note 1,2)		12.	Painting for gi circa moc: (note 10)
		(refer data sheet A2)		12.1	External (spray paint):
	2.	Wall / floor mounted hose			A. One coat of red oxide primer
		Cabinets suitable for 2 nos.63 mm			B. Two coats of synthetic enamel
		Dia x 15 m / 7.5 m long hoses, accessories			Finesh paint PO RED shade 538 as

		And hose reel as per is 884 :			per IS-5.
		Size: _____ h x _____ w x _____ d in mm.		12.2	Internal (spray paint):
		(note 1, 2)			a. One coat of red oxide primer
	3.	Special hose cabinet:-			B. Two coats of synthetic enamel
					finesh paint. Shade white
				13.	
		size: _____ h x _____ w x _____ d in mm.	Spares & maintenance tools & tackles	14.	
		(note 1, 2)		14.1	
	4.	canopy required: yes / no			
		(also see note-3)			
	5.				
Construction features	6.	Material of construction of	Tests and inspection	15.	As per shop inspection and tests and / or
		Cabinet body : frp / GI CRCA			
		IS 277 & base metal conforming			(note 11)
		To IS 513		16.	
	7.	Thickness of body if material of	Approved sub-vendors	17.	
		Construction is GI CRCA : 16/18/20 SWG		18.	
		Grade of zinc coating 200 as per IS 277		19.	
	8.	Thickness of glass panel: 3mm		20.	
	9.	Hammer with chain: 1 set chrome plated		21.	
	10.	Lock with duplicate set of keys		22.	
		For each cabinet: yes		23.	
	11.	Mounting clamps, structural		24.	
<u>Notes</u>					
1.	Following accessories shall be made available inside the hose box after installation at site a. 2 nos. 63 mm dia x 15 m / 7.5m long hoses with coupling b. 1 no. Branch pipe c. 1 no. Nozzle d. 1 no. Nozzle spanner				

2.	Floor mounted hose cabinets shall be provided with minimum 1 m high structural support legs.
3.	Canopy is required for hose cabinets to be located outdoors.
4.	Scope of supply with hose cabinets shall not include hoses, hose reels, branch pipes and nozzles.
5.	The word “FIRE”, in 150 mm letter size in red, shall be painted on the cabinet glass.
6.	The cabinet shall be provided with clamps for holding branch pipe, nozzle and hose reel where applicable.
7.	Provision to keep one key and one hammer in glass covered recess on the side of the cabinet shall be made.
8.	The cabinet shall be supplied with a small container having a set of spare rubber rings packed in french chalk.
9.	Making of pockets in the wall, grouting of bolts, finishing the wall as before, and mounting of cabinets on to the wall or the structural supports shall be in contractor's scope.
10.	Colour shade scheme for FRP hose box shall be same as that mentioned for GI CRCA MOC – however the colour shall be uv resistant fade proof integral type suitable for external atmosphere.
11.	Additional tests indicated as 'b' in shops inspection requirements shall also be carried out when it is applicable.

1.1.2. DATA SHEET A2



4.4.7 DATA SHEET FOR FIRE HOSES REELS

DATA SHEET A

General	1.	Standards:	Contd.	11.	Pipe with fittings: ms as per
	1.1	Hose reel : IS 884 or IS 884 or IS 884			IS 1239 (part 1 and part 2) or IS 304
	1.2	Nozzle : IS 8090 or IS 8090 or IS 8090	Constructi on features	12.	Hose length : 30 m
	1.3	Stop valve : as per IS 778 or ball valve		13.	Hose id : 19/32 mm

Materials of construction		As per bs 5159	Spares and maintenance tools and tackles	15.	Nozzle id : 6.35 mm maximum
	2.	Type : swinging (180°) wall		16.	
		Mounting / suitable for		17.	
		Mounting in hose cabinet		18.	
	3.	Hose reel connected to		18.1	
		Permanent water supply: yes		18.2	
	4.	Flow through nozzle : minimum 24 lpm		18.3	
	5.	Hub : al alloy conforming to a 8 wp of		18.4	
		Is 617 or CS sheet as per IS 513 or al	Tests and inspection	19.	Hydrostatic pressure 21 kg/cm ²
		Sheet as per is 737 or galvanised steel			Or 18 kg/ cm ² for 5 minutes.
		Or glass filled polypropylene		20.	As per shop inspection and tests and/
	6.	Sides: CS sheet as per IS 513 or al sheet			
		As per is 737 or al alloy conforming			And tac guidelines.
		To a 8 wp of is 617 or carbon steel			
		Polyester powder coated			
	7.	Wall bracket: CS as per IS 513			
		Or ci as per is 210			
	8.	Swivel joint : Leaded Tin	Approved subvendors	21.	
		Bronze gr ltb2 of IS 318		22.	
	9.	Hose reel tubing : Reinforced Rubber		23.	
		As per IS 444 or EN - 694		24.	
	10.	Nozzle: gunmetal or nylon or		25.	
		Acrolonitrile butadiene styrene (abs)			

4.4.8 DATA SHEETS FOR PORTABLE FIRE EXTINGUISHERS

DATA SHEET A

Sl. No.	Type	Capacity	Standard	Tac guide lines	Quantity (As per BOQ)					Spare refills	Remarks
					Floor	Wall	Column	Trolley			
					Mounted						
1.	Sand/ water bucket	9 lit		Yes							
2.1	Carbon dioxide	2.0 kg	IS 15683	Yes/no							
2.2		3.0 kg		Yes/no							
2.3		4.5 kg	IS 15683	Yes							
2.4		6.5 kg		Yes/no							
2.5		9.0 kg		Yes/no							
2.6		22.5 kg		Yes/no							
2.7		6 to 7 kg × 2 nos.		Yes/no							
2.8											
2.9											
3.1	Chemical foam	9.0 lit		Yes				--			
3.2		50.0 lit		Yes/no	--	--	--				
3.3		150.0 lit		Yes/no	--	--	--				
3.4											
3.5											
3.6											
3.7											
3.8											
3.9											
4.1	Mechanical foam	9.0 lit	IS 15683	Yes							
4.2		135.0 lit	IS 14951	Yes/no							
4.3											
4.4											
4.5											

Sl. No.	Type	Capacity	Standard	Tac guide lines	Quantity (As per BOQ)					Spare refills	Remarks
					Floor	Wall	Column	Trolley			
					Mounted						
4.6											
4.7											
4.8											
5.1	Soda acid	9.0 lit		Yes/no				--			
5.2		50.0 lit		Yes/no	--	--	--				
5.3											
5.4											
6.1	Abc type dry chemical powder with map-90 powder	0.5 kg		Yes/no				--			
6.2		1.0 kg		Yes/no				--			
6.3		2.0 kg		Yes/no				--			
6.4		6.0 kg	IS 15683	Yes				--			
6.5		9.0 kg	IS 15683	Yes				--			
6.6		1.0 kg		Yes/no				--			
6.7		2.0 kg		Yes/no				--			
6.8		5.0 kg		Yes/no				--			
6.9		10.0 kg		Yes/no				--			
6.10		25.0 kg	IS 10658	Yes	--	--	--				
6.11		50.0 kg		Yes/no	--	--	--				
6.12		75.0 kg		Yes/no	--	--	--				
6.13											
6.14											
7.1	Halon 1211	1.25 kg	IS 11108	Yes/no				--		--	
7.2		2.5 kg	IS 11108	Yes/no				--		--	
7.3		4.0 kg	IS 11108	Yes/no				--		--	
7.4		5.0 kg	IS 11108	Yes/no				--		--	
7.5		6.5 kg	IS 11108	Yes/no				--		--	
7.6											
7.7											
7.8											
7.9											

Sl. No.	Type	Capacity	Standard	Tac guide lines	Quantity (As per BOQ)					Spare refills	Remarks
					Floor	Wall	Column	Trolley			
8.1	Water (gas cartridge)	9.0 lit	IS 15683	Yes				--			
8.2											
8.3											
8.4											
8.5											
Spares and maintenance tools and tackles	9.					Approved sub-vendors	11.				
	10.						12.				
	10.1						13.				
	10.2						14.				
	10.3						15.				
	10.4						16.				
	10.5						17.				
	10.6						18.				
<u>notes</u>											
1.	All items conforming to is shall be isi marked.										
2.	Tests and inspection shall be as per shop inspection and testsand/ applicable indian standards and tac regulations. Additional tests indicated as 'b' in shops inpection requiremets shall also be carried out when it is applicable.										
3.	Mounting clamps and structural support legs complete with nuts and bolts etc. Shall be provided by the vendor for floor, wall and column mounted portable fire extinguishers.										

4.4.9 VALVES AND SPECIALITIES GENERAL REQUIREMENTS

4.4.9.1. SCOPE

The following paragraphs describe general requirements for valves and specialities. Only the applicable paragraphs for the type of valve or speciality are to be considered along with data sheet-A. These apply unless specified otherwise in data sheet-A.

4.4.9.2. CODES AND STANDARDS

Valves and specialities shall be generally as per the following standards:

ANSI B16.1 : Cast Iron Valve Ratings

ASME B16.34	:	Ratings of Valves-Flanged, Threaded and Welding Ends
API 594	:	Wafer and Wafer - Lug Check Valves
API 600	:	Steel Flanged and Butt Welding End Gate Valves
API 602	:	Steel Gate Valves, Threaded and Socket Welding Ends
API 609	:	Butterfly Valves
BS 1414	:	Steel Gate Valves, Flanged and Butt Welding Ends
BS 1868	:	Steel Check Valves, Flanged and Butt Welding Ends
BS 1873	:	Steel Globe Valves, Flanged and Butt Welding Ends
BS 5156	:	Diaphragm Valves
BS 5351	:	Steel Ball Valves
BS 5352	:	Steel Gate, Globe and Check Valves, 50 mm and Smaller
IS 778	:	Bronze Valves
MSS-SP 67	:	Butterfly Valves

4.4.9.3. GEAR OPERATORS

Gear operators shall be provided on the following basis:

4.4.9.4. GATE AND GLOBE VALVES

Up to and including ANSI 300 class	-	350 mm and larger
600 class and higher	-	200 mm and larger

4.4.9.5. OTHER VALVES

Plug and ball	-	150 mm and larger
Butterfly	-	200 mm and larger

Gear operators shall be suitable for a differential pressure corresponding to the maximum valve rating at room temperature.

All gear operators shall be of the enclosed type.

4.4.9.6. INTEGRAL BYPASS

Gate valves shall be provided with integral bypass valve, as per MSS-SP 45, as follows:

Classes 150 and 300	-	350 mm and larger
Class 600 and higher	-	200 mm and larger

Type of bypass valve shall generally be the same as the main valve. Bypass pipe shall be at least schedule 80 and material of construction of bypass valve and pipe shall be compatible with the main valve.

4.4.9.7. VALVE STEMS

Valve stems shall be of wrought materials. Castings are not acceptable.

4.4.9.8. BACKSEAT

All gate, globe and piston valves shall be provided with back seating arrangement to facilitate replacement of gland packing with the valve in service.

4.4.9.9. CHECK VALVES

Check valves of sizes 350 mm and larger shall be provided with features to prevent slamming and hammering. These can be in the form of springs or external dash pot.

4.4.9.10. HARDNESS

13% chromium steel seat surfaces shall have a minimum hardness of 250 BHN and a differential hardness of 50 BHN.

4.4.9.11. NAME PLATES

The details on name plates shall be as per MSS-SP 25.

4.4.9.12. TAG PLATES

Tag plates shall be of stainless steel type 304 or aluminium.

4.4.9.13. TESTING

Strength and leak tests shall be as per any of the standards MSS-SP-61, API 598 or BS EN 12266-1 and 2 at the test pressures indicated in data sheet-A. Stainless steel valves shall be tested using potable water.

4.4.9.14. NDT REQUIREMENTS

All cast steel valves shall be subject to radiography in all accessible areas, as defined in ASME B16.34, on the following basis:

- (a) Class 600 and higher - All sizes
- (b) Class 300 - Sizes 450 mm and larger
- (c) Class 150 - Sizes 600 mm and larger

All cast steel valves of class 600 and higher shall also be subject to magnetic particle or liquid penetrant examination as per ASME B16.34.

All cast steel valves of class 300 shall have radiography quality castings irrespective of size.

Acceptable levels of defects shall be as per ASME B16.34.

4.4.9.15. FACE-TO-FACE OR END-TO-END DIMENSIONS

Face-to-face dimensions of flanged-end valves and end-to-end dimensions of butt welding-end valves shall be as per ASME B16.10.

For valves not covered by ASME B16.10, the dimensions shall be as per applicable valve standards.

4.4.9.16. PREPARATION FOR DESPATCH

COATING

All carbon steel and cast iron exposed surfaces shall be given one coat of primer and two coats of aluminium finish paint after release has been given for painting and before despatch. Machined surfaces shall be coated with an easily removable rust protective except that this is not applicable for austenitic stainless steel components.

END PROTECTION

After completion of the requirements of para 14.1, body end ports, flange faces and welding ends shall be covered with suitable close fitting protectors to protect the machined ends and prevent ingress of dirt and moisture.

DISC

The disc shall be closed before despatch except in the case of soft-seated valves where the disc shall be backed off to relieve the pressure on the seal.

PACKING

Valves and specialities shall be so packed as to minimise the possibility of damage during storage or transit. The packing shall be suitable for tropical conditions.

4.4.9.17. DATA SHEET-A (GATE VALVE)

General	1.	Tag no.:	Later				Size	Quantity (As per BOQ)			
	2.	Size range:	≥ 50 NB								
	3.	Rating:	PN 1.6				Mm	P0	R0	R1	R2
	4.	Grade:	CT								
	5.	Fluid :	Fire water								
Construction features	8.	Stem : rising- outside screw & yoke									
	9.	Ends : Flanged, FF SERR conc. Finish as per ANSI B 16.5									
	11.	bonnet : bolted									
	12.	wedge : solid									
	13.	operator : handwheel									
	14.	seat : body -renewable									
		: wedge-integral									
	15.	Other requirements :									
		Conforming to IS 14846									
Materials	16.	Body/ bonnet	:	Cast iron to IS: 210 GR. FG 260							
	17.	Wedge	:	Cast iron to IS: 210 GR. FG 260							
	18.	Stem	:	13 % CR steel as per IS 6603							
	19.	Body seat ring	:	Gun metal as per IS 318 ltb 2							
	20.	Wedge facing ring	:	Gun metal as per IS 318 ltb 2							
	21.	Gland packing	:	Jute & hemp							
	22.	Gasket	:	Rubber as per IS 638 type b							
	23.	Bolts & nuts	:	Cs as per IS 1363 cl 4.6 / 4.0							

	24	handwheel	:	Cast iron to IS: 210 gr. Fg 260						
Tests & inspection	25	Shell hydro	:	24	Kg/ sq. Cm. Duration 5 mins.					
	26	Seat hydro	:	16	Kg/ sq. Cm. Duration 2 mins.					
	27									
	28	Inspection :as per shop inspection and tests.								
Notes: 1. General requirements: as per valves and specialities general requirements 2. Additional tests indicated as 'B' in shops inspection requiremets shall also be carried out when it is applicable.										

4.4.9.18. DATA SHEET-A (WAFER CHECK VALVES)

General	1 .	Tag no.	:		4. Fluid : fresh water	Size	Quantity(As per BOQ)				
	2 .	Size range	:	≥ 50 NB	5. Des. Pr. : *						
	3 .	Rating	:	PN 1.6	6. Des. Temp. : ambient	Mm	P0	R0	R1	R2	
	7 .	Standard	:	API 594	Grade: CT						
Construction features	8 .	Type	:	Dual plate, spring-loaded							
	9 .	Ends	:	Wafer to suit ANSI 150 Class							
				Flanges, RF, SERR. Finish							
	10 .										
	11 .										
	12 .										
	13 .										
	14 .	Other requirements	:								
Materials	15 .	Body	:	CI, IS 210 GR. FG 260							
	16 .	Plate	:	Carbon steel							
	17 .	Seal	:	Nitrile							

	18	Plate seat	:	Mfr's standard							
	19	Spring	:	Spring steel							
	20	Hinge pin & stop pin	:	SS 304							
	21										
Tests & inspection	24	Shell hydro	:	24	Barg						
	25	Seat hydro	:	16	Barg						
	26	Inspection :									
Notes: 1. General requirements: as per valves and specialities general requirements 2. Additional tests indicated as 'B' in shops inspection requiremets shall also be carried out when it is applicable.											

4.4.9.19. DATA SHEET-A (BALL VALVES)

General	1.	Tag no.	:	--				Size	Quantity (As per BOQ)				
	2.	Size range	:	≤ 40 NB									
	3.	Rating	:	800 class				Mm	P0	R 0	R1	R 2	
	4.	Grade	:	--									
Construction features	5.	Port	:	std port									
	6.	Stem	:	--									
	7.	Ends	:	Screwed									
	8.	Operation	:	≤ 100 mm (4") - lever									
	9.	Antistatic feature		:	Not required								
	10.	fire safe design (API 607)		:	Not required								
	11.	other requirements		:	Two piece construction								
		Size, (in/ mm)											
		Ins. Thk., mm											
	Material s	12.	Body		:	ASTM A 105							
13.		Ball (mirror finished)		:	SS 304								

	14	Stem	:	SS 304						
	15	Seat	:	--						
	16	Seal (stem & body)	:	-do-						
	17	Bolts, studs & nuts	:	ASTM A 193 GR. B7/ ASTM A 194 GR. 2H						
	18									
Tests & inspection	19	Shell hydro	:	25	Barg					
	20	Seat hydro	:	16	Barg					
	21	Seat air	:	6	Barg					
	22	Inspection :as per shop inspection and testsand if applicable								
Notes: 1. General requirements: as per valves and specialities general requirements 2. Additional tests indicated as 'B' in shops inspection requiremets shall also be carried out when it is applicable.										

4.4.9.20. DATA SHEET-A (Y STRAINER)

Design data	1.	Tag no.	Later
	2.	Quantity required	As per BOQ
	3.	Location	As per P & ID
	4.	Type	Y type
	5.	Fluid	Fire water
	6.	Flow rate m ³ /hr	As per detailed engineering
	7.	Operating pressure barg	11
	8.	Operating temperature ° c	Ambient
	9.	Design pressure barg	16
	10.	Design temperature ° c	50
	11.	Fluid viscosity (cp) at op.temp.	1
	12.	Fluid sp. Gravity at op. Temp.	1
	13.	Max. Permissible pr. Drop Under 50% clogged condition	0.5 bar(g) – for strainers on pump suction line 1 bar(g) – for strainers on other locations
	14.	Screen basket data	*
		1. Dia of perforations, mm	*
		2. Min. Thickness, mm	*
		3. Free straining area	Four times pipe cross sectional area min
	15.	Steam jacket	No
		1. Inlet pr. Barg, op. / desn.	-
		2. Inlet temp. ° c, op./desn.	-
	16.	End connections	RF
		1. Size, NB mm	As per drawings
		2. Type	Flanged

		3. Details/ standards	ANSI B 16.5,150 #
	17.	Cover	Bolted
	18.	IBR approval	No
Materials	19.	Body	Is:2062/IS:1239(pt-1)/IS:3589
	20.	Cover	IS:2062
	21.	Screen basket	SS 304
	22.	Bolts/ studs	ASTM A 193 B7
	23.	Nuts	ASTM A 194 2H
	24.	Gaskets	ARAMID FIBRE
	25.	Jacket	NA
	26.	Jacket couplings/ flanges	NA
ests & inspection	27.	Accessories by vendor:	
	27.1	Foundation bolts	No
	27.2	Differential pressure gauge	No
	27.3	Drain/ vent cock (ss 316)	Yes
	27.4	Support legs	No
	26.	Hydrostatic test pressure, barg	
	26.1	Shell side	1.5 x design press.
	26.2	Jacket side	Not applicable
	27.	Vacuum test required	No
	28.	Pressure drop test required	
		Clean/ 50% clogged	Yes
	29.	Inspection: as per a) shop inspection and testsand	
	30.		
Notes: 1. General requirements: as per valves and specialities general requirements 2. Additional tests indicated as 'b' in shops inspection requirements shall also be carried out when it is applicable. 3. '*': Bidder to furnish information.			

4.4.9.21. DATA SHEET-A (BUTTERFLY VALVE)

Sl. No.	Item	Unit	
1.0	General		
1.1.	Service		Fire fighting
1.2.	Tag nos.		-
1.3.	No. Of valves	No.	As Per BOQ
1.4.	Design standard		IS 13095/BS5155
1.5.	Valve category		-
1.6.	Disc		Concentric / offset / double / triple
1.7.	Body type		Lug / wafer / flanged short / long

Sl. No.	Item	Unit	
			pattern
1.8.	Valve size	NB	As per BOQ
1.9.	Valve rating / class		PN 16
1.10.	Fluid handled with its spec. Gravity		Water – 1.0
1.11.	Companion flange type and class		Class 125/ 150
1.12.	Type of valve operator		<ul style="list-style-type: none"> Manual-lever / gear/handwheel / chain wheel / electric / pneumatic / hydraulic /
1.13.	Maximum flow (indicate the related pressure also)	M ³ /hr, Kpa	
1.14.	Maximum flow velocity	M/s	3.0
1.15.	Design pressure	Bar	
1.16.	Operating pressure	Bar	
1.17.	Design temperature	°c	
1.18.	Operating temperature	°c	4 °c to 40 °c
1.19.	Valve location		Indoor / outdoor
1.20.	Maximum differential pressure		
1.21.	Shut off class / requirements		
1.22.	Valve flange face		Flat face / raised face
1.23.	Type of mating flange		
1.24.	Drilling standard		IS 1538 table 4 & 6
1.25.	Surface finish		
1.26.	Preferred face to face dimension	Mm	As per std./
1.27.	Power supply	Phase ,v, hz,	
1.28.	Air / hydraulic supply pressure	Bar	
1.29.	Valve opening / closing time	Sees	
1.30.	Fail safe position of actuator		Valve to close / valve to open
1.31.	Shut off applicability		
1.32.	Frequency of valve operation		
1.33.	Valve shaft orientation		
1.34.	Fire tested		Yes / No. (if “yes” specify the std. To which it should conform)
1.35.	Electric continuity between shaft /		Yes / no

Sl. No.	Item	Unit	
	body / disc		
1.36.	Motor spec. (for motorised actuator only)		
1.37.	Application of valve for dead end service		
1.38.	Application of valve for bi-directional service.		Yes / no .
2.	Accessories		
2.1.	Floor stand		
2.2.	Companion flange with bolts, nuts & gaskets		
2.3.	Lifting lugs		
2.4.	Tapped holes in lug		
2.5.	Extension spindle		
2.6.	Torque & limit switch mechanism		
2.7.	End limit switches		
2.8.	Adjustable seat		
2.9.	Reduction gear unit		
2.10.	Locking device		
2.11.	Valve position indicator		
2.12.	Body lining		Yes / no (if 'yes' specify lining matl.) Epdm
2.13.	Auxilliary hand wheel		Yes / no
2.14.	Blow out proof stem		Yes / no
3.	Additional requirement		
3.1.	Painting(refer note-9)		
3.2.	Seismic qualification of valve required If yes, indicate the document no. For response spectrum or equivalent data which the vendor has to refer		Yes / No.
3.3.	Any other requirement		
4.	Materials of construction		
4.1.	<ul style="list-style-type: none"> Body 		Cast iron - IS 210 gr. FG 220

Sl. No.	Item	Unit	
4.2.	• Disc		Ductile iron – IS 1865 GR. 450/10
4.3.	Stem		SS AISI 431
4.4.	Seat		
4.5.	Body seat rings		SS 410
4.6.	Disc seal rings		EPDM
4.7.	Seat retaining rings		SS AISI 304
4.8.	Companion flange		ASME B 16.5
5.	Tests and inspection		
5.1.	Additional tests indicated as 'b' in shops inspection requirements shall also be carried out when it is applicable.		
5.2.	Hydrostatic test pressure for body	$\frac{\text{Kg}}{\text{cm}^2}$	
5.3.	Hydrostatic test pressure for disc	$\frac{\text{Kg}}{\text{cm}^2}$	
5.4.	Disc strength test pressure	$\frac{\text{Kg}}{\text{cm}^2}$	
5.5.	actuator performance test pressure	$\frac{\text{Kg}}{\text{cm}^2}$	
5.6.	Air leak test pressure	$\frac{\text{Kg}}{\text{cm}^2}$	
5.7.	Electrical continuity test		Yes / no (if 'yes' indicate relevant std.)
6.	Spares		
6.1.	Disc seal rings		
6.2.	Flange gasket		
6.3.	Seat/seal clamping bolts		
6.4.	'O' ring seals or gland packing		

NOTES:-

- For general requirements refer valve and specialities. However, in case of overlapping requirements, those of the data sheet a, to be considered as the final one.
- The valve shall be designed considering the larger of the following torque requirements for which calculations shall be submitted:
 - Calculated as per AWWA-C504-80
 - Calculated as per the standard to which valve is designed.

3. For manually operated valves, torque required at hand wheel shall not exceed 7 kg.m.
4. Motor operated valve actuator shall be rated to provide an output torque of atleast 150% of torque required as per note-2 above unless otherwise noted.
5. The actuator shall be capable of operating in any mounting angle.
6. The transmission unit shall be designed to transmit twice the valve design torque unless otherwise noted.
7. The actuator shall provide an unseating torque of at least 50% in excess of valve seating torque at the specified voltage unless otherwise noted.
8. Segmental welded carbon steel flange plates above 20 mm thickness shall be subjected to preheating before welding and stress relieving after welding as per is 2825 unless otherwise specified.
9. Unless otherwise specified in specification, one coat of zinc rich primer and two coats of enamel shall be applied to all steel and cast iron exposed surfaces. The minimum thickness of coating shall be 100 microns.
10. The vendor may also suggest any additional spares and tools required for the successful operation, start up and maintainence of the valve.
11. In the absence of any test related data, the relevant testing standard for butterfly valves may be indicated.

4.4.9.22. AIR RELEASE VALVE

Air release valve shall be 15mm screwed inlet Brass single acting type and shall be fixed on all high points in the system (wet riser) with ball valves or as shown on drawings, suitable for pressure not less than 15 Kg/Sq.cm

4.4.10 FIRE PROTECTION SYSTEM PIPING MATERIAL SPECIFICATION (GRADE CT)

Service : fire water (fresh water)													
Design	Temp. ° f / ° c	50						Corr. All. Inch/ mm			1.5		
	Pr. Psig/ kg/ cm ² g	8.8						flange facing			Rf, conc.serr. (note -1)		
Nom. Pipe size	Inch mm	≤ 150	200	250	300	350	400						
Outside dia.	Inch mm		219	273	324	356	406						
Thickness	Inch mm	Heavy Cl	6	6	6	6	8						
Nom. Pipe size	Inch mm												

Outside dia.		Inch											
		mm											
Thickness		Inch											
		mm											
Line joint			≤ 40 - SW TO ANSI B16.11										
			≥ 50 - BW TO ANSI B16.25										
Item			Nominal pipe Size range Inch / mm	Material Specification		Dimensional Standard		Remarks					
Pipes			≤ 150	IS 1239 PT.1		IS 1239 PT.1		ERW, BLACK, ≤ 40 - PE, ≥ 50 - BE					
			≥ 200	IS 3589 GR. FE 410		IS 3589		ERW / EFW, BLACK, BE					
B.w. fittings	Elbows, caps, reducers ,tees		50 to 150	ASTM A234 GR. WPB		ANSI B16.9		SCH40, SMLS (NOTE -2)					
	Stub ends												
S.w.fittings			≤ 40	ASTM A105		ANSI B16.11		3000CL					
Fabricated reducers			≥ 200	Same as pipe				Included angle =30 ⁰ , Site fabricated					
Mitres			≥ 200	Same as pipe		R=1.5 d		15 ⁰ , 30 ⁰ , 30 ⁰ , 15 ⁰ , Site fabricated					
Branch connections			All	Same as pipe				Use stub-in type					
Flanges			≤ 150	ASTM A105		ANSI B 16.5		So , 150 CL					
			200 to 300	IS 2062 GR. A		ANSI B 16.5		So , 150 CL					
			≥350	IS 2062 GR. A		ANSI B 16.5		So , 150 cl, light weight (note - 3)					
Blind flanges			≤ 150	ASTM A105		ANSI B 16.5		150 cl					
			200 to 300	IS 2062 GR. A		ANSI B 16.5		150 cl					
			≥350	IS 2062 GR. A		ANSI B 16.5		150 cl, light weight (note -3)					
Machine / stud bolts			All	IS 1367		IS 1364 CL 4.6							

ITEM	NOMINAL PIPE SIZE RANGE inch / mm	MATERIAL SPECIFICATION	DIMENSIONAL STANDARD	REMARKS			
HEAVY HEX. NUTS	ALL	IS 1367	IS 1364 CL4				
GASKETS	ALL	BLACK RUBBER	ANSI B16.21 CL150	3mm THICK RING , SELF CENTERING TYPE (NOTE-1) SHORE HARDNESS 60			
THREADED FITTINGS	≤ 40	ASTM A105	ANSI B 16.11	3000 / 2000 CL, NPT / IS 554 TAPER AS REQUIRED			
TYPE OF VALVE	SIZE RANGE	MATERIAL		PRESSURE RATING	TYPE OF ENDS	SPECIFICATION OR	REMARKS
	inch / mm	BODY	TRIM	ANSI/ IS		TAG NUMBER	
GATE GLOBE CHECK	≤ 40	BRONZE ASTM B62	BRONZE ASTM B62	PN-1.6	NPT/ IS-554 TAPER		
GATE (NOTE-4)	≥ 50	CHS	BRONZE				
GLOBE (NOTE-4)	FOR DETAILS REFER INDIVIDUAL DATA SHEETS.						
CHECK		200	M B62				
BUTTERFLY (NOTE-5)	≥ 150	CHS 210 Gr. FG-200	NITRILE	PN-1.6	WAFER		SUITABLE FOR INSTALLATION BETWEEN FLANGES OF 150 CLASS
Y TYPE STRAINERS	50 TO 150	IS-1239 PART-1	SS 304 SCREEN	ANSI B16.5 150 CLASS	RF		
	200	IS-3589 GRADE FE-410	SS 304 SCREEN	ANSI B16.5 150 CLASS	RF		

ITEM	NOMINAL PIPE SIZE RANGE inch / mm	MATERIAL SPECIFICATION	DIMENSIONAL STANDARD	REMARKS
NOTES				
1. Use flat face flanges and full face gaskets with cast iron flanged valves.				
2. Use flat end covers instead of caps for sizes ≥ 200 mm.				
3. Light weight flanges shall be ring type as per class d of table 1 or hub type as per class d of table 2 of awwa c207.				
4. Hydrotest pressure of installed piping: 13.2 kg/cm ² g.				
5. Buried piping shall be coated and wrapped as per data sheets and requirements of TAC.				

4.4.11 FIRE WATER PIPING GENERAL REQUIREMENTS

DATA SHEET A

Scope	1. Supply of pipes and fittings:	Design data	8. Piping: as per specification
	Yes		
	2. Supply of valves and specialities:		9. Welding: as per specification
	yes		10. Underground protection:
	3. Supply of structural steel for		as per specification and tac
	pipe supports: yes		11. Valve chambers: brick masonry/
	4. Erection, testing and		Stone masonry/see as per drg
	commissioning of piping system:		*
	yes	Tests and inspection	12. As per shop inspection and tests and/or
	5. Excavation and back filling:		
	yes		
	6. Valve chambers with covers (wherever necessary):		(Note 1)
	No		13.
	7. Painting and corrosion		14.
	protection: yes		15.
Notes:			
1.	Additional tests indicated as 'B' in shops inpection requiremets shall also be carried out when it is applicable.		
	Also be carried out when these are applicable.		
*	bidder shall submit the drawing and the same shall be revised to incorporate the comments of client / Project Manager before being released for construction.		

4.4.11.1. SCOPE

This specification covers the general design, materials, manufacture, shop inspection and testing at manufacturer's works, delivery at site, handling at site, erection, testing, commissioning, performance testing and handing over of fire water piping and accessories.

4.4.11.2. CODES AND STANDARDS

The design, materials, manufacture, erection, inspection, testing and performance of fire water piping and accessories shall comply with all the currently applicable statutes, regulations and safety codes in the locality where it is to be installed. The piping shall also conform to the currently applicable Indian and international codes and standards. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility

4.4.11.3. DESIGN AND GENERAL REQUIREMENTS

- a) All pipes, fittings, flanges, valves and specialities etc. shall conform to the enclosed piping material specifications.
- b) Piping design and layout shall satisfy the requirements of applicable section of ASME B31, Tariff Advisory Committee (TAC), other applicable codes and statutory regulations.
- c) Piping shall be routed to avoid interference. If interference is noticed at site, piping shall be suitably modified and rectified by the CONTRACTOR at no extra cost to the EMPLOYER.
- d) All high points in the piping system shall be provided with vents with valves and low points with drains with valves.
- e) Top of buried piping shall not be less than one (1) metre below the ground level. Buried piping shall be provided with underground protection as per the enclosed specification and requirements of TAC. Valves in buried piping shall be provided with valve chambers with covers. At road crossings buried piping shall run through Hume pipes. Diameter of Hume pipes shall be at least equal to two (2) times the diameter of fire water pipe. Hume pipe shall extend at least 300 mm beyond the road.
- f) Supports for above ground piping shall follow good engineering practice, requirements of TAC and statutory regulations. Structural steel for pipe supports and other requirements shall conform to IS 2062 grade A.
- g) For underground piping wherever soil conditions are unsatisfactory, brick masonry or concrete supports shall be provided at regular intervals not exceeding three (3) metres. In case of poor soil conditions, it may be necessary to provide continuous brick masonry or concrete support. The CONTRACTOR shall bring such conditions to the notice of the EMPLOYER and follow his instructions.

- h) Effective precautions such as capping or sealing shall be taken to protect ends of all pipes, fittings, valves and specialties against ingress of dirt and damage during transit or storage. Flange gasket contact surfaces shall be suitably protected against damage.
- i) All piping shall be cleaned and purged with air blast to remove all rust, mill scale etc from inner surface. Rotary wire brush may be used for cleaning pipes of sizes above 300 mm. The method of cleaning shall be such that no material is left on the inner surfaces, which may affect the serviceability of the pipe.
- j) The CONTRACTOR'S scope for erection under this contract shall include supply of the following:
 - (i) Welding materials like welding electrodes, filler rods and wires, oxygen, acetylene, propane and other consumable materials and backing rings, etc. as required
 - (ii) Joining material as required for all screwed joints and bolts, nuts, studs, washers and gaskets as required for all flanged joints
 - (iii) Isotopes for gamma ray, equipment and films for radiography, liquid dye penetrant and other required testing materials and equipment. All these shall be taken back by the CONTRACTOR after completion of work.
 - (iv) Erection tools, tackles, scaffolding materials and materials including welding machines, thermocouples, asbestos paper including blankets, cables, temperature recorders and charts and testing equipment, air compressors etc. All these shall be taken back by the CONTRACTOR after completion of work.
 - (v) Services of erection superintendent, erection supervisors, fitters, riggers, and other skilled and unskilled labour.
- k) For general welding requirements refer enclosed specification. The CONTRACTOR shall be responsible for the quality of welding carried out and shall conduct tests to determine the suitability of the welding procedure used. Tests shall be conducted in accordance with codes specified. The results and specimens from qualification tests and operator tests shall be made available to the EMPLOYER. Only qualified welders shall be used and the CONTRACTOR shall inform the EMPLOYER the names of the welders and their experience for approval. A welding procedure qualification shall be submitted to the EMPLOYER for approval before commencement of work.
- l) All surplus materials from those supplied by the CONTRACTOR shall be taken back by the CONTRACTOR.
- m) All pipes and fittings shall be tested hydrostatically at the shops where manufactured, to test pressures which are given in the respective codes and standards. All piping systems shall be tested hydrostatically after erection to specified test pressure. The test duration shall be two (2) hours or until all joints are examined, whichever is longer. In case of leakage, re-test shall be carried out for the same duration after rectification of defects.

- n) At least 10% of all the butt-welded joints on hydrant mains shall be radiographically tested and half of the joints radiographed shall be field joints. Acceptable levels of defects shall be as per the applicable code.
- o) For hydrostatic testing and water flushing, the CONTRACTOR shall furnish necessary tanks, pumps, compressors, other equipment, instruments, piping and supports etc. The EMPLOYER may provide water at one point of supply to which the CONTRACTOR'S temporary piping shall be connected. All temporary equipment, piping and supports shall be dismantled and taken back by the CONTRACTOR after completion of testing and flushing operation.

4.4.11.4. EXCAVATION AND BACK FILLING

- a) The CONTRACTOR shall carry out necessary civil works associated with buried piping such as excavation, de-watering, back-filling, levelling and compacting. During excavation, large stones and rubbles shall be segregated and removed from the excavated soil and stacked separately. The material from excavation shall be deposited on either side of the trench leaving adequate clear distance from the edges of the trench. This is necessary to prevent the excavated material or the sides of the trench to slip and to avoid covering the laid pipes, hydrant valves, sluice valves and manhole covers etc.
- b) All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structures and pipelines. If rock is encountered, it shall be removed up to 150 mm below the bottom of pipes, fittings, valves and specialities and the space resulting shall be refilled with granular materials and properly consolidated. The excess excavated material shall be carried away from site of works up to a distance as directed by the EMPLOYER.
- c) In case, during excavation, sub-soil water is encountered, the CONTRACTOR shall provide necessary equipment and labour for de-watering the trenches. The CONTRACTOR shall also make necessary arrangements for the disposal of drained water to nearby storm water drain. In no case shall water be allowed to spread over the adjoining areas. All precautions shall be taken to prevent dirt etc. from entering into pipes, when the pipe laying is not in progress by closing the pipe ends with water tight plugs or other approved methods. Trenches shall be back-filled with selected excavated material only after the successful testing of the piping. Tamping around the pipe shall be done by hand or other hand-operated mechanical means. Back filling shall be done in layers not exceeding 300 mm. Each layer shall be consolidated by watering and ramming.

4.4.11.5. PAINTING AND CORROSION PROTECTION

- a) All exposed piping shall be painted with approved paints.
- b) Before applying the paints, all surfaces shall be cleaned by sand blasting or rotary wire brushing and by dry air blast. All surfaces shall be free of all dirt, mud, rust, grease, scale, or other foreign material.

- c) After sand blasting or wire brushing is complete, the surfaces shall be protected so that these do not come in contact with grease, oil, other organic matter or moisture prior to application of primer coating.
- d) Primer coating shall be carried out as quickly as possible after sand blasting or wire brushing. No sand blasted or wire-brushed surface shall be allowed to remain un-coated overnight. Any clean surface that subsequently rusts shall be re-blasted or re-wire brushed before the application of primer.
- e) Painting operation shall generally be in line with IS 1477 (Parts 1 and 2) and colour of finish paint shall be fire red shade no. 536 of IS 5.

4.4.11.6. MEASUREMENTS

- a) Above ground and underground pipe lengths shall be measured separately. Pipe length shall be measured along the centre line of the pipe. End-to-end or flange face-to-flange face length of fittings, flanges, valves and specialities shall not be deducted from the pipe length. Unit price for supply of pipe shall include supply of fittings and flanges. Similarly, unit price for erection of pipe shall include erection of fittings and flanges. However, supply and erection of valves and specialities shall be considered separately as per para 6.6 below.
- b) Unit prices for supply and erection of above ground and underground pipes shall also include supply and erection of all piping support items, auxiliary steel and accessories like shoes, saddles, base plates, clamps, bolts and nuts etc.
- c) Unit prices for supply and erection of above ground pipes shall also include supply of all surface preparation and painting materials and application of painting.
- d) Unit prices for supply and erection of underground pipes shall also include supply of all surface preparation and wrapping and coating materials required and application of underground protection.
- e) For valves and specialities the BIDDER shall quote unit price for supply and unit price for erection of each type and size of valve and speciality.
- f) Non-destructive testing like radiography and die penetrant tests etc. shall be included in the unit price for erection of pipe. No separate charges are payable on this account.
- g) For concrete pedestals for support of above ground pipes, the BIDDER shall quote unit price for erection of each type and size of pedestal. Supply of all materials required for construction of such pedestals shall be included in the unit price.
- h) For valve chambers for underground pipes, the BIDDER shall quote unit price for erection. Supply of all materials required for construction of such valve chambers, shall be included in the unit price.
- i) For excavation and backfilling, the bidder shall quote unit price per M3 for each type of soil indicated in the schedule of prices. Payment shall be made based on the volume arrived at, as given below, irrespective of the width and depth of the trench actually

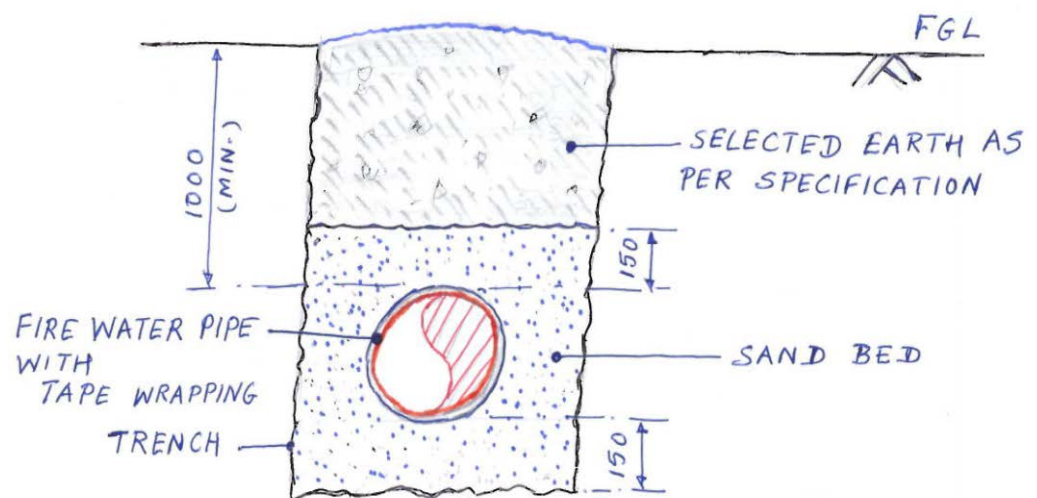
excavated or larger trench excavated at locations of pipe fittings and flanges and locations of weld joints:

$$V = L (D_1 + D_2 + \dots + 0.5) (1.2 + D_1 \text{ or } D_2 \dots \text{ whichever is higher}) \text{ Where,}$$

$D_1, D_2 \dots$ etc : Nominal diameters of pipes buried in the same trench in M L

: Length of trench in M

V : Volume of trench in M³



4.4.12 FIRE PROTECTION SYSTEM WELDING REQUIREMENTS FOR PIPING

Sl. No.	Material	P.No.	Welding process		Filler material		Gas		Notes
			Root	Filler	Root	Filler	Purging	Shielding	
1.0	Carbon steel								
1.1	≤ 50 mm NPS and/or up to and including 3 mm thick	1	GTA W	GTA W	E R70 S2	E 6013	--	--	1
1.2	> 50 mm NPS	1	SMA W	SMA W	E 6010	E 6013	--	--	1
2.0	Stainless steel type 304	8	GTA W	GTA W	ER 308	ER 308	NITROGEN 0.2 TO 0.3 M ³ /HR	ARGON 0.35 TO 0.6 M ³ /HR	2

Notes		
1.	For fillet welds, E 6013 may be used.	
2.	Non-consumable electrode for gtaw process shall be 2% thoriated tungsten.	
3.	Electrodes and filler wires shall be from reputed manufacturers such as advani-oerlikon, esab, d&h secheron.	
Legend		
GTAW	-	Gas tungsten arc welding
SMAW	-	Shielded metal arc welding

4.4.13 FIRE UNDERGROUND PROTECTION FOR PIPING

(DATA SHEET A)

General and materials	1.	Supply of all coating and Wrapping materials	By contractor/ Employer
	2.	Soil resistivity	$\leq 1000 \text{ ohm-cm}$ $> 1000 \text{ ohm-cm}$
	3.	Type of underground protection	3.1 3 coats and 3 wraps of coal tar coating / 3 layers of wrapping tape 3.2 2 coats and 2 wraps of coal tar coating / 2 layers of wrapping tape / 1 layer of 4 mm thick wrapping tape
	4.		
	5.	Application methodology	As per specification
	6.		
	7.	Coating thickness	Required
	8.	Bond/ adhesion test for coating / Wrapping tapes	Required
	9.	Holiday test	Required
Documents	10.	Documents required after the Award of contract	10.1 material test certificates 10.2 manufacturer's installation instructions for storage,

		preparation and application
		of coating materials

4.4.13.1. SCOPE

The purpose of this specification is to describe the technical requirements for the application of hot coal-tar enamel and fibre glass wrapping or pipeline wrapping tapes for the protection of external surface of underground carbon steel piping.

4.4.13.2. GENERAL

- The coating shall consist of coal-tar enamel, inner wrap of fibre glass, final outer wrap of enamel-impregnated fibre or enamel-impregnated kraft paper. The primer and the enamel shall be from the same supplier.
- Alternatively, if specified in Data Sheet-A, ready-made tapes available for underground protection shall be used. Tape shall be of approved make. The CONTRACTOR shall furnish all the technical information, experience details etc. of the tapes proposed to be used for review.
- The two ends of each length of pipe shall be left bare of primer coating and wrapping for a distance of 150 mm from the end to facilitate field welding and subsequent field coating or wrapping.
- The supply, application, characteristics of materials and testing requirements shall be strictly as per IS 10221.
- Type of coating system based upon the soil resistivity may be selected on the following basis :

Soil resistivity	Corrosively	Coal tar coatings	Wrapping tap
≤ 1000 ohm-cm	Extremely corrosive	3 coats and 3 wraps	3 layers of taps
> 1000 ohm-cm	Corrosive & non Corrosive	3 coats and 3 wraps	3 layers of taps

- If no specific choice is indicated in Data Sheet-A, system 2.5(b) using coal tar coating shall be used.

4.4.13.3. SURFACE PREPARATION

Pipe surfaces to be provided with underground protection shall be cleaned by shot or sand blasting. The cleaning shall be so carried out that the piping surface is free from mill scale, rust, oil, welding scale and other foreign materials. Primer shall be applied immediately after shot or sand blasting to prevent rust forming. Superficial rust formed shall be removed by wire brushing or by the use of emery paper. If the rust formation is heavy, re-blasting may be necessary. Around field joints, the pipe surfaces may be cleaned by wire brushing prior to the application of anti-corrosive protection.

4.4.13.4. PRIMER COAT

- a) The primer shall be compatible with the grade of enamel used. It shall be thoroughly mixed before using by stirring or by rocking the drum to provide uniformity of material. The primer coat shall be applied over a thoroughly clean and dry surface within three (3) hours of the cleaning operation, and shall be applied preferably immediately with a uniform thickness on the entire surface of the piping using appropriate quantity per unit area of surface as recommended by the manufacturer. The primer coating shall be free of bubbles, globules, drips and runs. Pipes having a longitudinal seam shall be carefully examined to determine that all excess primer has been brushed out of each side of the welding seam. The primer shall be thoroughly dry before the enamel is applied. If ready-made tapes are used, then primer, as suggested by the manufacturer, shall be used.
- b) Freshly-primed pipe shall be handled carefully to prevent damage. The damaged area shall be re-primed before applying enamel/wrapping tapes.

4.4.13.5. ENAMEL AND WRAPPING MATERIALS FOR COAL TAR ENAMEL APPLICATION

- a) The material to be used for coating and wrapping shall be coal-tar enamel, fibre glass inner wrap, fibre glass or kraft paper outer wrap, all as per IS 10221.
- b) Well-experienced personnel shall be placed in charge of coating and wrapping operations. They shall strictly follow the manufacturer's instructions regarding recommended temperature in the heating kettles and the temperature at which the hot coating is applied to the pipe. Clean dry enamel in lumps not exceeding 35 kg in weight shall be heated slowly in clean kettles to the recommended temperature, and after reaching the required temperature, the heating flame shall be controlled to prevent over-heating. Any enamel heated in excess of manufacturer's specifications shall be discarded. Only batch heating of enamel shall be permitted.
- c) Kettles shall be completely emptied of one batch and cleaned, if necessary, before preparing the next batch of enamel. The enamel shall be stirred continuously with metal agitators. Enamel kettles shall be equipped with indicating or recording thermometers having temperature range from 100 to 350°C. Enamel withdrawn from the kettles shall be strained through a 1.5 mm strainer.
- d) Enamel shall be moisture - and dirt-free at all times prior to and at the time of heating and application. The primed surface shall be dry and clean at all times and the enamel shall be applied not later than three (3) days after the application of primer. Along with the first coat of enamel, a single spiral inner wrap of fibre glass shall be applied overlapping at least 20 mm on pipes upto 250 mm diameter and 25 mm on larger diameter pipes. It shall be ensured that fibre glass impregnates in the first coat. The second coat of enamel and the second outer wrap of enamel-impregnated fibre glass or enamel-impregnated kraft paper shall be applied in the same way and shall conform to Table-10 or 12 of IS 10221. The total thickness of the coating shall not be less than 2.5 mm.
- e) A third coat of enamel and wrapping shall be applied wherever soil resistivity is below 1000 ohm-cm (extremely corrosive).

- f) During cold weather, when the pipe surface temperature is below 7°C or during rainy and foggy weather when moisture tends to collect on the cold pipe, enamelling shall be preceded by warming of the primed pipe. Warming shall be done by any method that will heat the pipe uniformly to the recommended temperature without damage to the primer. Temperature of the pipe shall not exceed 70°C.
- g) Each end of the pipe left bare for welding purpose shall be hand-coated and wrapped after completion of field welding and satisfactory hydrotesting of pipe.

4.4.13.6. APPLICATIONN OF WRAPPING TAPES

- a) After the surface preparation as per para 3.0, the primer shall be applied by brush or spay so as to give a coating thickness is between 2 and 4 mils when wet. The primer shall be allowed to dry to the touch prior to tape application. Primer and tape shall be furnished by the same manufacturer. If application is done in cold weather, the surface of the pipe shall be preheated until it is warm to the touch, and until all traces of moisture are removed and then the primer shall be applied and allowed to dry.
- b) The tape shall be wrapped strictly in accordance with the manufacturer's recommendations in a manner that shall meet the adhesion and holiday detection requirements of IS 10221. There shall be a minimum overlap of 12 mm per single wrap. Each layer of tape shall be of 2 mm thickness.

4.4.13.7. TESTING

a) THICKNESS

- i. The thickness of the pipe coating shall be measured either by elcometer or by coating thickness gauge.

b) BOND

- i. Bond test shall be carried out by cutting 25 mm square at three locations of the coating on a sample test specimen to qualify the procedure. Coating shall be pulled out by lifting one corner of the square. For a good coating, the section shall not peel off easily.
- ii. The coating on the pipe shall be carried out only after satisfactory completion of the qualifying test.
- iii. In case of doubt regarding the quality of coating, bond test shall be carried out on any location of the pipe to the satisfaction of the EMPLOYER. The tests indicated under clauses 7.1 and 7.2 are applicable for coal tar enamel applications only.

c) FIELD ADHESION TEST FOR WRAPPING TAPES

- i. Adhesion test shall be made to determine the proper bond between the tape and primed pipe. The temperature of the tape and pipe to be tested shall be between 10 and 27 °C. If the temperature is outside this range, hot or cold water shall be poured over the test area until this temperature range is

attained. A test area shall be selected by the inspector where the tape is smooth for 15 cm in the longitudinal direction of the tape. Two knife cuts that are 15 cm long and 5 cm apart shall be made through the tape. A flat blade shall be used to pry up 5 cm of the fabric. This 5 cm flap of fabric shall be grasped firmly in one hand and shall be pulled with a quick motion in the direction of the remaining 10 cm of the 15 cm knife cut.

- ii. The adhesion is satisfactory if the tape tears at the point of stripping or the fabric strips from the underlying coal tar component, leaving exposed not more than 10% of the primer or metal.

d) HOLIDAY TEST

- i. On completion of coating/wrapping, the quality of the coating shall be tested using efficient high voltage holiday detectors, operating at a voltage high enough to jump an air gap, the length of which is equal to the thickness of the coating/wrapping. All holidays found shall be repaired and the repairs shall be retested with the holiday detector to ensure that adequate repairs have been made.

- ii. The suggested test voltage shall be as follows :

$$V = 1250 (t)^{1/2} \text{ where}$$

$$V = \text{voltage, in volts}$$

$$t = \text{coating thickness in mils (1 mil = 0.001 in.)}$$

e) CERTIFICATES

The CONTRACTOR shall furnish certificates of all the materials purchased by him and also complete instructions from the manufacturer regarding the storage, preparation and application of the coating materials.

4.4.14 FIRE PROTECTION EQUIPMENT WET PIPE TYPE SPRINKLER SYSTEM

DATA SHEET A

General	1. Standard: NFPA, IS, QISD TAC/FM GLOBAL	Materials of construction (contd.)	11.3 clapper: bronze to IS 318
	2. Area to be covered:		gr.ltb2/
			11.4 clapper facing: bronze to IS 318 gr.ltb2/
	3. Hazard class: light/ordinary/ high/storage/class-iv		11.5 handhole cover: CI to IS 210
			GR.FG 225/
	4. Quality of water: raw water		11.6 clapper/ handhole gasket:
	5.		neoprene rubber/

	6.		11.7
Construction features	7. Installation control valve:		11.8
	7.1 size: 150mm		12. Sprinkler: brass as per IS 319/
	7.2 pressure at inlet:		bronze as per is 318 gr.ltb2,
	7.3 end connection: flanged to		chrome plated
	ANSI b 16.5,150#		13.
	7.4 water motor gong to be		14.
	provided:		15.
	yes		
	8. Sprinkler:	Companion specifications	16. P&I diagram:
	8.1 standard: is 9972/UL /FM		
	8.2 type: pendent/upright/universal/		17. GA drawing:
	sidewall		
	8.3 nominal temperature rating:		18. Pump:
	As per individual risk requirement		19. Piping: as per specification
	9.		
	10.		20. Instruments:as per specification
	11. Installation control valve:		21. Control panel: as per
	11.1 body: CI to is 210 GR.FG 200/		Specification
			22.
	11.2 seat ring: bronze to IS 318		23.
	gr.ltb2/		24.
Tests and inspection	25. As per shop inspection and tests and	Approved sub-vendors	33. Installation control valve:
			33.1
	186-30 and applicable nfpa, oisd,		33.2
	tae and fm global regulations		33.3
	(note 2)		33.4
	26. Foe/ul/fm approval certificates		33.5
	for installation controlvalve and		34. Sprinkler:
	sprinkler		34.1
	27.		34.2
	28.		34.3
	29.		34.4
	30.		34.5
	31.		
	32.		

<u>Notes</u>	
1.	Test connection at the remotest nozzle shall be provided.
2.	Additional tests indicated as 'B' in shops inspection requirements shall also be carried out when it is applicable.

4.4.15 WELDING SPECIFICATION FOR SHOP AND SITE FABRICATED EQUIPMENT

4.4.15.1. SCOPE

- a) This specification shall apply to shop and site fabrication of all welded joints in carbon steel, low alloy steel and stainless steel equipment like pressure vessels, tanks, columns and heat exchangers etc. The specification shall apply to all the joints indicated below:
 - i. Butt joints produced by double sided welding which produce the same quality of deposited weld metal on both inside and outside weld surfaces
 - ii. Butt joints produced by single sided welding having backing strip which remains in place and full penetration butt weld without backing strip
 - iii. Corner or those joints connecting two (2) members approximately at right angles to each other in the form of L or T
 - iv. Partial penetration welds of the groove type which are used for connections not subjected to external loading
 - v. Fillet welded joints of approximately triangular cross-section joining two (2) surfaces at approximately right angles to each other and having a throat dimension at least 70% of the thinner of the parts being joined but not less than 6 mm
 - vi. Welds attaching nozzles and other connections
 - vii. Welds which are used to join non-pressure parts like supports, lugs, brackets, stiffeners and other attachments to the vessel wall
 - viii. Any other similar joint which is not specified above but may be encountered during fabrication

4.4.15.2. CODES AND STANDARDS

- a) The welding equipment, welding consumables, preheating, Post weld Heat Treatment (PWHT), other auxiliary functions and welding personnel shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment are to be fabricated and installed. Nothing in this specification shall be construed to relieve the VENDOR/CONTRACTOR of this

responsibility. Specifically, the latest editions of the codes and standards listed below shall apply:

- i. ASME Boiler and Pressure Vessel Code (BPV Code), Section II Part C - Material Specifications for Welding Rods, Electrodes, and Filler Metals
 - ii. ASME BPV Code, Section V - Non-destructive Examination (NDE)
 - iii. ASME BPV Code, Section VIII Division 1- Rules for Construction of
 - iv. Pressure Vessels
 - v. ASME BPV Code, Section IX - Welding and Brazing Qualifications
 - vi. American Society of Non-destructive Testing (ASNT) SNT-TC-IA-Recommended Practice
 - vii. Indian Boiler Regulations (IBR)
 - viii. Any other codes and standards specified in Specification or data sheet A of
Data sheetsof enquiry specification
- b) The codes and standards listed in para 2.1 forms an integral part of this specification. In the event of conflict between this specification and the codes and standards, the more stringent shall govern.
- c) If no specific requirements are given in this specification, the requirements of the applicable code shall govern.

4.4.15.3. WELDING PROCESSES

- a) GAS TUNGSTEN ARC WELDING (GTAW)
- i. The root pass of single-sided groove welds without backing
 - ii. Full penetration nozzle connection where other side is inaccessible
 - iii. Any butt and fillet weld on equipment with thickness 5 mm or less
 - iv. For all passes of butt and fillet welding of nozzles on equipment and integral piping of size 50 mm NB or smaller
- b) Shielded Metal-Arc Welding (SMAW)
- c) SUBMERGED ARC WELDING (SAW)
- Maximum weld deposit per pass shall be 12.7 mm for carbon steel (P-1) and 9.5 mm for other materials.
- d) Gas Metal Arc Welding (GMAW) and Flux Cored Arc Welding (FCAW) processes

- e) Other processes such as plasma-arc and electro-slag welding may be used only with the approval of the EMPLOYER and depending upon the process and application proposed. These processes may require testing in addition to that specified by the governing procedure qualification code.
- f) Table 1 gives recommendations for welding processes to be used for carbon, low alloy and austenitic stainless steels.

4.4.15.4. WELDING CONSUMABLES

- a) The VENDOR/CONTRACTOR shall provide, at no additional cost, all the welding consumables such as electrodes, filler wires, flux, oxygen, acetylene and argon etc., in order to complete the welding in all respects. The consumables shall be from reputed and approved manufacturers. All the consumables shall be approved by the EMPLOYER.
- b) The electrodes and filler wires shall be of the class specified in Table 1 Welding Specification Chart.
- c) Electrode qualification test records shall be submitted for the EMPLOYER's approval. The VENDOR/CONTRACTOR shall also submit batch test certificates from the electrode manufacturer for physical and chemical tests.
- d) Electrodes shall be in sealed containers and adequate care shall be taken for storage, strictly in accordance with the manufacturer's recommendations.
- e) Electrodes, which have been removed from the original containers, shall be kept in baking ovens as per the manufacturer's recommendations and, once these are taken out, shall be consumed within the time limits stipulated by the manufacturer. Care shall be taken in handling the electrodes to prevent any damage to the flux covering. Portable ovens shall be used for carrying the electrodes from the main oven to the field. Electrodes of different specifications shall be stored in different compartments of a baking oven to avoid mix up.
- f) The electrodes, filler wires and flux used shall be free from contamination such as rust, oil, grease and such foreign matter.
- g) Low hydrogen electrodes shall be used for weld joints in carbon steel if the wall thickness exceeds 19 mm and low alloy steel of all thicknesses except that non- low hydrogen electrodes shall be permitted for the root pass of carbon steel only.
- h) If ultimate tensile strength of base material permits, E 6010 electrodes may be used, for root pass of butt welds and for fillet welds, in carbon steel.

4.4.15.5. WELDING QUALIFICATIONS

- a) Qualification of the welding procedures to be used and the performance of welders and welding operators shall conform to the requirements of the BPV Codes and Section IX. For equipment under the purview of IBR, these shall also meet the requirements of IBR.

- b) No production welds shall be undertaken until the qualification requirements are completed to the satisfaction of the EMPLOYER.
- c) When impact testing is required by the code or by the specification, these requirements shall be met in qualifying welding procedures.
- d) The VENDOR/CONTRACTOR shall be responsible for qualifying any welding procedure, welders and welding operators intended to be deployed. The VENDOR/CONTRACTOR shall submit the Welding Procedure Specification (WPS) for acceptance by the EMPLOYER. After approval by the EMPLOYER, the procedure qualification test shall be carried out by the VENDOR/CONTRACTOR, at his own expense, duly witnessed by the EMPLOYER. A complete set of test results, in specified format, shall be submitted to the EMPLOYER for approval immediately after successful completion of procedure qualification test. All tests as required by the BPV code Section IX or IBR shall be carried out. The WPS shall require re-qualification, if any of the essential variables or supplementary variables is altered.
- e) Welders and welding operators shall be qualified in accordance with BPV Code and Section IX or IBR, as applicable. The qualification shall be carried out in the presence of the EMPLOYER. Only those welders and welding operators who are qualified by the EMPLOYER shall be deployed on the job. For equipment under the purview of IBR, approval of the local IBR inspector shall be obtained by the VENDOR/CONTRACTOR.
- f) Welders and welding operators shall always keep their identification cards with them and shall produce them on demand. The VENDOR/CONTRACTOR shall issue the identity cards after the same are duly certified by the EMPLOYER. Welder or welding operator, who is not in possession of the identity card, shall not be allowed to work.
- g) The VENDOR/CONTRACTOR shall use forms as per BPV code, section IX, form QW-482, form QW-483 and form QW-484. Other forms are also acceptable subject to approval by the EMPLOYER.
- h) Unless agreed otherwise, the VENDOR/CONTRACTOR shall advise the EMPLOYER, in writing, at least three (3) weeks before any welder or welding operator is deployed on the work, the names and qualifications of the proposed welders, welding operators and welding supervisors. It shall be the VENDOR/CONTRACTOR's responsibility to ensure that all welders and welding operators employed by him or his SUB-VENDORS/SUB-CONTRACTORS, on any part of the work either in the VENDOR/CONTRACTOR's or his SUB-VENDOR/SUB-CONTRACTOR's works or at site are fully qualified as required by the code. Each welder and welding operator shall qualify for all types of welds, positions and materials or material combinations he may be called upon to weld.
- i) Should the EMPLOYER require to qualify or requalify any welder or welding operator, the VENDOR/ CONTRACTOR shall make available, at no extra cost to

the EMPLOYER the men, equipment and materials for the tests. The cost of testing the welds shall be borne by the VENDOR/CONTRACTOR.

- j) Welding supervisors shall have qualifications such as engineering degree or engineering diploma in welding technology with adequate knowledge of welding consumables, welding machines, NDE and a minimum of five (5) years of experience in supervising welding of joints.
- k) All welding, including the tacking up of all welds shall be carried out by qualified welders and welding operators as per approved WPS. Any weld made by other than a qualified welder or welding operator or not carried out as per approved WPS shall be cut out and re-welded.
- l) For purposes of identification and to enable tracing full history of each joint, each welder and welding operator employed on the work shall be given a designation. The welder and welding operator's designation and the date on which the joint was made, shall be stamped near the relevant joint and on the relevant drawings also. Copies of the drawings so marked shall be furnished to the EMPLOYER for record purposes. For austenitic stainless steels, welder and welding operator's designation shall be applied with water-proof paint or by etching or stencilling machine that is not detrimental to the metal. Alternatively, record cards may be used.
- m) For each welder and welding operator, a record card shall be maintained showing the procedures for which he is qualified. These cards shall note the production welds, the date of the welding done, the type of defects produced and their frequency. The record shall be reviewed once in a week by the EMPLOYER and those welders and welding operators whose work required a disproportionate amount of repair shall be disqualified from welding. Re-qualification of welders and welding operators disqualified more than three (3) times shall be entirely at the discretion of the EMPLOYER. As far as possible, the qualification shall be carried out at the location (site or shop) where the actual fabrication and welding work is to be carried out.

4.4.15.6. PREPARATION FOR WELDING

- a) Surfaces to be welded shall be smooth, uniform and free from fins, tears and other defects, which would adversely affect the quality of the weld. All welding faces and adjoining surfaces, for a distance of at least 50 mm from the edge of the welding groove or 12 mm from the toe of the fillet in the case of socket welded or fillet welded joints, shall be thoroughly cleaned of rust, scale, paint, oil or grease, both inside and outside.
- b) Joints for welding shall be as per the project specifications and approved fabrication drawings.
- c) Butt joints shall be prepared as per ASME BPV Code Section VIII Division 1, unless specified otherwise. For equipment under the purview of IBR, these shall be as per IBR. Any other end preparation which meets the WPS is acceptable.

- d) Internal misalignment shall be reduced by trimming but such trimming shall not reduce the finished wall thickness below the required minimum wall thickness. Trimming shall not be abrupt. It shall be tapered with a minimum slope of 1:3. Root opening of the joint shall be within the tolerance limits of the WPS.
- e) Welds shall be as per ASME BPV Code Section VIII Division 1 or in accordance with IBR for equipment under the purview of IBR.
- f) Reinforcing pads and saddles shall have a good fit with the parts to which they are attached. A tell-tale hole shall be provided on the side of any pad or saddle to reveal leakage in the weld and to allow venting during welding and heat treatment. Pad or saddle shall be added, after the branch weld has undergone satisfactory visual and NDE.
- g) The ends shall be prepared by machining, grinding, flame cutting or plasma cutting. Where flame cutting is used, the effect on the mechanical and metallurgical properties of the base metal shall be taken into consideration. Flame cutting of alloy steel is not advisable. If alloy steel is cut using flame, the heat affected zone shall be removed completely by grinding and/or machining. Magnetic Particle (MT) or Liquid Penetrant (PT) testing shall be carried out to ensure soundness of edges. However, flame cutting of carbon steel is permitted. Wherever practicable, flame cutting shall be carried out by machine. Machine flame-cut edges shall be substantially as smooth and regular as those produced by edge planning and shall be cleaned free of slag. Manual flame cutting shall be permitted only where machine flame cutting is not practicable and with the approval of the EMPLOYER, and such surfaces shall be ground or dressed to a smooth finish as required by the specification and to the satisfaction of the EMPLOYER. Slag, scale or oxides shall be removed by grinding to bright metal at least two (2) mm beyond the burnt area.
- h) Thermal cutting of carbon steel shall be performed under the same conditions of preheating and PWHT as for the welding of each class of material. However, PWHT is not required when:
 - i. The heat affected zone produced by thermal cutting is removed by mechanical means immediately after cutting. However, in any case, all remaining slag, scale or oxides shall be removed by grinding to bright metal at least two (2) mm beyond the burnt area, or
 - ii. Thermal cutting is part of fabrication, manufacturing or erection sequence leading to a weld end preparation where welding immediately follows.
- i) On austenitic stainless steels, plasma cutting, machining or grinding methods shall be used for edge preparation. Flame cutting is not permissible. Cut surfaces shall be machined or ground smooth after plasma cutting. Stainless steel materials shall be ground with Al₂O₃ grinding wheels and cleaned with stainless steel wire brushes.

- j) Before fitting up the weld joint, the profile and dimensions of the weld end preparation shall be checked by the EMPLOYER. If the specified tolerances are exceeded, this shall be corrected (with prior approval) by grinding, machining or any other method acceptable to the EMPLOYER.
- k) Fit-ups shall be examined by the EMPLOYER prior to welding the root pass.

4.4.15.7. TECHNIQUE AND WORKMANSHIP

- a) Stainless steel welding shall be carried out at a location away from carbon steel welding.
- b) Components to be welded shall be aligned and spaced as per the requirements of the code and WPS.
- c) Alignment and spacing shall be achieved using suitable wires to maintain the gap. These shall be removed after tack welding. The ends to be welded shall be held using suitable clamps, yokes or other devices which will not damage the surfaces in any manner. It shall be ensured that welding operations do not result in distortions.
- d) Earthing shall be provided on the job using earthing clamps of similar material as the job. Earthing shall not be given through welding rotators.
- e) Tack welds at the root joint, for maintaining joint alignment, shall be made only by qualified welders or welding operators and with filler metal equivalent to that used in the root pass. Tack welds shall be fused with the root pass weld, except that those which have cracked shall be removed. Peening is prohibited on the root and final passes of a weld. The required preheat shall be maintained prior to tack welding. Means shall be made available to measure preheat temperature.
- f) No welding shall be carried out if there is any impingement in the weld area of rain, snow, excessive wind or if the weld area is wet.
- g) Irrespective of the class of steel, root runs shall be made without interruption other than for changing the electrodes or to allow the welder or welding operator to reposition him. Root runs made in the shop may afterwards be allowed to cool by taking suitable precautions to ensure slow cooling e.g. by wrapping in a dry asbestos blanket. Welds made at site shall not be allowed to cool until the thickness of weld metal deposited exceeds one third of the final weld thickness or 10 mm, whichever is greater.
- h) When welding alloy steels, it is strongly recommended that interruption of welding be avoided. Where such interruption is unavoidable, either the preheat shall be maintained during the interruption or the joint shall be post heated or wrapped in dry asbestos blankets to ensure slow cooling. Before recommencing welding, preheat shall be applied again.
- i) Welded-on bridge pieces and temporary attachments shall preferably be avoided. Where approved by the EMPLOYER, these may be used. Material of these shall be compatible with material with which they are temporarily welded. All such

pieces shall be removed after welding of joints and the weld area ground flush. These areas shall be subjected to MT and PT examination. These pieces shall be welded by qualified welders and welding operators and with electrodes compatible with the parent material. The preheating requirements of material shall be applied and maintained during the welding of attachments. These temporary attachments shall be removed by grinding, chipping, sawing or by arc or flame gouging. When arc or flame gouging is used, at least three (3) mm of metal shall be left around the surface which shall be removed by grinding. This metal shall not be removed by hammering or by use of force.

- j) The arc shall be struck only on those parts of parent metal where weld metal is to be deposited. When inadvertent arc-strikes are made on the base metal surfaces outside the joint groove, the arc-strikes shall be removed by grinding and shall be examined by MT and PT procedures.
- k) Oxides shall not be permitted to form during welding or heat treatment or both, on the internal surfaces which will not be subsequently cleaned. Inert gas purging is an acceptable method to prevent such oxidation. All joints in materials which contain more than 1¼ % chromium shall be purged to assure that less than 1% of oxygen is present on the joint underside before initiation of the welding. The purging operation shall be maintained for a minimum of two (2) passes.
- l) Argon gas used in GTAW process for shielding and purging shall be at least 99.95% pure. Purging shall be carried out at a flow rate depending on diameter until at least five (5) times the volume between dams is displaced. In no case shall the initial purging period be less than 10 minutes. After initial purging, the flow of the backing gas shall be reduced to a point where only a slight positive pressure prevails. Any dams used in purging shall be fully identified and removed after welding and accounted for in order to avoid leaving them in the system. The rate of flow for shielding purposes shall be established in the procedure qualification.
- m) Thorough check shall be exercised to maintain the required inter-pass temperature.
- n) All equipment necessary to carry out the welding, for supporting of the work, for preheating and PWHT including thermal insulation for retaining the heat and for the protection of the welder and welding operator shall be provided by the VENDOR/CONTRACTOR at no extra cost. All necessary precautions shall be taken during cutting and welding operations. It shall be ensured that proper ventilation is available in the welding area and adequate protective gear such as goggles, masks, gloves, protection for the ears and body are used at all times. For guidelines refer ASME standard Z49.1, "Safety in Welding and Cutting".
- o) After deposition, each layer of weld metal shall be cleaned with a wire brush to remove all slag, scale and defects, to prepare for the proper deposition of the next layer. The material of wire brush shall be compatible with parent material. Stainless steel materials shall be cleaned with grinding wheels or stainless steel brushes which have not been used on other materials. Either aluminium oxide or silicon carbide

grinding wheels shall be used. Special care shall be taken to secure complete and thorough penetration of the fusion zone into the bottom of the weld. It is recommended that the root run be checked by MT or PT procedures for critical equipment.

- p) If specified, upon completion of welding, the joints shall be wrapped in dry asbestos blankets to ensure slow cooling, unless PWHT is applied immediately.
- q) No welding or welded parts shall be painted, plated, galvanised or heat treated until inspected and approved by the EMPLOYER. Welds shall be prepared and ground in such a way that the weld surfaces merge smoothly into the base metal surface, particularly for welds which are to undergo NDE.
- r) Except where necessary to grind flush for NDE, reinforcement for butt welds may be provided. The height of such reinforcement shall meet the requirements of the code. The reinforcement shall be crowned at the centre and tapered on each side of the joined members. The exposed surface of the weld shall be ground where required to present a workmanlike appearance and shall be free from depressions below the surface of the joined members. The exposed surface of the butt welds shall be free from undercuts, overlaps or abrupt ridges or valleys and shall merge smoothly into the surface at the weld toe.
- s) Repair of weld metal defects shall meet the requirements of the code.
- t) Any weld repair shall be subject to the approval of the EMPLOYER.
- u) In the event of several unsuccessful repair attempts or if the EMPLOYER feels that a satisfactory repair is not feasible, the joint shall be completely remade.
- v) It is preferable to use welding rectifier or DC generator for welding of austenitic steels and while using low hydrogen electrodes.
- w) IDENTIFICATION OF WELDS

Wherever code symbol stamps are required on carbon steel and ferritic alloy steel they shall be applied directly on to the member with low stress dotted design metal die stamps or to a small stainless steel plate especially provided for such marks. These plates shall be lightly tack welded using electrodes, of diameter three (3) mm or less, of the type specified for the material. Before making the required tack weld, the material in the immediate surrounding area shall be preheated, as required, by electric means or propane or natural gas burners. Cooling shall take place under asbestos insulation in a draft-free area. Stress relieving of these welds is not required. Steel stamping directly on the surface of alloy steel with other than low stress die stamps shall not be used.

- x) SEAL WELDS
 - i. Seal welding shall be carried out by qualified welders and welding operators and in accordance with approved drawings.

- ii. Threaded joints that are to be seal welded shall be made without the use of thread lubricating compound. Seal weld shall cover all exposed threads.

y) WELD ENCROACHMENT AND MINIMUM DISTANCE BETWEEN WELDS

- i. Welded joints, more specifically longitudinal welds, shall be placed not closer than 50 mm to opening or branch welds, reinforcements, attachment devices or from supports etc. In case of deviation, the EMPLOYER may specify additional NDE.

4.4.15.8. The longitudinal welds of two adjacent components shall be staggered by at least 30o. The minimum distance between welds shall be 50 mm or three (3) times the wall thickness, whichever is greater. Intersection of welds shall be avoided as far as possible. If such welds are present, they shall be subject to suitable NDE at the discretion of the EMPLOYER.

4.4.15.9. PREHEATING

- a) Preheating prior to tack welding, welding and thermal cutting shall be used as a means of crack prevention and improving weld reliability. The general requirements of PWHT also apply to preheating.
- b) Preheating shall be used as per the recommendations of ASME BPV Code Section VIII Division 1. For equipment under the purview of IBR, the requirements of IBR shall govern. Preheating of austenitic stainless steels is not required, except at low ambient temperatures, in which case a minimum preheat temperature of 10oC is recommended. Table 2 gives the requirements of preheating for commonly used materials
- c) The preheating zone shall extend 75 mm or a distance equal to four (4) times the material thickness, whichever is greater, beyond the edge of the weld.
- d) The preheat temperature shall be measured at least 75 mm away from the weld preparation.
- e) Where preheating is specified, welding shall continue without interruption. In case interruption cannot be avoided, preheating shall be carried out before recommencement of welding.
- f) Oxy-acetylene preheating shall not be applied.
- g) For preheating, fuel gas/air torches, burner systems (high velocity gas or oil burners) or electrical heating may be used either locally or in a furnace. For preheating above 250oC, electric heating (resistance or inductive heating) is recommended.
- h) Approved temperature - indicating crayons, thermocouples or digital contact or laser pyrometers shall be used to measure preheat and inter-pass temperatures. A calibration report of the pyrometers and thermocouples shall be available.

- i) When the preheat temperature is 150oC or higher, the metal shall be maintained at or above the preheat temperature until the weld is completed.
- j) The welding of groove welds in low alloy steels of P-3 to P-5 groups with wall thickness of 19 mm or greater may only be interrupted, provided at least 10 mm of weld metal is deposited, or 25% of the welding groove is filled, whichever is greater. If the welding is interrupted prior to the above, the weld area shall be adequately covered with insulating material to ensure slow cooling. After cooling and before welding is resumed, visual examination of the weld shall be performed to assure that no cracks are formed. Required preheat shall be applied before welding is resumed.

4.4.15.10.POSTWELD HEAT TREATMENT

PWHT shall meet the requirements of ASME BPV Code Section VIII Division 1. Table 3 summarises the PWHT requirements for commonly used materials. For equipment under the purview of IBR, PWHT shall be as per IBR.

a) GENERAL REQUIREMENTS

- i. A complete automatic temperature recording shall be made of preheating and stress relieving operations. Where propane gas burners or electrical resistance coils are employed, a complete temperature record of the preheating and stress relieving operation shall be made by means of a box type potentiometer. Other means of recording temperatures are permissible subject to the EMPLOYER's approval.
- ii. Stress relief may be local or full furnace. Local stress relief shall be performed with electric induction or electric resistance coils. Suitable gas burning equipment using natural gas or propane may be employed.
- iii. At no time during a stress relieving/preheating cycle shall any water or liquid cooling medium be employed.
- iv. Where members being joined are unequal in thickness, the dimension of the heavier section shall govern the selection of width of the heated band and the duration of the holding period shall be based on maximum weld thickness.
- v. For local stress relief, using electrical methods, a minimum of two (2) thermocouples tack-welded to the surface and potentiometers shall be used on the part under at least four (4) layers of asbestos paper. The hot junctions of the thermocouples shall be located on either side of the joint at least 12 mm from the edge of the joint but no further away than 100 mm. When employing induction heating, at least six (6) turns of induction cable shall be used on each side of the weld. Induction coils shall be wrapped on top of the asbestos paper protecting the thermocouples with the first turn approximately 150 mm from the centre of the weld.

- vi. Local stress relief using gas torches or ring burners may be employed.

However, the procedure shall be limited to small items and shall be approved by the EMPLOYER.

- vii. The stress relieving temperature shall be maintained for a period of time proportioned on the basis of one (1) hour per 25 mm of weld thickness at the joint, but in no case less than one (1) hour.
- viii. For piping joints and socket welded joints, pads, bosses, branch welds and couplings, one (1) thermocouple shall be positioned at a minimum distance of two (2) pipe wall thicknesses from the weld.
- ix. Equipment on both sides of any joint shall be adequately supported throughout the preheating, welding and stress relieving operations to prevent distortion.
- x. All heating and cooling rates shall be maintained as per ASME BPV Code and time-temperature charts from the recorder shall be made available for review and acceptance.
- xi. The VENDOR/CONTRACTOR shall submit a detailed written procedure for the

PWHT for the approval of the EMPLOYER.

b) CARBON STEEL

- i. Welded joints in carbon steel shall be stress relieved, upon completion of the welding operation, in accordance with Table 3.
- ii. When local stress relief is employed, the welded joint shall be heated to a temperature of not less than 600°C. The temperature level shall be maintained between 600 and 650°C, one (1) hour per 25 mm of weld thickness but in no case less than one (1) hour. The weld area shall then be allowed to cool undisturbed in still air to a temperature not exceeding 315°C.
- iii. Heating and Cooling

Carbon steels, after having reached their specific stress relief temperatures, may be cooled in the furnace or under wraps, i.e., leaving the induction coils or resistance heaters and insulation in place. This means that, at the stress relief temperatures, the power to the furnace or heating coils may be shut off and cooling takes place in the furnace or with all insulation and coils remaining on the part. For furnace stress relief, the doors of the furnace may be opened after the power is shut off, at or below 315°C. Thermocouples controlling the temperatures shall remain during the cooling cycle so that excessive cooling, if it occurs, can

be observed and immediately corrected. The stress relieving coils and insulation shall only be removed after the part has cooled to below 315°C or if stress relieved in a furnace the part may be removed from the furnace and permitted to cool in still air at a temperature not below 10°C.

c) ALLOY STEEL

- i. Welds in alloy steel shall be stress relieved after the welding operation in accordance with Table 3. After welding, the material shall be wrapped in asbestos and allowed to cool slowly if PWHT is not carried out immediately.
- ii. For full furnace stress relief of a welded assembly, the entire fabricated section shall be heated uniformly to the temperature specified. The temperature shall be maintained for a period of time proportioned on the basis of one (1) hour per 25 mm of weld thickness of the piece having the greatest weld thickness in the furnace charge, but in no case, less than one (1) hour.

d) AUSTENITIC STAINLESS STEEL

- i. Welded joints in austenitic stainless steel need not be stress relieved after welding. Solution annealing shall be carried out, if specified.

4.4.15.11.ELECTRODES

- (a) The specification and size of the electrodes, voltages and amperages, thickness of beads and number of passes shall be as specified in the approved welding procedure or otherwise agreed in writing. Only basic coated electrodes shall be used, which will deposit weld metal having the same or higher physical properties and similar chemical composition to the members being joined. For each batch of approved brand, certificate showing compliance with the specification shall be submitted to the EMPLOYER for review before being released for use. All electrodes shall be purchased in sealed containers and stored properly to prevent deterioration. As welding electrodes deteriorate under adverse conditions of storage leading to dampness in the electrode coating, they shall normally be stored in dehumidified air-conditioned rooms or in hot boxes or ovens in their original sealed containers whose temperatures shall be maintained within specified limits. The condition of electrodes shall be frequently inspected. Electrodes with damage to coating shall not be used. Electrodes shall remain identified until consumed. It is preferable to procure low hydrogen electrodes in hermetically sealed containers and preserve them without damage to the containers.
- (b) All low hydrogen electrodes, after baking as per the manufacturer's recommendations, shall be stored in ovens kept at 80 to 100°C before being used. Recommendations of the electrode manufacturer shall be strictly followed. Until the electrodes are taken out for welding, they shall be stored in portable ovens. The electrodes shall not be exposed to open atmosphere.

- (c) For welding of all grades of steel and alloys by the GTAW process, a 2%thoriated tungsten electrode conforming to SFA-5.12-86 EWTh-2 (AWS-A5.12-80, EWTh-2) classification shall be used.
- (d) All electrodes to be used on alloy and carbon steel shall conform to ASME BPV Code Section II Part C or any other equivalent code.
- (e) The type of electrodes used shall be only those recommended by the manufacturer for the use in the position in which the welds are to be made.
- (f) Current and polarity shall be maintained as recommended by the electrode manufacturer.

4.4.15.12.INSPECTION AND TESTING

- (a) The EMPLOYER shall have free access to inspect welding or any other related operations at any time and at any stage of fabrication.
- (b) The EMPLOYER may require NDE of any weld for reasons other than those given in the specification. The responsibility for the cost of such testing shall be mutually decided between the EMPLOYER and the VENDOR/CONTRACTOR.
- (c) The VENDOR/CONTRACTOR shall inform the EMPLOYER when the weld preparation and set-up for welding of various members selected by the EMPLOYER are in progress so that the EMPLOYER can inspect the assembly before welding starts.
- (d) The responsibilities of the EMPLOYER's representative shall in no way reduce the VENDOR/CONTRACTOR's responsibilities to ensure that the work is carried out in accordance with the specification
- (e) Any examination by NDE methods shall be performed before or after PWHT based on the applicable code requirements
- (f) For a welded branch connection and for any weld, necessary repairs and NDE shall be completed before any reinforcing pad is added.

4.4.15.13.EXAMINATION OF WELDS

- (a) Examination refers to the quality control functions performed by the VENDOR / CONTRACTOR during fabrication, erection and testing.
- (b) As a minimum, the following shall be examined by visual examination:
 - i. Materials and components to ensure that these are as per the specification and are free from defects. If defects are noticed on "free-issue" items, these shall be brought to the notice of the EMPLOYER without delay.
 - ii. Joint preparation and cleanliness
 - iii. Fit-up, joint clearance, and internal alignment prior to joining

- iv. Preheating as applicable
 - v. Variables specified by the welding procedure, including filler material, position and electrode
 - vi. Condition of the root pass after cleaning - external and where accessible, internal
 - vii. Slag removal and weld condition between passes
 - viii. Appearance of the finished joint and weld dimensions
- (c) Acceptance for the visual examination shall be as per ASME BPV Code Section VIII Division 1 or IBR as applicable.

4.4.15.14. QUALIFICATION AND CERTIFICATION OF NDE PERSONNEL

- (d) Approved and documented NDE procedure prepared by level III personnel shall be made available.
- (e) The VENDOR's/CONTRACTOR's examining personnel shall have training and experience commensurate with the needs of the specified examinations. NDE supervisors/ examiners shall be qualified at level II or above of ASME BPV Code Section V.
- (f) The VENDOR/CONTRACTOR shall make available to the EMPLOYER copies of certificates of qualification of the examiners he proposes to use for the EMPLOYER's approval.

4.4.15.15. METHODS OF EXAMINATION

- (a) The methods of examination used, Ultrasonic (UT), Radiographic (RT), MT and PT shall be in accordance with ASME BPV Code, Section V.

4.4.15.16. ACCEPTANCE STANDARDS

- (a) Levels of acceptance of defects in welds shall be in accordance with ASME BPV Code Section VIII Division 1.
- (b) For equipment under the purview of IBR, the levels of acceptable defects shall be as per IBR.

4.4.15.17. REPAIR WELDING

- (a) All defects in welds requiring repair shall be removed by flame or arc gouging, grinding, chipping or machining. The major repairs may involve:
 - (i) Cutting through the weld
 - (ii) Cutting out a portion of material containing the weld, or
 - (iii) Removing the weld metal down to the root depending upon the magnitude of the defects.

- (b) After removing the defect, the repaired portion and adjacent area shall be examined by the same NDE methods as specified for the original weld and the same acceptance criteria shall hold good.
- (c) All the repair welds shall be made using the same or other specified welding procedures as those used in making the original welds including preheating and stress relieving if originally required.

TABLE 1

WELDING SPECIFICATION CHART FOR COMMONLY USED MATERIALS

L. No.	Base material	P. No.	Welding process		Filler material		Notes
			Root	Filler	Root	Filler	
1.0	Carbon steels	1	GTAW	GTAW	ER 70S2 OR ER 70S3	ER 70S2 OR ER 70S3	
1.1	5 mm thick						
1.2	5 mm and 19 mm thick	1	GTAW OR SMAW	SMAW OR SAW	ER 70S2 OR ER 70S3 OR E 6010	E 6013 F6--EL8 OR E 7018 F7--EL12	
1.3	19 mm thk	1	GTAW OR SMAW	SMAW OR SAW	ER 70S2 OR ER 70S3 OR E 6010	E 7018 F7--EL12	1
2.0	Low alloy steels	4	GTAW	GTAW	ER 80S B2	ER 80S B2	
2.1	1¼% cr ½% mo 5 mm thick						
2.2	1¼% cr ½% mo 5 mm thick	4	GTAW	SMAW	ER 80S B2	E 8016 OR E8018-B2	
2.3	2¼% cr 1% mo 5 mm thick	5	GTAW	GTAW	ER 90S B3	ER 90S B3	2 to 7
2.4	2¼% cr 1% mo 5 mm thick	5	GTAW	SMAW	ER90S B3	E 9015 OR E 9016 OR E 9018-B3	2 to 7
3.0	Austenitic stainless steels	8	GTAW	GTAW FOR 5 MM THICK	ER 308 (ER 308L)	ER 308 (ER 308L)	2 to 7
3.1	Type 304 (304L)			SMAW FOR > 5 MM THICK		E 308 (E 308L)	

3.2	Type 316 (316L)	8	GTAW	GTAW FOR 5 MM THICK	ER 316 (ER316L)	ER 316 (ER 316L)	2 to 7
				SMAW FOR > 5 MM THICK		E 316 (E 316L)	
3.3	Type 321	8	GTAW	GTAW FOR 5 MM THICK	ER 321 OR ER 347	ER 321 OR ER 347	2 to 7
				SMAW FOR > 5 MM THICK		E 321 OR E 347	
4.0	Stainless steel to carbon steel	8 to 1	GTAW OR SMAW	SMAW	ER 309 OR E 309	E 309	
4.1	SS 304/321						
4.2	SS 316	8 to 1	GTAW OR SMAW	SMAW	ER 309 MO OR E 309 MO	E 309 MO	
4.3	SS 304L	8 to 1	GTAW OR SMAW	SMAW	ER 309L OR E 309L	E 309L	
4.4	SS 316L	8 to 1	GTAW OR SMAW	SMAW	ER 309 MOL OR E 309 MOL	E 309 MOL	

N

NOTES

1.Low hydrogen electrodes shall be used for critical systems such as chlorine, hydrogen, caustic and similar toxic inflammable fluids and also whenever the wall thickness exceeds 19 mm

2. The argon shielding gas flow rate shall not be less than 0.34 M3/Hr.

3. For purging and shielding argon gas shall be used. However, nitrogen may be used as an alternative to argon for purging purpose only. In case of stainless steel, nitrogen may be used where corrosion resistance is not critical.

4. For fillet welds, SMAW may be used instead of GTAW for thicknesses above 5 mm.
5. For GTAW, electrode shall be 2% thoriated tungsten.
6. Initial purging prior to welding process shall be a minimum of five (5) times the volume between dams or ten minutes minimum whichever is higher. When welding commences, The purge gas flow shall ensure that the gas pressure is only marginally higher than atmospheric pressure to ensure no root concavity.
7. Back purging using argon/nitrogen shall be maintained for the root run and a minimum of one (1) additional pass.
8. Electrodes and filler wires manufactured by reputed firms duly approved by the EMPLOYER shall only be used.
9. Electrodes shall have at least the same or higher physical properties and similar chemical composition to the members being joined.
10. Read the table in conjunction with para 3.0

TABLE 2

PREHEAT REQUIREMENTS

Sl. No.	Base material	P. No.	Nominal wall thickness, mm	Specified minimum tensile strength, mpa	Recommended minimum preheat temperature, °c
1.	Carbon steel	1	25	490	10
2.	Carbon steel	1	25	490	100
3.	Low alloy steel - 1¼% cr ½% mo	4	All	All	149
4.	Low alloy steel - 2¼% cr 1% mo	5	All	All	210

TABLE 3

POSTWELD HEAT TREATMENT REQUIREMENTS (FOR COMMONLY USED STEEL MATERIALS)

Sl. No.	Base material	P. No.	Nominal wall thickness mm	Metal temperature range °c
1.	Carbon steel	1	32	None
2.	Carbon steel	1	> 32	600 to 650
3.	Low alloy steel 1¼% cr ½% mo	4 GR 1 AND 2	All	600 to 650
4.	Low alloy steel 2¼% cr 1% mo	5A GR 1	All	680 to 700
5.	Austenitic stainless steels	8, 9	All	Note 3

NOTES

1. In IBR systems, in carbon steels, PWHT is also required, when the carbon percentage exceeds 0.25%, at the temperature range of 600 +/- 20°C.

2. For all low alloy steel welds under the purview of IBR, the PWHT shall be carried out at the temperature range of 620 to 660° C for 1 1/4% Cr 1/2% Mo steels and at a range of 660 to 750°C for 2 1/4% Cr 1% Mo steels.

3. Solution annealing shall be carried out after welding of austenitic stainless steel as per the applicable services.

4. For equipment in carbon steels or alloy steels and meant for lethal service, PWHT of all welds shall be carried out.

4.4.16 LOW VOLTAGE INDUCTION MOTORS

4.4.16.1. SCOPE

The specification covers the design, material, constructional features, manufacture, inspection and testing at the VENDOR's / his SUB-VENDOR'S works, delivery to site and performance testing of Low Voltage induction motors rated up to 1000V.

4.4.16.2. CODES AND STANDARDS

The design, material, construction, manufacture, inspection, testing and performance of induction motors shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the applicable standards specified in data sheet A1 latest revision as on the date of offer. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility. In case of conflict between the standards and this specification, this specification shall govern.

4.4.16.3. DRIVEN EQUIPMENT

- (a) When this specification forms part of the driven equipment specification, information not given in the Data Sheet-A will be governed by the driven equipment specification.
- (b) Motors shall be capable of satisfactory operation for the application and duty as specified in the motor Data Sheet-A and as specified for the driven equipment.

4.4.16.4. PERFORMANCE AND CHARACTERISTICS

- (c) Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under either of the following supply conditions as specified in Data Sheet-A.

Supply Condition

	I	II
(i) Variation in supply voltage from rated voltage	±6%	±10%
(ii) Variation in supply frequency from rated frequency	±3%	±5%
(ii) Combined voltage and Frequency variation	9%	10%

- (a) Motors shall be suitable for the method of starting specified in the Data Sheet-A.
- (b) The minimum permissible voltage shall be 85% of the rated voltage during motor starting.

- (c) Motors shall be capable of starting and accelerating the load with the applicable method of starting, without winding temperatures reaching injurious levels, when the supply voltage is in the range of 85% of the rated motor voltage to maximum permissible voltage specified in Data Sheet-A.
- (d) The locked rotor current of the motor shall not exceed 600% of full load current (subject to tolerances as per the applicable standard) unless otherwise specified. The locked rotor current of VFD controlled motor shall be within the limit of IS12615 / IEC.
- (e) Motors shall be capable of developing the rated full load torque even if the supply voltage drops to 70% of the rated voltage. The pull out torque of the motor shall be at least 205% of full load torque.
- (f) Motors when started with the driven equipment coupled shall be capable of withstanding at least two successive starts from cold conditions & one start from hot condition without injurious heating of windings. The motors shall also be suitable for three equally spread starts per hour under the above referred supply conditions.
- (g) Motors shall be of Energy Efficient type if specified in Data sheet-A1. Category of Energy efficiency shall be as mentioned in data sheet-A1.

4.4.16.5. SPECIFIC REQUIREMENTS OF VFD DRIVEN MOTORS

- (a) The motor shall be suitable for operation with a solid-state power supply consisting of an adjustable frequency inverter for speed control.
- (b) The motor shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.
- (c) The Motor shall be designed to operate continuously at any speed over the range 10-100 % of rated speed.
- (d) The permitted voltage variation should take into account the steady state voltage drop across the AC drive and all other system components upstream of the motor.
- (e) The motor shall be constructed to withstand torque pulsations resulting from harmonics generated by the solid-state power supply.
- (f) The driven equipment manufacturer shall be solely responsible for proper selection of the motor for the given load application and the output characteristics of the driven equipment.

4.4.16.6. INSULATION

- (a) The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate.
- (b) Motors which are VFD controlled shall be inverter grade and shall be suitably derated to take care of reduced cooling at lower speeds.

- (c) Insulation of VFD controlled Motors shall be designed to withstand a dv/dt of 0.1 micro sec rise from 10 % to 90 % of steady voltage and a maximum peak of 1600 volts as per NEMA standard MG1 Part 31.40.4.2 .
- (d) The insulation shall be of double coat winding wires which having superior electric strength and thermal capability for VFD controlled motors.
- (e) Winding shall be insulated as VPI (Vacuum Pressure Impregnation) of winding with suitable resin forces which eliminating voids for VFD controlled motors.

4.4.16.7. TEMPERATURE RISE

- (a) The temperature rises shall not exceed the values given in IS 12802. Under extremes of supply condition, the temperature rise shall not exceed the value indicated in IS by 10°C.
- (b) For motors specified for outdoor installation heating due to direct exposure to solar radiation shall be considered.

4.4.16.8. CONSTRUCTIONAL FEATURES

- (a) All windings shall be of Copper. The winding insulation shall be Non-hygroscopic, oil resistant and, flame resistant.
- (b) Motors weighing more than 25 kg. shall be provided with eyebolts, lugs or other means to facilitate safe lifting.
- (c) Noise level and vibration limit should not exceed as specified in relevant IS / IEC.

4.4.16.9. BEARINGS

- (a) Unless otherwise specified in data sheet-A, motor bearings shall not be subjected to any external thrust load.
- (b) Unless otherwise specified, motor bearings shall have an estimated life of at least 40,000 hrs.
- (c) The bearings shall permit running of the motor in either direction of rotation.
- (d) When forced oil lubrication or water cooling is required, prior approval from the Employer shall be obtained.
- (e) It shall be possible to lubricate the bearings without dismantling any part of the motor.
- (f) VFD controlled Motors shall have their bearings insulated to prevent motor shaft currents from entering the bearing race.

4.4.16.10. TERMINAL BOX

- (a) Terminal boxes shall have a degree of protection of atleast IP 55 for out door applicable.

- (b) Unless otherwise approved, the terminal box shall be capable of being turned through 360° in steps of 90°.
- (c) Terminals shall be of stud type & the terminal box shall be complete with necessary lugs, nuts, washers.
- (d) When single core cables are to be used the gland plates shall be of non magnetic material.
- (e) Sizes of terminal boxes and lugs shall be as given in Table-I, unless specified otherwise in data sheet A or Specification.

TABLE-I

415 V MOTORS - SIZES OF CABLES, STUDS, TERMINAL LUGS & TERMINAL BOXES
(TO BE PROVIDED ON MOTORS BY VENDOR)

Sl No.	Motor Rating (kW)	1100V Al Conductor, armoured PVC/XLPE Cable Cores x mm ²
1.	Upto 3	3x4
2.	3.1 - 7.5	3x6
3.	7.6 - 15	3x16
4.	16 - 25	3x35
5.	26 - 40	3x70
6.	41 - 55	3x120
7.	56 - 70	3x185
8.	71 - 85	3x240
9.	86 - 110	3x400
10.	111 - 200	3Rx1Cx500

4.4.16.11. PAINT AND FINISH

- (a) All motor parts exposed directly to atmosphere shall be finished and painted to produce a neat and durable surface which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, all rust, sharp edges and scale removed and treated with one coat of primer and finished with two coats of grey enamel paint.

4.4.16.12. HEATING DURING IDLE PERIODS

- (a) Motors rated above 30 kW shall have space heaters suitable for 240V, single phase, 50 Hz, AC supply. Space heaters shall have adequate capacity to maintain motor internal temperature above dew point to prevent moisture condensation during idle period. The space heaters shall be placed in easily accessible positions in the lowest part of the motor frame.

4.4.16.13. ACCESSORIES

- (a) Two independent earthing points shall be provided on opposite sides of the motor, for bolted connection of the EMPLOYER'S earthing conductors as specified in data sheet-A. These earthing points shall be in addition to earthing stud provided in the terminal box.
- (b) Except when otherwise specified, the motors shall be provided with a bare shaft extension having a key slot and a key at the driving end.

4.4.16.14. TESTS

- (a) Motor shall be subjected to all the routine tests as per applicable standard in the presence of the EMPLOYER'S representative. Copies of test certificates of type and routine tests shall be furnished as specified in the distribution schedule, for the EMPLOYER'S approval. The VENDOR shall ensure to use calibrated test equipment/instruments having valid calibration test certificates from standard laboratories traceable to national/international standards.
- (b) If type tests have not been carried out on similar Motors, or if the type test reports submitted are not found in order, then VENDOR shall carry out these tests without any extra cost to the Employer.

4.4.16.15. LOW VOLTAGE INDUCTION MOTORS DATA SHEET-A1

Sl.no .	Description	Unit	Technical particulars
1.0	General		
1.1	Application		(*)
1.2	Numbers required		(*)
1.3	Type of motor		Squirrel cage (energy efficient- IE-3 as per 12615) type
1.4	Supply system fault level	Mva	16KA
1.5	Type of earthing of supply system neutral		Effectively earthed system
2.0	Rating		
2.1	Rated output :	Kw	Kw (*)
2.2	Rated voltage :	V	415v
2.3	Number of phases & frequency		3 phase, 50 hz
2.4	Supply condition as per specification		Ii
2.5	Synchronous speed	Rpm	Rpm(*)
3.0	Duty		
3.1	Type of duty (clause 9.2 of is:325 or equivalent)		(*)
3.2	Power required by load	Kw	(*)

Sl.no .	Description	Unit	Technical particulars
3.3	Energy efficiency class as per is-12615-2011		IE3
4.0	Method of starting		D.O.L /STAR DELTA
5.0	Insulation		
5.1	Class of insulation		F with temp. Rise class-b
5.2	Ref. Ambient temperature	°c	50°c
5.3	Temperature rise by		Corresponding to class b insulation
5.3.1	Thermometer method	°c	55°c
5.3.2	By winding resistance method		65°c (class b)
6.0	Installation		
6.1	Location		Indoor
6.2	Hazardous area division (is:5572 or equivalent)		Not applicable
6.3	Atmosphere		Chemical
7.0	Enclosure		
7.1	Type of cooling (is 6362)		Tefc
7.2	Designation for degree of protection (is 4691)		Ip 55
8.0	Main terminal box		
8.1	Location as seen from non- drive end:		Top/right/left (*)
	Ratings		(*)
8.2	(a)	Short time	
		I. Current :	Ka(rms)
		Ii. Duration :	Secs. 0.1
	(b)	Dynamic :	Ka (peak)
8.3	External cable details		(#)
8.3.1	Type		
8.3.2	Size & no of cores		
8.4	Earthing conductors		
8.4.1	Material		Gi
8.4.2	Size		(#)

Sl.no .	Description	Unit	Technical particulars
9.0	Miscellaneous requirements		<u>To be filled if motors are bought seperately</u>
9.1	Shaft orientation		Horizontal/vertical/hollow vertical (*)
9.2	Mounting symbol (is:2253 or equivalent)		(*)
9.3	Rotation as seen from non-drive end		Clockwise/anti-clockwise/ bi-directional (*)
9.4	Type of bearing		
9.4.1	Drive end		(*)
9.4.2	Non drive end		(*)
9.5	Whether bed plate required		(#)
9.6	Motor shall match the following torque requirements of the driven equipment:		(*)
	A) Starting torue		
	B) Full load (rated) torque		
	C) Pull out torque		
	D) Pull up torque		
9.7	Coupling by motor supplier		Yes/no (will be informed later)
9.8	If yes, type of coupling		
10.0	Colour shades of paint		Light grey (shade -631 of is-5)
11	Whether vibration pads required		(#)
12	Temperature detectors/indicators		
12.1	Embedded temperature detectors for winding required		No
12.2	Embedded temperature detectors for bearings required		No
12.3	Bearing thermometers for driving end & non driving ends required		No
13	Space heaters for motors required (for motors greater than 30kw)		Yes for motors of 30kw & above

4.4.16.16.LOW VOLTAGE INDUCTION MOTORS DATA SHEET-A2

Sl.no.	Brief title	Reference number of standards
1.	Three phase induction motors	<input type="checkbox"/> IS-325 <input type="checkbox"/> BS-4999 <input type="checkbox"/> IEC-34
2.	Rotating electrical machines	<input type="checkbox"/> IS-4722 <input type="checkbox"/> BSEN60034-1 <input type="checkbox"/> IEC-34-1

Sl.no.	Brief title	Reference number of standards
3.	Single phase induction motors	<input type="checkbox"/> IS-996 <input type="checkbox"/> BS <input type="checkbox"/> IEC
4.	Code of practice for climate proofing	<input type="checkbox"/> IS <input type="checkbox"/> BS-6751 <input type="checkbox"/> IEC
5.	Designations for types of construction and mounting arrangement of rotating electrical machines	<input type="checkbox"/> IS-2253 <input type="checkbox"/> BSEN60034-7 <input type="checkbox"/> IEC-34-7
6.	Terminal marking & direction of rotation for rotating electrical machinery	<input type="checkbox"/> IS-4728 <input type="checkbox"/> BS-4999-108 <input type="checkbox"/> IEC-34-8
7.	Designation of methods of cooling for rotating electrical machines	<input type="checkbox"/> IS-6362 <input type="checkbox"/> BSEN 60034-6-1994 <input type="checkbox"/> IEC-34-6
8.	Degrees of protection provided by enclosure for rotating electrical machinery	<input type="checkbox"/> IS-4691 <input type="checkbox"/> BS-EN60529 <input type="checkbox"/> IEC-529
9.	Guide for testing three phase induction motors	<input type="checkbox"/> IS-4029 <input type="checkbox"/> BSEN60034-2 <input type="checkbox"/> IEC-34-2
10.	Measurement and evaluation of vibration of rotating electrical machines	<input type="checkbox"/> IS-12075 <input type="checkbox"/> BS-4999142 <input type="checkbox"/> IEC-34-14
11.	Classification of hazardous areas for electrical installation	<input type="checkbox"/> IS-5572 <input type="checkbox"/> BS <input type="checkbox"/> IEC-79
12.	Dimensions of slide rails for electric motors	<input type="checkbox"/> IS-2968 <input type="checkbox"/> BS-4999-141 <input type="checkbox"/> IEC
13.	Permissible limits of noise level for rotating electrical machines	<input type="checkbox"/> IS-12065 <input type="checkbox"/> BSEN 60034-9-1994 <input type="checkbox"/> IEC
14.	Guide for testing insulation resistance of rotating machines	<input type="checkbox"/> IS-7816 <input type="checkbox"/> BS <input type="checkbox"/> IEC
15.	Induction motors- energy efficient three phase squirrel cage-specification	<input type="checkbox"/> IS-12615-2011 <input type="checkbox"/> IEC-60034-3
16.	Flame proof a c motors for use in mines.	<input type="checkbox"/> IS- 3682
17.	Flame proof enclosures of electrical apparatus	<input type="checkbox"/> IS-2148

Sl.no.	Brief title	Reference number of standards
18.	Starting performance of single speed three phase cage induction motors for voltage up to 600 v	<input type="checkbox"/> IS-8789 <input type="checkbox"/> BSEN-60034-12 <input type="checkbox"/> IEC-34-12
19.	Cage induction motors when fed from converters – application guide	<input type="checkbox"/> IEC-34-17
20.	Adjustable speed electrical power drive system- emc requirements and specific test methods.	<input type="checkbox"/> BS-EN-61800 <input type="checkbox"/> IEC-61800
21.	Dimensions and output series for rotating electrical machines.	<input type="checkbox"/> IS-1231 <input type="checkbox"/> BS-4999-141 <input type="checkbox"/> IEC- 72-1
22.	Electrical apparatus for explosive gas atmosphere – classification of hazardous area.	<input type="checkbox"/> IS-5571 <input type="checkbox"/> BSEN-60079 <input type="checkbox"/> IEC-79-10
23.	Temperature rise measurement of rotating electrical machines	<input type="checkbox"/> IS-12802 <input type="checkbox"/> BS <input type="checkbox"/> IEC
24.	Type of duty and classes of rating assigned to rotating electrical machines	<input type="checkbox"/> IS 12824 <input type="checkbox"/> BS <input type="checkbox"/> IEC
25.	Cbip recommendation for motors	

NOTES:

1. Details marked thus (*) will be decided and intimated by the bidder based on driven equipment characteristics
2. Data marked thus (#) will be intimated to vendor after placement of order.
3. Data marked thus (^) will be decided and intimated by the bidder.
4. Associated accessories, components/parts, raw material and tests shall in general conform to ☐ is ☐ bs ☐ iec .
5. Offers conforming to other authoritative standards may also be considered/may not be considered.
6. Use ☒ mark for applicable for relevant is and iec.

4.4.16.17.SHOP INSPECTION REQUIREMENTS VALVES-METALLIC

Serial no.	Description	Visual examination	Dimensions	Material test cert.	Identification and correlation	Positioning	Pt / mt	Radio-graphy	Ultrasonic test	Heat treatment	Hardness test	Shell, gland leak test	Seat, back seat	Seat leak test - air	Set point	Disc strength test	Performance / operation tests	Type tests	Routine tests	Adhesion, hardness, spark, thickness	Endurance (type) test
1	Pressure parts - materials	D		C	D	D	B	B	B	C	D	D									
2	Trims (seats, stem, plug, disc etc.)			C			D		B		B										
3	Springs			C														C		C	
4	Diaphragm										C									D	
5	Non - metallic items, if any			C							D										
6	Actuators, positioners, if any	A	A									A ^Z					A	C	C		
7	Finished items	A	A									A	A	B			A				
8	Safety relief valves - additional tests											D		A	A						
9	Butter fly valves - additional tests															B					
10	Control valves - additional tests																A ^Y				
11	Linings, if any	A																	A		
Leged A - witnessed by tce. B - witnessed by tce if requirement is specified. C - records verified by tce wherever applicable. D - a or c, at tce's discretion wherever applicable. X - scrag test and load / deflection test.		Notes 1 - all stages shall be checked 100 % by vendor and records thereof shown to tce. 2 - witnessing by tce may be 100 % or on random samples. 3 - this document shall be read in conjunction with inspection requirements mentioned in and relevant technical specifications. 4 - the pressure gauges and instruments for measuring critical parameters shall have valid calibration certificate traceable to national laboratory.																			
	Y - including cv. Z - for actuator chamber.																				

4.4.16.18.SHOP INSPECTION REQUIREMENTS PIPES AND PIPE FITTINGS-METALLIC

Serial no.	Description	Visual examination	Dimensions	Material test cert.	Identification and correlation	Ultrasonic test	Welding qualification	Fit up	Backchip-pt	Pt / mt	Radiography	Ovality, thinning	Heat treatment	Surface finish	Hydrostatic leak test	Hardness test	Spark, adhesion test	Thickness check	Material check test		
A	Ordered on manufacturer																				
1	Plates / pipes for fabricated items	D	D	C	D	D															
2	Rolling, forming for fab. Items	D	D									D									
3	Butt, groove welds for fabricated items	D	D			B	C/a	D	D	B	B										
4	Finished items	A	A	C	A	B							C	B	B				D		
5	Linings, if any	A														A	A	A			
6	Coatings, if any	A																A			
B	Ordered on dealers / stockists etc.	A	A	C	A									A	C	A ^x	A ^x	A ^x	D		

Leged		Notes
A - witnessed by tce.		1 - all stages shall be checked 100% by vendor and records thereof shown to tce. 2 - witnessing by tce may be 100 % or on random samples. 3 - this document shall be read in conjunction with inspection requirements mentioned in and relevant technical specifications. 4 - the pressure gauges and instruments for measuring critical parameters shall have valid calibration certificate traceable to national laboratory.
B - witnessed by tce if requirement is specified.		
C - records verified by tce wherever applicable.		
D - a or c, at tce's discretion wherever applicable.		
	X - for lined items.	

4.4.16.19.SHOP INSPECTION REQUIREMENTS FOR STRAINERS

Serial no.	Description	Visual examination	Dimensions	Material test cert.	Identification and correlation	Welding qualification	Hydrostatic leak test	Performance / operation test	Hardness test	Spark, adhesion test	Thickness check					
1	Pressure parts - materials			C	D											
2	Finished item	A	A			C/a	A	D								
3	Linings, if any	A							A	A	A					
<u>Legend</u> A - witnessed by tce. B - witnessed by tce if requirement is specified. C - records verified by tce wherever applicable. D - a or c, at tce's discretion wherever applicable.		<u>Notes</u> 1 - all stages shall be checked 100 % by vendor and records thereof shown to tce. 2 - witnessing by tce may be 100 % or on random samples. 3 - this document shall be read in conjunction with inspection requirements mentioned in and relevant technical specifications. 4 - the pressure gauges and instruments for measuring critical parameters shall have valid calibration certificate traceable to national laboratory.														

4.4.16.20.SHOP INSPECTION REQUIREMENTS FIRE PROTECTION EQUIPMENT

Serial Numbers	DESCRIPTION	Visual	Dimensions	Material test cert.	Body leak test	Seal leak test	Flow test	Operation test	Performance test	Percolation test	Change in dia. And length	Kink test	Accelerated ageing	Weight per unit length	Balancing	Filament	Makes and ratings of parts	Wiring, function check	Interlock test	H.V., I.T., connection test	Flame/smoke detection	Fire test	Type test	Routine test
1	Landing / hydrant valve	A	A	C	A	A	D	A																
2	Branch pipes, nozzles, hose couplings	A	A	C	A																			
3	Fire hoses	A	A	C	A					B	A	B	B	A										
4	Portable fire extinguisher	A	A	C					D															
5	Sprinkler	A	A	C					A															
6	Alarm valve	A	A	C	A	A		A																
7	Main and jockey pump	A	A	C	D			A	A						D									
8	Diesel engine	A	A	C	C			A	A						C									
9	Pipes, fittings, valves	A	A	C	D	D																		
10	Fire hose boxes	A	A	C												A								
17	Motors > 30 kw / <30 kw	D	D																				C	A/C

<u>Legend</u>		<u>Notes</u>
A - witnessed by tce.		1 - all stages shall be checked 100 % by vendor and records thereof shown to tce.
B - witnessed by tce if requirement is specified.		2 - witnessing by tce may be 100 % or on random samples.
C - records verified by tce wherever applicable.		3 - this document shall be read in conjunction with inspection requirements mentioned in tce. And relevant technical specifications.
D - a or c, at tce's discretion wherever applicable.		4 - the pressure gauges and instruments for measuring critical parameters shall have valid calibration certificate traceable to national laboratory.

4.4.17 SHOP INSPECTION AND TESTS

4.4.17.1. SCOPE

- (a) This specification covers the requirements for Shop Inspection and Tests to be carried out by the EMPLOYER/PROJECT MANAGER/INSPECTION AGENCY.

4.4.17.2. GENERAL

- (a) The plant and equipment covered by the PURCHASE ORDER/CONTRACT shall be subjected to inspection and testing. The VENDOR/CONTRACTOR shall provide all services to establish and maintain quality of workmanship in his works and that of his SUB-VENDOR's/SUB-CONTRACTOR's works to ensure the mechanical accuracy of components, compliance with approved drawings, identification and acceptability of all materials, parts and equipment.
- (b) For supply of systems, the VENDOR/CONTRACTOR shall, at the start of the PURCHASE ORDER/CONTRACT, furnish a total list of items in his scope of work. This list, giving a brief description of the item, quantity, names of probable SUB-VENDORS/SUB-CONTRACTORS, and a blank column for agency for final approval of drawings and documents, shall be submitted for approval by EMPLOYER/PROJECT MANAGER. The blank column shall be filled by EMPLOYER/PROJECT MANAGER. The list shall be submitted within two weeks from the date of Letter of Intent.
- (c) For systems and major items such as pressure and load bearing items, machineries etc., the VENDOR/CONTRACTOR shall furnish quality plan giving details of checks and tests to be conducted by them on material, process, sub- assembly and assembly. These shall include requirements as prescribed in the applicable specifications, codes and statutory requirements. The quality plan shall be reviewed by the EMPLOYER/PROJECT MANAGER and the stages to be witnessed and verified shall be indicated by the EMPLOYER/PROJECT MANAGER in the approved quality plan.
- (d) The VENDOR/CONTRACTOR shall give the EMPLOYER/PROJECT MANAGER written notice of any material being ready for testing as per format enclosed. The clear notice period shall be seven (7) days for local inspection and fifteen (15) days for outstation inspection. Such tests shall be to the VENDOR's/CONTRACTOR's account except for the expenses of the EMPLOYER/PROJECT MANAGER. The EMPLOYER/PROJECT MANAGER, unless the inspection of the tests is virtually waived, shall fix a date for inspection with the VENDOR/CONTRACTOR and attend such tests within fifteen (15) days of the date on which the equipment is notified as being ready for test and inspection failing which, the VENDOR/CONTRACTOR may proceed with the tests and shall forthwith forward to the EMPLOYER/PROJECT MANAGER duly certified copies of tests in triplicate. If the VENDOR/CONTRACTOR fails to offer the equipment for inspection as per the agreed date, he is liable to pay for the time and expenses for the infructuous visit of the EMPLOYER/PROJECT MANAGER.
- (e) In all cases where inspection and tests are required whether at the premises or works of the VENDOR/CONTRACTOR or of any SUB-VENDOR/SUB- CONTRACTOR or at

- laboratory, the VENDOR/CONTRACTOR, except where otherwise specified, shall provide free of charge all facilities such as labour, materials, electricity, fuel, water, stores, test bed, apparatus and instruments, laboratory tests etc. as may be required by the EMPLOYER/PROJECT MANAGER to carry out effectively such tests of the equipment in accordance with the PURCHASE ORDER/CONTRACT and shall give facilities to the EMPLOYER/ PROJECT MANAGER to accomplish testing.
- (f) The EMPLOYER/PROJECT MANAGER shall at all working hours have access to all parts of the VENDOR's/CONTRACTOR's and his SUB-VENDOR's/SUB- CONTRACTOR's factory where the items of the plant are being prepared, for carrying out inspection activities as deemed necessary. A set of the relevant latest approved drawings with approval marking of the EMPLOYER/ PROJECT MANAGER and drawings for proprietary items shall be made available by the VENDOR/CONTRACTOR to the EMPLOYER/PROJECT MANAGER, for reference during inspection.
 - (g) In the case of stage inspection hold points, the VENDOR/CONTRACTOR shall proceed from one stage to another only after the component is inspected by the EMPLOYER/PROJECT MANAGER and written permission given to proceed further. The same procedure shall be adopted for any rectifications and repairs suggested by the EMPLOYER/PROJECT MANAGER.
 - (h) The EMPLOYER/PROJECT MANAGER shall have the right to inspect any machinery, material, structures, equipment or workmanship furnished or used by the VENDOR/CONTRACTOR and may reject any which is defective or unsuitable for the use and purpose intended, or which is not in accordance with the intent of the PURCHASE ORDER/CONTRACT. The VENDOR/ CONTRACTOR, upon demand by the EMPLOYER/PROJECT MANAGER, shall remedy or replace at the VENDOR's/CONTRACTOR's expense such defective or unsuitable items of the plant, or the EMPLOYER/PROJECT MANAGER may, at the expense of the VENDOR/CONTRACTOR, remedy or replace such defective or unsuitable items of the Plant.
 - (i) All principal mill test reports, the VENDOR/CONTRACTOR inspection and tests reports, test certificates and test curves shall be supplied for all inspection and tests carried out including other records such as stress relieving charts, radiographic charts and other non-destructive testing records in accordance with the provisions of the PURCHASE ORDER/CONTRACT, duly certified by the main VENDOR/CONTRACTOR. The EMPLOYER/PROJECT MANAGER shall reserve the right to call for certificates of origin and test certificates for all raw material and equipment at any stage of manufacture.
 - (j) The EMPLOYER/PROJECT MANAGER shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the VENDOR/ CONTRACTOR of any non-conformance pertaining to all or any equipment and workmanship which in his opinion is not in accordance with the PURCHASE ORDER/CONTRACT. The VENDOR/CONTRACTOR shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the EMPLOYER/PROJECT MANAGER giving reasons therein that no modifications are necessary to comply with the PURCHASE ORDER/CONTRACT.

- (k) When the factory tests and documentation have been satisfactorily completed at the VENDOR's/CONTRACTOR's or SUB-VENDOR's/CONTRACTOR's works, the EMPLOYER/PROJECT MANAGER shall issue acceptance note or shipping release note or a certificate to this effect within fifteen (15) days after completion, but if the tests are not witnessed by the EMPLOYER/ PROJECT MANAGER, the certificate or comments thereof shall be issued within fifteen (15) days of the receipt of the VENDOR's/CONTRACTOR's test certificate by the EMPLOYER/PROJECT MANAGER. Failure of the EMPLOYER/ PROJECT MANAGER to take such an action shall not prevent the VENDOR/ CONTRACTOR from proceeding with the work. The completion of these tests or the issue of the certificates shall not bind the EMPLOYER/ PROJECT MANAGER to accept the equipment, should it, on further tests after erection, be found not to comply with the PURCHASE ORDER/CONTRACT.
- (l) None of the plant and the equipment to be furnished or used in connection with the PURCHASE ORDER/CONTRACT shall be despatched until shop inspection, satisfactory to the EMPLOYER/PROJECT MANAGER has been made. However, such shop inspection and/or certification shall not relieve the VENDOR/CONTRACTOR of his responsibility for furnishing the plant and the equipment conforming to the requirements of the PURCHASE ORDER/ CONTRACT nor prejudice any claim, right or privilege which the EMPLOYER/ PROJECT MANAGER may have because of the use of defective or unsatisfactory items. Should the EMPLOYER/PROJECT MANAGER waive the right to inspect any item, such waiver shall not relieve the VENDOR/CONTRACTOR in any way from his obligation under the PURCHASE ORDER/CONTRACT. In the event of the EMPLOYER's/PROJECT MANAGER's inspection revealing poor quality of goods, the EMPLOYER/PROJECT MANAGER shall be at liberty to specify additional inspection procedures, if required, to ascertain the VENDOR/CONTRACTOR's compliance with the equipment specifications.

4.4.17.3. SUB-ORDERS AND SUB-CONTRACTS

- (a) In order to facilitate the inspection of bought-out materials and plant, the VENDOR/CONTRACTOR shall submit for approval, three (3) copies of all sub- orders and sub-contracts placed by him as soon as these are issued. Copies of any drawings referred to in the sub-order or sub-contracts shall also be submitted, unless agreed otherwise by the EMPLOYER/PROJECT MANAGER.
- (b) The sub-orders, sub-contracts and drawings referred to above shall include all components which are subjected to electrical and mechanical pressure or stress when the plant is in operation, and also auxiliaries and spares which are to be directly despatched to site from the SUB-VENDOR's/SUB-CONTRACTOR's works.
- (c) All sub-orders and sub-contracts of the main VENDOR/CONTRACTOR shall clearly be marked with the main VENDOR's/CONTRACTOR's name and the EMPLOYER's/PROJECT MANAGER's name and the PURCHASE ORDER/ CONTRACT reference. These shall include the following statement:

The plant or the equipment which is the subject of this PURCHASE ORDER/ CONTRACT shall comply in every respect with the requirements of the

EMPLOYER's/PROJECT MANAGER's technical specifications and shall be subject to inspection and tests to the satisfaction of the EMPLOYER/PROJECT MANAGER.

- (d) For the purpose of this para, it is obligatory on the VENDOR/CONTRACTOR that he advises his SUB-VENDOR/SUB-CONTRACTOR of the pertinent clauses in this specification when ordering bought-out plant, equipment or materials. In particular, the VENDOR/CONTRACTOR shall advise every SUB- VENDOR/SUB-CONTRACTOR that he is required to supply design calculations, drawings, inspection reports and test certificates strictly in accordance with this specification and technical information for inclusion in the Instruction Manual as specified in specification. The SUB-VENDORS/SUB-CONTRACTORS should also be reminded that they shall include with their offer all tools and appliances necessary for proper maintenance and all spare parts as per specified in specification. Itemised prices of the recommended spare parts shall be submitted together with the appropriate part numbers and drawings.
- (e) Sub-ordering and sub-contracting for major items such as pressure and load bearing items, machinery etc. can be done only with the approval of the EMPLOYER/PROJECT MANAGER.

4.4.17.4. MATERIAL TESTS

- (a) In the event of the EMPLOYER/PROJECT MANAGER being supplied with the certified particulars of tests which have been carried out for the VENDOR/ CONTRACTOR by the supplier of material, the EMPLOYER/PROJECT MANAGER may, at his own discretion, accept the same as proper evidence of compliance with the requirements of appropriate specifications for the materials.
- (b) The VENDOR/CONTRACTOR is to provide test pieces as required by the EMPLOYER/PROJECT MANAGER to enable him to determine the quality of material supplied under the PURCHASE ORDER/CONTRACT. If any test piece fails to comply with the requirements, the EMPLOYER/PROJECT MANAGER may reject the entire lot of material represented by the test piece.
- (c) Critical materials used in manufacture of the equipment and construction of the plant covered by the PURCHASE ORDER/CONTRACT may also be subjected to one or more of the Non-Destructive Tests (NDT) as called for in the enquiry document or as mutually agreed. Salvaging of material due to unacceptable defect is to be attempted by the VENDOR/CONTRACTOR only after getting specific concurrence from the EMPLOYER/PROJECT MANAGER and according to the approved procedures.

4.4.17.5. WELDING

- (a) All welding involved in construction and fabrication of the plant and items covered under the PURCHASE ORDER/CONTRACT shall be carried out in accordance with specifications and applicable codes.

- (b) Welding procedures and welders' qualifications shall be approved by the EMPLOYER/PROJECT MANAGER. Where applicable, welders shall be tested as detailed in codes specified for pipe welding, vessel welding and structural welding and appropriate to the corresponding weld position using test pieces of appropriate parent metal to be used on the job. The EMPLOYER/ PROJECT MANAGER shall have the right to have any welder re-tested at any time during the PURCHASE ORDER/CONTRACT.
- (c) Recommendations of applicable codes shall be followed for non-destructive tests, wherever applicable.
- (d) Copies of all welding procedures, procedure qualification records, welders' performance qualification certificates, post-heating and stress relieving records, NDT records and other test results shall be made available upon request of the EMPLOYER/PROJECT MANAGER.

4.4.17.6. FABRICATION AND INSPECTION

- (a) Fabrication and inspection procedures for vessels, heat exchangers, pipes, tubes and valves etc. shall be in accordance with procurement specifications, quality plan, applicable codes or any other approved equal.

4.4.17.7. TESTS AT MANUFACTURER'S WORKS

- (a) GENERAL

The tests at works shall include electrical, mechanical and hydraulic tests in accordance with the appropriate clauses of Statutory Regulation, relevant codes and standards and approved drawings and specifications and in addition any test called for by the EMPLOYER/PROJECT MANAGER to ensure that the plant being supplied fulfils the requirements of the specifications. The VENDOR/ CONTRACTOR shall carry out all the shop tests and inspections specified under individual items of the equipment in Data Sheets of the enquiry document, in addition to those normally required as per codes and standards. For items not covered by any code or specifically mentioned in the specifications, the tests are to be agreed with by the EMPLOYER/PROJECT MANAGER. If considered necessary by the EMPLOYER/PROJECT MANAGER, multi-part assemblies shall be fully erected and tested in the works prior to packing and despatch to the site.

- (b) TEST CERTIFICATES

Test certificates including test records, performance curves and balancing certificates shall be supplied according to the Distribution Schedule. All the tests shall be carried out in accordance with the provisions of the PURCHASE ORDER/CONTRACT.

All test certificates must be endorsed with sufficient information to identify the material or the equipment to which the certificates refer, and must carry at the top right hand corner the identification of the EMPLOYER/PROJECT MANAGER and the PURCHASE ORDER/CONTRACT.

- (c) CALIBRATION

All instruments used for critical measurement such as pressure gauges for leak tests, instruments for measuring performance parameters; instruments for precision dimension measurements shall have valid calibration certificates traceable to national standards. This means that the calibrating agency engaged by the VENDOR/CONTRACTOR shall use instruments which are in turn calibrated by Government approved agencies and such information shall be recorded in the calibration certificate issued by the calibrating agency by giving the certificate number, date and date of validity of the certificate given by the Government approved agency.

4.5 LIST OF APPROVED MAKES

4.5.1 FIRE PROTECTION SYSTEM

This section provides details of the Approved Vendors / Approved makes for bought-out items, which form a part of this enquiry package.

BIDDER shall clearly indicate the makes of all bought-out items and shall at no point in time during execution shall deviate from those indicated in the offer document.

NOTE:

- All materials and products shall conform to the relevant standards and shall be of approved make and design. A list of manufacturers/ vendors is given separately herein below for guidance. The Engineer shall give the approval of a manufacturer/ vendor/ only after review of the sample/ specimen. In case the same is not available in the market or in case of change in trade name, equivalent makes/ re-designated manufacturer then an equivalent approved make shall be used with the approval of Employer/ Engineer. The complete system and installation shall also be in conformity with applicable Codes & Standards and Tender specifications.
- Only “First” class quality materials shall be used.
- Employer reserves the right to choose any of the approved make / vendors as per this list.
- In case of products not indicated in this list, bis marked products shall be preferred.
- Specification of manufacturer’s item shall be checked against tender item / specifications before selecting any product or brand name. In case of any discrepancy, tender item/ specifications shall prevail, and any such brand of item shall not be used which is not conforming to tender specifications even if it is listed in this list.
- For use of material from a bis listed/ certified manufacturer, the contractor shall furnish a copy of the BIS certificate to Employer before procuring the material.
- In case non-availability of any item/ material among approved manufacturers/ brands at a particular site/ region, alternate manufacturers/ brands conforming to BIS/ BS etc. shall be used subject to approval by Employer.
- In case of non-availability of any manufacturer among approved manufacturers at a particular site/ region, alternate manufacturer’s name shall be proposed along-with required credentials for Employer’s approval.
- In case of any item/ product neither covered in this list nor having A BIS specifications, the contractor shall submit the proposed item/ product along-with technical details/ specifications (as per bid), test certificates etc. And other credentials of the manufacturer for Employers approval.

LIST OF APPROVED MAKES FOR PRODUCTS AND MATERIALS FOR FIRE FIGHTING WORKS ARE INDICATED IN THE TABLE BELOW. HOWEVER, ANY OTHER MAKE WHICH IS EQUIVALENT AND MEETING THE TENDER SPECIFICATIONS ARE ALSO ACCEPTABLE WITH PRIOR APPROVAL OF THE ENGINEER

SR. NO.	ITEMS	MANUFACTURER
1.	Pump	Grundfos/ KBL/ Mather & Platt / Armstrong/ Greaves Ltd.
2.	Motors	Refer Appendix-2 of specification for approved/preferred makes of electrical items.
3.	Diesel Engines	Cummins/ Kirloskar Oil Engines / Greaves / Clarke
4.	C.I. Gate Valves	KBL / Nibco /Zoloto
5.	Butterfly valves	Audco / KSB / KBL / Tyco
6.	C.I.Non Return Valves (Wafer Pattern)	Kirloskar / Upadhaya/ BDK/ Intervolve.
7.	valves (For hose reels, sprinkler test/drain connection, air release valve)	ZOLOTO/ Leader/ Hawa Valves (India) Pvt. Ltd./ Avishkar Engineers Pvt. Ltd./ Upadhaya
8.	Wrapping coating (for underground pipes)	IWL (PYPEKOTE)/Rustech
9.	Pipe Fittings (below 50 mm dia) 'T', elbow, sockets, reducers	JK Forging / Gautam Industries / M. S. Fitting Manufacturing Pvt. Ltd.
10.	Pipe Fittings (bends, reducers) (above 50mm dia)	MS Fittings (Calcutta) / Echjay / Tubebend
11.	M.S Pipes	Tata steel / Jindal(Hissar) / SAIL
12.	Sprinkler Heads(pendent, upright, concealed sprinkler with rosette, side wall) / Nozzle/ (UL/FM)	Viking /Newage /Tyco /Globe /Star
13.	Hydrant valves, Branch Pipe with nozzles and Hose coupling.	Newage / Sukan / SBJ/Shah Bhogilal
14.	Hoses	Newage / CRC.
15.	Paint	Berger Paints/ Asian Paints/ Nerolac / Shalimar Paints
16.	Strainers	Filtration Engineers Pvt. Limited, Mumbai/ Kwikflow Filters & Equipment, Mumbai/ Pennant Engg Pvt Ltd., Pune/ Spirax Marshall Ltd., Pune / Superflow Filters Ltd., Mumbai, Jaypee./zoloto
17.	Anti vibration pads	Dunlop, EasyFlex

SR. NO.	ITEMS	MANUFACTURER
18.	Fire Extinguishers	Minimax/Safex/Firex /Ceasefire/Nitin Fire
19.	Installation Control Valve LPC / UL / FM / TAC	Viking/HD/Newage/Tyco

4.5.2 ELECTRICAL SYSTEM

APPENDIX-2

Sr. No.	Items	Manufacturer
1.	L V Switchgear	L&T/ Schneider/ ABB
2.	Distribution Boards	L&T/ Legrand/ ABB
3.	Moulded Case Circuit Breaker	L&T/ Schneider/ ABB
4.	Motor Protection Circuit Breaker	L&T/ Schneider/ ABB
5.	Contactors	L&T/ Legrand/ Schneider
6.	Current Transformer	Kappa/ Silkans / Pragati / Indcoil / Precise
7.	Ammeter and Voltmeter	AE/Rishabh / Conzerve
8.	Push buttons	Siemens/Teknic/Vaishno/BCH
9.	LED Indicating lamps	Teknic / Mathura / Siemens / Binay
10.	MCB	L&T/ Schneider/ ABB
11.	Control fuses	SIEMENS / GE
12.	Terminal Block	SIEMENS / GE
13.	Switch-socket	Anchor / Reputed
14.	Space Heater	Girish / reputed
15.	L T Motor	Siemens/ABB/Kirloskar/CGL
16.	L T Cable	KEI/ CCI/ Finolex
17.	HFFR wires (including panel wiring)	Finolex/ LAPP/ RR KABEL
18.	Local Push button station (LPBS)	L&T/ Teknic/ Schneider/ Mathura

Sr. No.	Items	Manufacturer
19.	Cable Trays	Indiana/ Patny/ Profab/ OBO

Any other make subjected to prior approval of Employer / Project Manager.

4.5.3 INSTRUMENTATION & CONTROL SYSTEM

This section provides details of the Approved Vendors / Approved makes for Electrical and I&C items, which form a part of this tender. For any other type of item/instrument; makes shall be subject to Employer's/Project Manager's Approval.

Sr. No	Description	Manufacturer
1.	Pressure Indicators	Forbes Marshal/Waree/H. Guru/FIEBIG
2.	Pressure switch	Switzer /Dunfoss/System sensor
3.	Water flow switch	System sensor/Potter
4.	level gauge	Pune Techtrol/Levcon/Chemtrol/R.K.Dutt
5.	Level switch	Yokogawa/SBEM/Chemtrol/R.K.Dutt
6.	Panel Integrators	Industrial controls & Appliances/Industrial switchgear control/Sun Industrial Automation
7.	Panel Enclosure	Rittal/President
8.	Local Indicator	Emerson/Yokogawa/Masibus
9.	Instrument erection Hardware	Parker/Swagelok/Excel Hydropneumatics/Wintec
10.	Cables	Polycab/CCI/Nicco/Aisan(RPG)/Lapp cable/Sterlite/RP cables/Thermocable Ltd, AP/Universal
11.	Relays	Siemens/OEN/Omron
12.	Terminals	Elmex/Connectwell/Wago/Phoenix
13.	24V DC power supply units	Apla/Pheonix/Cosel
14.	GI Cable trays	Indiana/Profab /Patny /Sterlite/Reliance

TECHNICAL SPECIFICATION

HVAC WORKS

HVAC WORKS

5.1 SPLIT AIR-CONDITIONERS

5.1.1 SCOPE

This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at manufacturer's works, delivery at site, handling at site, installation, testing, commissioning, performance testing and handing over of split air-conditioners (SAC).

5.1.2 CODES AND STANDARDS

The design, materials, construction, manufacture, inspection, testing and performance of split air-conditioners shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility. In particular, the split air-conditioners shall conform to the latest editions of following standards:

- a) ASHRAE 15 Safety Standard for Refrigeration Systems & Addenda.
- b) ASHRAE 37 Methods of Testing for Rating Electrically Driven
Unitary Air-Conditioning and Heat Pump Equipment
- c) ANSI B 31.5 Code for Refrigeration Piping

5.1.3 CONSTRUCTION FEATURES

5.1.3.1 CABINETS

The split air-conditioners comprise of two cabinets viz. indoor unit (IDU) and condensing/outdoor unit (ODU).

Indoor unit shall house air handling fan, cooling coil, insulated drain tray and filter. The unit shall be of heavy gauge steel, corrosion resistant, finished with synthetic enamel paint and acoustically insulated with resin bonded fiberglass or equivalent material. Suitable drain connection shall be provided for removal of condensate collected inside the drain tray under cooling coil. The front panel shall be decorative type with supply air grille of adjustable type and having adequate return air passage. The front panel shall be made of plastic or aluminum and shall be easily removable for cleaning of filter. The unit shall be suitable for wall mounting and can also be ceiling suspended.

Condensing/outdoor unit shall house compressor and condenser and shall be of heavy gauge corrosion resistant carbon steel and shall be suitable for mounting in open space (e.g. on terrace or on outside wall).

5.1.3.2 COMPRESSOR

The compressor shall be hermetic Scroll or Rotary and shall be mounted on vibration absorbers. Necessary crank case heaters shall be provided.

5.1.3.3 CONDENSER

The air cooled condenser shall be with copper tubes and aluminium fins with low noise fan(s). Speed of axial fan(s) shall not exceed 960 RPM for fan with impeller diameter above 450 mm and 1440 RPM for fan with impeller diameter 450 mm and less. The impeller shall be statically and dynamically balanced. Condenser coil shall have anti-corrosion treatment.

5.1.3.4 AIR HANDLING FAN

The fan shall be centrifugal type with forward curved impeller. The impeller shall be statically and dynamically balanced.

5.1.3.5 COOLING COIL AND FILTER

The cooling coil shall be of direct expansion type with copper tubes and aluminium fins. This shall be minimum three (3) rows deep and with minimum three (3) fins per centimetre. The air before it enters the cooling coil shall be filtered by dry and cleanable type filter.

5.1.4 REFRIGERATION PIPING AND CONTROLS

5.1.4.1 The refrigeration piping shall be complete with externally equalised thermostatic expansion valve, liquid line strainer, dehydrator with replaceable drying agent and liquid line shut-off valve.

5.1.4.2 Refrigerant piping, fittings, piping joints shall conform to the requirements of ANSI B 31.5.

5.1.4.3 The piping shall be designed for an internal pressure representing the most severe condition of coincident pressure and temperature expected in normal operation.

5.1.4.4 Vacuum testing shall be done for medium vacuum of around 40 mm Hg absolute and held with vacuum pump in operation for at least 4 hours. Thereafter unit shall be sealed and vacuum held for at least 12 hours. Vacuum break shall be done using refrigerant and pressure raised to standing pressure in refrigerant cylinder.

5.1.4.5 ON-OFF thermostat with adjustable setting shall be provided for temperature control. A selector switch enabling the running of the air handling fan alone or fan with cooling shall be provided. Interlock shall be provided such that compressor can start only after starting the air handling fan. Provision shall also be made to interlock the compressor with the air cooled condenser fan motor. Safety devices such as high/low refrigerant pressurestat (HP/LP) and compressor oil pressurestat (OP), hermetic motor winding thermostat etc. shall be provided. HP and OP cut out shall be manual reset type while LP cut out shall be auto reset type.

5.1.4.6 Refrigerant and oil shall be supplied along with the unit. The refrigerant and oil charging shall be carried out at site. Exposed refrigerant piping shall have anti-corrosive coating.

5.1.5 ELECTRICAL

5.1.5.1 A sequential controller shall be provided if asked for in Datasheet A. This controller shall facilitate the automatic periodic switching of the units from working to standby mode in a predefined sequence so that all the units shall be in operation for a defined period of time. This system shall be required in (N+1) OR (N+2) type combination of working & standby units.

5.1.5.2 The unit shall be provided with single phase preventers for all motors.

5.1.5.3 Each SAC shall be provided with three pin Plug and cable.

5.1.5.4 The indoor and outdoor units shall be pre-wired at the factory and shall be complete with starters for all motors.

5.1.5.5 Wiring between indoor and outdoor units shall be carried out at site.

5.1.5.6 Cordless remote controller shall be provided. Remote controller shall have ON/OFF & temperature control option.

5.1.6 PERFORMANCE GUARANTEE

5.1.6.1 Performance guarantees for the Split Air conditioners (SAC) shall be as specified in data sheet- A.

5.1.7 DATA SHEET – A

SL. NO.	ITEM	UNIT	
1.0	GENERAL		
1.1	DESIGNATION		SPLIT ACS FOR SERVE ROOM
1.2	NUMBERS REQUIRED: TABLE HAS GIVEN BELOW	Nos.	TABLE HAS GIVEN BELOW
1.3	TAG NUMBERS: TABLE HAS GIVEN BELOW		811-SAC-01 & 02
1.4	REFRIGERANT USED		R-410a/ R407C
1.5	STAR RATING (BEE)		3/4 / 5
1.6	OPERATION		CONTINUOUS / INTERMITTENT hrs/DAY
2.0	DESIGN DATA		
2.1	REQUIRED MINIMUM ACTUAL	TR	2.0

SL. NO.	ITEM	UNIT	
	CAPACITY REQUIRED		
2.2	DESIGN OUTDOOR CONDITIONS		
2.2.1	DRY BULB TEMPERATURE	⁰ C	42.0
2.2.2	WET BULB TEMPERATURE	⁰ C	26.8
2.3	DESIGN INDOOR CONDITIONS		
2.3.1	DRY BULB TEMPERATURE	⁰ C	20.0
2.3.2	WET BULB TEMPERATURE	⁰ C	14.5
3.0	INDOOR UNIT		
3.1	TYPE		HI-WALL / CASSETTE / FLOOR
3.2	REQUIRED DEHUMIDIFIED AIR FLOW CAPACITY OF EACH INDOOR UNIT		MINIMUM 330 CFM / TR
3.3	FILTRATION		
3.3.1	ANTIDUST FILTERS (PRE-FILTERS)		YES / NO
3.3.2	DEODORIZATION FILTERS		YES / NO
3.3.3	ANTI-BACTERIA FILTERS		YES / NO
3.4	ULTRAVIOLET SCREEN		YES / NO
3.5	FAN TYPE		FORWARD CURVED, COUPLED
3.6	FAN SPEED		SINGLE / MULTISPEED
3.7	FAN MOTOR TYPE		STD / FLAMEPROOF
3.8	NOISE LEVEL @ 1.0 M FROM UNIT	dB(A)	45 (MAXIMUM)
3.9	NO. OF UNITS / OUTDOOR		ONE / TWO
3.10	RETURN GRILLE		FRONT / TOP
3.11	COOLING COIL		INNER GROOVED COPPER
3.12	FINS		ALUMINUM
3.13	ANTI-CORROSIVE COATING ON COIL		YES / NO
4.0	OUTDOOR UNIT		
4.1	COMPRESSOR		HERMETIC SCROLL / ROTARY / RECIPROCATING
4.2	VIBRATION ISOLATORS		NEOPRENE RUBBER PADS
4.3	NOISE LEVEL @ 1.0 M FROM UNIT	dB(A)	65
4.4	ANTI-CORROSIVE COATING ON BODY		YES / NO
4.5	ANTI-CORROSIVE COATING ON COIL		YES / NO

SL. NO.	ITEM	UNIT	
4.6	FAN TYPE		AXIAL, PROPELLER
4.7	FAN SPEED		SINGLE / MULTISPEED
5.0	ELECTRICAL		
5.1	OUTDOOR MOTOR		AS PER MFR's STD
5.2	POWER SUPPLY		230V, 1 PHASE, 50 Hz
5.3	POWER SUPPLY LOCATION		NEAR INDOOR UNIT / AT BOTH LOCATIONS
5.4	MINIMUM CABLE LENGTH WITH PLUG & SOCKET	m	3
6.0	INTERCONNECTED PIPING		
6.1	MAXIMUM PERMISSIBLE DISTANCE BETWEEN IDU AND ODU		
6.1.1	VERTICAL	m	15
6.1.2	TOTAL	m	25
6.2	INSULATED REFRIGERANT PIPING BETWEEN IDU AND ODU	m	UP TO 7
6.3	ACCESSORIES IN REFRIGERANT PIPING		
6.3.1	ECONOMIZER		YES / NO
6.3.2	SIGHT GLASS		YES / NO
6.4	INSULATED CONDENSATE DRAIN PIPING		UPTO 10 M / NEAREST DRAIN POINT
7.0	ACCESSORIES, AUXILIARIES AND SERVICES		
7.1	CORDLESS REMOTE CONTROLLER		YES / NO
7.2	OCCUPANCY SENSOR IN IDU		YES / NO
7.3	ON-OFF TIMER		YES / NO
7.4	MOUNTING FRAME FOR IDU & ODU WITH ALL ACCESSORIES		BY EMPLOYER / BY CONTRACTOR
7.5	MOUNTING FRAME WITH EPOXY COATING		YES / NO
7.6	SEQUENTIAL CONTROLLER		YES / NO
8.0	SPARES AND MAINTENANCE TOOLS AND TACKLES		
8.2	ESSENTIAL SPARES		
8.3	SPECIAL TOOLS		
9.0	PERFORMANCE GUARANTEES		

SL. NO.	ITEM	UNIT	
9.1	CAPACITY OF EACH SAC AT DESIGN CONDITION	TR	2.0 Min.
9.2	TOTAL POWER INPUT AT DESIGN CONDITION	kW	2.4 Max.
9.3	DEHUMIDIFIED AIR FLOW OF INDOOR UNIT	m ³ /hr	660 Min.
9.4	NOISE LEVEL		
9.4.1	AT INDOOR UNIT @ 1.0 M	dB(A)	45
9.4.2	AT OUTDOOR UNIT @ 1.0 M	dB(A)	75
10.0	COST LOADING AND PENALTY		
10.1	FOR DIFFERENTIAL TOTAL POWER INPUT AT DESIGN CONDITIONS	Rs/kW	
11.0	TESTS AND INSPECTION		
11.1	AS PER STANDARD		

5.1.8 SPLIT AC DETAILS:

Sr. No.	Building Name	Selected	Capacity	Qty.	Total	Model/ Type
		(TR)	TR	Nos	TR	
A	ADMIN BUILDING					
A.3	SECOND FLOOR					
	SERVER ROOM	2	2	1	2	Split AC Unit
	SUB TOTAL	2.0		1.0	2.0	
B	PRODUCTION & TRAINING BLOCK					
B.1	FIRST FLOOR					
	SERVER ROOM	2.5	1.5	1	1.5	Split AC Unit
			1	1	1	
	SUB TOTAL	2.5		2.0	2.5	
C	EXECUTIVE HOSTEL					
C.1	GROUND FLOOR					
1.1	GUEST ROOM-2	1	1	1	1	Split AC

1.2	GUEST ROOM-1	1	1	1	1	Unit
	SUB TOTAL	2.0		2.0	2.0	
C.2	FIRST FLOOR					
2.1	GUEST ROOM-3	1	1	1	1	Split AC Unit
2.2	GUEST ROOM-4	1	1	1	1	
2.3	GUEST ROOM-5	1	1	1	1	
2.4	GUEST ROOM-6	1	1	1	1	
	SUB TOTAL	4		4	4	
D	DINING BLOCK					
D.1	GROUND FLOOR					
1.4	INJECTION RM	1	1	1	1	Split AC Unit
1.5	BANK COUNTER	2	2	1	2	
	SUB TOTAL	3.0		2.0	3.0	
D.2	FIRST FLOOR					
2.1	KIOSK	1	1	1	1	Split AC Unit
2.2	EXECUTIVE DINING	5	1.5	2	3	
			2	1	2	
	SUB TOTAL	6.0		4.0	6.0	
E	UTILITY BLOCK					
E.1	GROUND FLOOR					
1.1	UPS ROOM	2.5	1.5	1	1.5	Split AC Unit
			1.0	1.0	1	
	SUB TOTAL	2.50		2.00	2.50	
	GRAND TOTAL	20		16	20	

5.2 AIR-COOLED VARIABLE REFRIGERANT FLOW SYSTEM

5.2.1 SCOPE

The scope of this section comprises the supply, erection testing and commissioning of inverter based Variable Refrigerant Volume System with Scroll Compressor conforming to these specifications and in accordance with the requirements of drawing and Schedule of Quantities.

5.2.2 TYPE

Units shall be air cooled, variable refrigerant volume air conditioner of R410A gas based consisting of outdoor unit and multiple indoor units. Each indoor units having capability to cool or heat independently for the requirement of the rooms. It shall be possible to connect several indoor units on one refrigerant circuit. The indoor units on any circuit can be of different type and also controlled individually. Following type of indoor units shall be connected to the system:

- a. Floor Mounted Packaged units
- b. Ductable type
- c. Wall hung

Both indoor units and outdoor unit shall be factory assembled, tested and filled with first charge of refrigerant before delivering at site.

5.2.3 OUTDOOR UNIT

The outdoor unit shall be factory assembled, 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 and switch gears: The outdoor unit shall be modular in design and should be allowed for side by side installation. The outdoor unit shall be provided with welded steel support with two coats of paint for erection purpose.

- a. All outdoor units above 8 HP shall have minimum two scroll compressors and be able to operate even in case one of compressor is out of order.
- b. In case of outdoor units above 14HP, the outdoor unit shall have at least 2 inverter compressors and inverter motor of brushless DC Type so that the operation is not disrupted with failure of any compressor.
- c. It should also be provided with duty cycling for switching starting sequence of multiple outdoor units.
- d. The noise level shall not be more than 68 dB (A) at anechoic chamber conversion value, measured horizontally 1m away and 1.5m above ground level.
- e. The outdoor unit shall be modular in design and should be allowed for side by side Installation.

- f. The unit shall be provided with its own microprocessor control panel. The outdoor unit should be fitted with low noise, aero spiral design fan with large airflow and should be designed to operate compressor-linking technology. The unit should also be capable to deliver 78 Pa external static pressure to meet long exhaust duct connection requirement.

The condensing unit shall be designed to operate safely when connected to multiple fan coil units, which have a combined operating nominal capacity up to 160 % of indoor units for outdoor units up to 40 HP.

5.2.4 COMPRESSOR

The compressor shall be highly efficient scroll type and capable of inverter control. It shall change the speed in accordance to the variation in cooling or heating load requirement:

The inverter shall be IGBT type for efficient and quiet operation. All outdoor units shall have at least 10 to 30 steps of capacity control to meet load fluctuation and indoor unit individual control. All parts of compressor shall be sufficiently lubricated stock. Forced lubrication may also be employed. Oil heater shall be provided in the compressor casing. C.O.P for the units shall not be less than 4.5.

5.2.5 HEAT EXCHANGER

The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminum fins to form a cross fin coil.

The aluminum fins shall be covered by anti-corrosion resin film.

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.

5.2.6 REFRIGERANT CIRCUIT

The refrigerant circuit shall include liquid & gas shut-off valves and a solenoid valves at condenser end.

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

5.2.7 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, crankcase heater, fusible plug, over load relay, protection for inverter, and short recycling guard timer.

5.2.8 OIL RECOVERY SYSTEM

Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigeration piping lengths.

5.2.9 INDOOR UNIT

This section deals with supply, installation, testing, commissioning of various type of indoor units confirming to general specification and suitable for the duty selected. The type, capacity and size of indoor units shall be as specified in detailed Bill of Quantities.

5.2.10 GENERAL

Indoor units shall be wall mounted type or ceiling mounted ductable type as specified in BOQ. These units shall have electronic control valve to control refrigerant flow rate respond to load variations of the room.

- a. The address of the indoor unit shall be set automatically in case of individual and group control
- b. There shall be localized control only.

The fan shall be dual suction, aerodynamically designed turbo, multi blade type, statically & dynamically balanced to ensure low noise and vibration free operation of the system. The fan shall be direct driven type, mounted directly on motor shaft having supported from housing.

The cooling coil shall be made out of seamless copper tubes and have continuous aluminum fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically/ mechanically expanded for minimum thermal contact resistance with fins. Each coil shall be factory tested at 21kg/sqm air pressure under water.

Unit shall have cleanable type filter fixed to an integrally molded plastic frame. The filter shall be slide away type and neatly inserted.

Each indoor unit shall have computerized PID control for maintaining design room temperature. Each unit shall be provided with microprocessor thermostat for cooling and heating.

The outdoor unit shall be pre-charged with first charge of R 410A refrigerant. Additional charge shall be added as per refrigerant piping at site. All the units shall be suitable for operation with 380 - 415 V 50 Hz + 3%, 3 Phase supply for outdoor units & 220 – 240 V, 50 Hz + 3%, 1 Phase supply for in-door units.

- 5.2.10.1 The units shall be integrated with Fire Alarm system and in case of fire all units shall be switched off.
- 5.2.10.2 The Al fins of Condenser Coils shall be provided with suitable factory installed protective for corrosion prevention.
- 5.2.10.3 The outdoor units must be suitable for up to 150m (straight length) refrigerant piping between outdoor unit & the farthest indoor units, total piping of 500m for all the indoor units. Allowable level difference between outdoor unit & indoor units shall be 50m in case of outdoor unit on top & 40 m in case of outdoor unit at bottom. Allowable level difference between various indoor units connected to one out door unit shall be up to 15m.

- 5.2.10.4 The outdoor unit shall employ system of equal run time for all the compressors, inverter or on/ off type, within each outdoor unit – Single Module or Multi Module.
- 5.2.10.5 The outdoor units shall be suitable to operate within an ambient temperature range of – 5 Deg C to 43 Deg C, in cooling mode & -20 Deg C to 15 Deg C in heating mode.
- 5.2.10.6 Air cooled condenser shall have Axial Flow, upward throw fan, directly coupled to fan motors with minimum IP 55 protection. The outdoor unit condenser fan shall be able to develop external static pressure up to 6 mm of H₂O.
- 5.2.10.7 The entire operation of outdoor units shall be through independent remotes of indoor units. No separate Start/ Stop function shall be required.
- 5.2.10.8 Starter for the Outdoor Unit compressor shall “Direct on Line” type. Inverter compressor of the unit shall start first & at the minimum frequency, to reduce the inrush current during starting.
- 5.2.10.9 Refrigerant control in the outdoor unit shall be through Electronic Expansion Valve. Complete refrigerant circuit, oil balancing/ equalizing circuit shall be factory assembled & tested.
- 5.2.10.10 Outdoor units shall be complete with following safety devices:
- a. High pressure switch
 - b. Fan driver overload protector
 - c. Over current relay
 - d. Inverter Overload Protector
 - e. Fusible Plug

5.2.11 CEILING MOUNTED DUCTABLE TYPE UNIT

- 5.2.11.1 Unit shall be suitable for ceiling mounted type. The unit shall include pre filter, fan section & DX coil section .The housing of unit shall be light weight powder coated galvanized steel. The unit shall have high static fan for Ductable arrangement.
- 5.2.11.2 These units shall be ceiling suspended with suitable supports to take care of operating weight of the unit, without causing any excessive vibration & noise. The cold air supplied by these units will be supplied to the area to be air conditioned, through duct system specified in the tender.
- 5.2.11.3 Each indoor unit must have electronic expansion valve operated by microprocessor thermostat based temperature control to deliver cooling/ heating as per the heat load of the room.

- 5.2.11.4 Unit must be insulated with sound absorbing thermal insulation material, Glass Fiber. The noise level of unit at the highest operating level shall not exceed 49 dB(A), at a vertical distance of 1.5 m below the units with duct connected to the unit.
- 5.2.11.5 Unit must have Thermal Fuse for fan motor protection, in case of motor heating. The unit will be connected in series to a suitable outdoor unit & it must be possible to operate the unit independently, through corded/ cordless remote specified in the bill of quantities. The unit will be further connected to Intelligent Building Management System (To be supplied by other vendors) & it shall be possible to operate the unit through this IBMS system.

5.2.12 DATA SHEET – A

1.0 Make	Dakin/ Bluestar/ Voltas
2.0 Casing	CS/ (CS/ CAST AL)/ EN8
3.0 Type: Ductable/ Cassete/ High wall	Ductable/Package Floor Mounted/ High wall
4.0 Dimension WxDxH (M)	Ducatble - 1500x750x650
	Package Floor Mounted - 1250x750x1800
	High wall - 1100x300x350
5.0 Cooling Capacity	VRF Table is given below
6.0 Air quantity at max. Speed	
And 1 m long duct collar CMH	
7.0 Air quantity at min. Speed	
And 1.0 m. Long duct collar CMH	
8.0 Whether auxiliary drain pan	
Provided: Yes/No.	Yes/No.
9.0 Make & model of room thermostat.	
10.0 Whether acoustic lined	Yes/No.
duct collar included in Unit price	Yes/No.
11.0 Does Indoor Unit have return air plenum. Yes/No.	Yes/No.
12.0 Noise Level at 1 m distance:	55db
OUTDOOR	
1. Manufacturer	Dakin/ Bluestar/ Voltas
2. Type	Copeland
3. Model	
4. Overall dimensions (mm) WxDxH	1100x1100x1750
5. Operating Weight (kg.)	300
6. No. of fans	1
7. CMH per fan	
8. Outlet velocity (Mts. Per min)	
9. Tip speed (Mts per min)	
10. Compressor Type	Digital Scroll + Fixed Scroll
11. Vibration isolator	Rubber pads
12. Noise Level at 1 m distance:	62db

5.2.13 VRF Equipment Details:

Sr. No.	Building Name	Area	Unit/TR			Model/ Type
			TR	Qty	Total TR	
		(sqft.)				
A	ADMIN BUILDING					
A.1	GROUND FLOOR					
1.1	FIRE CONTROL ROOM	151.7	1	1	1	Hi-wall
1.2	ENTRANCE LOBBY AND GUEST WAITING AREA	1009.9	1.5	2	3	
1.3	CONFERENCE ROOM-1	719.0	1.5	3	4.5	
1.4	WAITING &PS	371.9	1	1	1	
1.5	GM OFFICE	303.4	1	1	1	
1.6	ELECTRICAL & UPS ROOM	191.5	1.5	1	1.5	
1.7	CONFERENCE	271.2	1.5	1	1.5	
1.8	SR. ENGG	106.5	1	1	1	
1.9	SR. MANAGER-SE&SW	100.1	1	1	1	
1.1	DGM CABIN	113.0	1	1	1	
1.11	SR. MANAGER	106.5	1	1	1	
1.12	MARKETING OFFICE	433.6	1	1	1	
1.13	MANAGER ADMIN	379.2	1	1	1	
1.14	MANAGER ADMIN CABIN	87.2	1	1	1	
1.15	MEETING RM	80.7	1	1	1	
1.16	OFFICE	460.3	1.5	1	1.5	
1.17	PURCHASE OFFICER	407.9	2	1	2	
1.18	CABIN	87.2	1	1	1	
1.19	CABIN-1	93.6	1	1	1	
	SUB TOTAL			22.0	27.0	
A.2	FIRST FLOOR					
2.1	GREEN ROOM	166.1	1	1	1	Hi-wall
2.2	GREEN ROOM-1	162.7	1	1	1	
2.3	CONFERENCE HALL	3127.9	8	2	16	CSU
	SUB TOTAL			4.0	18.0	
A.3	SECOND FLOOR					
3.1	IT DEPT	283.6	1	1	1	Hi-wall
3.2	SERVER ROOM	273.3	2	1	2	

	SUB TOTAL			2.0	3.0	
	TOTAL			28.0	48.0	
D	GROUND FLOOR					
D.1	TRAINING					
1.1	Sr. MANAGER	110.4	1	1	1	
1.2	HOD ROOM	102.2	1	1	1	
1.3	TRAINING OFFICE	581.0	1.5	1	1.5	
1.4	MANAGER ROOM	258.2	1	1	1	
1.5	PLACEMENT CELL WITH VC	581.0	1.5	1	1.5	
1.6	COUNCELLING ROOM	258.2	1	1	1	
1.7	V C	220.8	1	1	1	
1.8	CLASS ROOM (NW&NE)	807.0	2	3	6	
1.9	CLASS ROOM (NE)	807.0	1.5	3	4.5	
1.10	CLASS ROOM (NE)	807.0	1.5	3	4.5	
1.11	CLASS ROOM (NE)	807.0	1.5	3	4.5	
1.12	CLASS ROOM (NE)	807.0	1.5	3	4.5	
1.13	CLASS ROOM (SE&NE)	807.0	1.5	2	3	
			2	1	2	
1.14	CLASS ROOM (NW)	807.0	2	3	6	
1.15	CLASS ROOM (SW)	807.0	2	2	4	
			1.5	1	1.5	
1.16	CLASS ROOM (SW)	807.0	2	2	4	Hi-wall
			1.5	1	1.5	
1.17	CLASS ROOM (SW)	807.0	2	2	4	
			1.5	1	1.5	
1.18	CLASS ROOM (SW)	807.0	2	2	4	
			1.5	1	1.5	
1.19	LABORATORY (NW)	645.6	1.5	3	4.5	
1.20	LABORATORY (NE)	645.6	2	2	4	
1.21	LABORATORY (NE)	645.6	2	2	4	
1.22	LABORATORY (NE)	645.6	2	2	4	
1.23	LABORATORY (NE)	645.6	2	2	4	
1.24	LABORATORY (NE)	645.6	2	2	4	
1.25	LABORATORY (SW)	645.6	2	2	4	
1.26	LABORATORY (SW)	645.6	2	2	4	
1.27	LABORATORY (SW)	645.6	2	2	4	
1.28	LABORATORY (SW)	645.6	2	2	4	
1.29	LABORATORY (SW)	645.6	2	2	4	
1.3	LABORATORY (SW)	645.6	2	2	4	

1.31	LANGUAGE LABORATORY	538.0	1.5	1	1.5	
			1	1	1	
1.32	BOARD ROOM	286.9	1.5	1	1.5	
1.33	EXAMINATION CELL	530.3	1.5	1	1.5	
			1	1	1	
1.34	SERVER ROOM	286.2	1.5	1	1.5	
			1	1	1	
	PRODUCTION					
1.35	ELECTRONIC ASSEMBLY -NE	1162.1	7	1	7	AHU
1.36	ELECTRONIC ASSEMBLY-SW	1162.1	7	1	7	AHU
1.37	CALIBRATION LAB-NE	581.0	2	1	2	CSU
1.38	CALIBRATION LAB-SW	581.0	2	1	2	CSU
1.39	TESTING LAB-NWNE	581.0	1.5	1	1.5	Hi-wall
			2	1	2	
1.4	TESTING LAB-NE	581.0	2	1	2	
1.41	TESTING LAB-NE	581.0	2	1	2	
1.42	TESTING LAB-NWSW	581.0	2	2	4	
1.43	TESTING LAB-SW	581.0	2	1	2	
1.44	TESTING LAB-SW	581.0	2	1	2	
1.45	DESIGN OFFICE-1	1033.0	2	1	2	
			1.5	1	1.5	
1.46	DESIGN OFFICE-2	1033.0	2	1	2	
			1.5	1		
1.47	DESIGN OFFICE-3	351.6	1.5	1	1.5	
1.48	SERVER ROOM	191.5	1	1	1	
1.49	CONFERENCE ROOM	567.9	1.5	1	1.5	
			1			
1.51	EMS/PROUDCTION-NE	430.9	2	1	2	
1.52	EMS/PROUDCTION-NE-R	430.9	2	1	2	
1.53	EMS/PROUDCTION-NE-R	430.9	2	1	2	
1.54	EMS/PROUDCTION-NE-R	430.9	2	1	2	
1.55	EMS/PROUDCTION-NWNE	430.9	2	2	4	
1.56	EMS/PROUDCTION-NWSW	430.9	2	2	4	
1.57	EMS/PROUDCTION-SW-R	430.9	1.5	1	1.5	
			1	1	1	
1.58	EMS/PROUDCTION-SW-R	430.9	1.5	1	1.5	
			1	1	1	
1.59	EMS/PROUDCTION-SW-R	430.9	1.5	1	1.5	
			1	1	1	

1.6	EMS/PROUDCTION-SW	430.9	1.5	1	1.5	
			1	1	1	
1.61	EMS/PROUDCTION-SW	430.9	1.5	1	1.5	
			1	1	1	
1.62	EMS/PROUDCTION-SW	430.9	1.5	1	1.5	
			1	1	1	
1.63	EMS/PROUDCTION-SESW	430.9	1.5	1	1.5	
			1	1	1	
	SUB TOTAL			113.0	199.0	
D.2	FIRST FLOOR					
2.1	FACULTY ROOM	2107.2	2	5	10	Hi-wall
2.2	EXAMINATION/DRAWING HALL	2257.0	2	4	8	
2.3	LIBRARY	1635.5	2	2	4	
			1	1	1	
2.4	PRODUCTION OFFICE 1	1033.0	1.5	2	3	
			2	1	2	
2.5	PRODUCTION OFFICE 2	647.1	2	2	4	
2.6	PRODUCTION OFFICE 3	1033.0	1.5	3	4.5	
2.7	CONFERENCE ROOM	368.0	2	1	2	
2.8	TESTING LAB-NESE	581.0	2	1	2	
2.9	TESTING LAB-NE	581.0	2	1	2	
2.10	TESTING LAB-SW	581.0	2	1	2	
2.11	TESTING LAB-SW	581.0	2	1	2	
2.12	CALIBRATION LAB-NE	581.0	2	1	2	CSU
2.13	CALIBRATION LAB-SW	581.0	2	1	2	CSU
2.14	SERVER ROOM	191.5	1	1	1	Hi-wall
2.15	EMS/PROUDCTION-NE-R	430.9	2	1	2	
2.16	EMS/PROUDCTION-NE-R	430.9	2	1	2	
2.17	EMS/PROUDCTION-NE-R	430.9	2	1	2	
2.18	EMS/PROUDCTION-SW-R	430.9	1.5	1	1.5	
			1	1	1	
2.19	EMS/PROUDCTION-SW-R	430.9	1.5	1	1.5	
			1	1	1	
2.2	EMS/PROUDCTION-SW-R	430.9	1.5	1	1.5	
			1	1	1	
2.21	EMS/PROUDCTION-SESW	430.9	1.5	1	1.5	
			1	1	1	
	SUB TOTAL			39.0	67.5	
	TOTAL			152.0	266.5	

5.3 MTHERMAL INSULATION FOR COLD SURFACES:

5.3.1 SCOPE

This specification covers the technical requirements and essential particulars for the supply, application and finishing of the complete thermal insulation for cold equipment, piping systems, air-conditioning ducts etc. for temperatures between ambient and (-) 80°C and also for dual temperatures (both hot and cold) service with hot temperature above ambient and up to 230°C. Unless specified otherwise in data sheet A, the scope of supply of the CONTRACTOR shall include, but not be limited to, the following items:

- a. Insulation materials of all types as specified and required
- b. Insulation adhesives, vapour barriers and finishing materials of all types as specified and required
- c. Auxiliary materials such as binding and lacing wires, wire netting, bands, screws, pop rivets etc., as specified and required
- d. Angles, clamps, lugs etc. for supporting insulation
- e. Weather hoods
- f. Any other material as may be required for making the insulation complete

5.3.2 CODES AND STANDARDS

The supply and application of thermal insulation and finishing covered under this specification shall comply with all currently applicable statutes, regulations and safety codes in the locality where it is to be applied. The materials and application shall also conform to the latest editions of the codes and standards listed. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility.

5.3.2.1 The following are some of the codes and standards relevant to this specification :

IS 277	Galvanised Steel Sheets (Plain and Corrugated)
IS 737	Wrought Aluminium and Aluminium Alloy Sheet and Strip for General Engineering Purposes
IS 3144	Mineral Wool Thermal Insulation Materials - Method of Test
IS 3677	Unbonded Rock and Slag Wool for Thermal Insulation
IS 4671	Expanded Polystyrene for Thermal Insulation Purposes
IS 8183	Bonded Mineral Wool
IS 9842	Preformed Fibrous Pipe Insulation
IS 14164	Industrial Application and Finishing of Thermal Insulation Materials at Temperatures above (-) 80°C and up to (+) 750°C

BS 3927	Rigid Phenolic Foam (PF) for Thermal Insulation in the Form of Slabs and Profiled Sections
BS 5608	Preformed Rigid Polyurethane (PUR) and Polyisocyanurate (PIR) Foams for Thermal Insulation of Pipework and Equipment
BS 5970	Thermal Insulation of Pipework and Equipment (in the Temperature Range (-) 100 ⁰ C to (+) 870 ⁰ C)

5.3.3 MATERIALS

5.3.3.1 GENERAL

All materials shall be new and fresh, incombustible, fire retardant, rot-proof, non-hygroscopic, vermin proof, fungus proof, non-injurious to health, chemically inert, non-corrosive to steel and aluminium (even if soaked in water for extended periods) and shall be guaranteed to withstand continuously and without deterioration the minimum and maximum temperatures to which these shall be subjected to under the specified applications.

5.3.3.2 The insulation materials and any component of the finished insulation job shall not react chemically, singly or in combination, with water or moisture to form substances that are more actively corrosive to applied surface than water or moisture alone.

5.3.3.3 In order to protect the workers from the hazards of insulation materials, suitable protective gadgets shall be provided. Required safety precautions shall be taken during handling and application of insulation.

5.3.3.4 The insulation material shall be kept dry at all times during transport, storage and installation. Decking and covering tarpaulins alone are not adequate for any length of time and shall not be allowed except in extreme emergencies and only for short period. Stacking of insulation materials directly on ground shall not be done. No wet insulation shall be installed. If wet insulation is present, it shall be removed and replaced with new dry insulation. The insulation may be protected with plastic film but shall be vented to prevent sweating.

5.3.4 INSULATION MATERIALS

The insulation material shall be one or more of the following types as specified in data sheet A.

SL. NO.	INSULATION MATERIAL	STANDARD	DENSITY, Kg/M ³	TEMP. RANGE, ⁰ C	MATERIAL CODE
1.	Fire-retardant quality expanded polystyrene	IS 4671	20	(-)80 to 80	EP
2.	Rigid polyurethane / Polyisocyanurate foam	BS 5608	32	(-)80 to 110	PUR/ PIR

3.	Phenolic foam	BS 3927	32	(-)80 to 130	PF
4.	Lightly resin-bonded glass wool mattresses	IS 8183	32	(-)40 to 230	LRG
5.	Resin-bonded glass wool pipe sections	IS 9842	85	(-)40 to 230	PSG
6.	Unbonded rock and slag wool	IS 3677	150	(-) 80 to 230	U150

5.3.5 INSULATION ADHESIVES

The insulation adhesive shall be one or more of the following types as specified in data sheet A.

	Material Description	<u>Material Code</u>
1.	Hot bitumen of grade 85/25 or 85/40 conforming to IS 702 shall be uniformly applied at 1.5 Kg/M ² on the surface to be insulated. A similar layer shall also be applied on the inside surface of the insulation. This material shall not be used for stainless steel surfaces.	BIT
2.	CPRX compound shall be uniformly applied at 1.5 Kg/M ² on the surface to be insulated. A similar layer shall also be applied on the inside surface of the insulation. This material shall not be used for stainless steel surfaces.	CPRX
3.	MAS 83 with 0.5 mm wet film thickness shall be uniformly applied at 0.5 lit/M ² by trowelling. MAS 83 shall not be used with polystyrene as insulation material. MAS 83 can be used only between (-) 46 and (+) 149°C.	MAS 83

5.3.6 VAPOUR BARRIERS

The vapour barrier shall be one or more of the following types as specified in data sheet A.

	Material Description	<u>Material Code</u>
1.	Hot bitumen of grade 85/25 or 85/40 conforming to IS 702 shall	VB1

	be uniformly applied at 2.5 Kg/M ² on the outer surface of insulation and allowed to dry. Reinforced Plastic (RP) tissue paper shall be applied on the dried bitumen. This material shall not be used for stainless steel surfaces.	
2.	0.1 mm thick factory-laminated aluminium foil with craft paper shall be provided. All joints shall be provided with 50 mm overlap and all joints shall be sealed with aluminium tape. For temperature between (-) 43 and (+) 149°C MAS 35 may also be used as sealant.	ALF
3.	MAS 130 with 1.02 mm wet film thickness primer coat at 1.0 lit/M ² and 2.25 mm wet film thickness finish coat at 2.5 lit/M ² shall be uniformly applied over the insulation by spatula or trowelling. MAS 130 shall not be used with polystyrene as insulation material. MAS 130 can be used only between (-) 40 and (+) 60°C.	MAS 130

5.3.7 FINISHING MATERIALS

The finishing material shall be one or more of the following types as specified in data sheet A.

Material Description		Material Code
Portland cement and inorganic fibre with water proofing compound at an application density of 1050 to 1100 Kg/M ³ .		FC
Aluminium sheet as per IS 737, designation 31000, condition H3.		AL1
(a)	Insulation outside diameter above 450 mm - sheet thickness 18 SWG	
(b)	Insulation outside diameter 150 to 450 mm - sheet thickness 20 SWG	
(c)	Insulation outside diameter below 150 mm - sheet thickness	AL1
(d)	Air-conditioning ducts - sheet thickness	
(e)	Equipment - sheet thickness	

Galvanized Steel (GS) sheet as per IS 277, designation GP		
(a)	Insulation outside diameter above 450 mm - sheet thickness 20 SWG	GS1
(b)	Insulation outside diameter 150 to 450 mm - sheet thickness 22 SWG	
(c)	Insulation outside diameter below 150 mm - sheet thickness 24 SWG	
(d)	Air-conditioning ducts - sheet thickness 26 SWG	
(e)	Equipment- sheet thickness 20 SWG	

MAS 134 with 1.0 mm wet film thickness at 1.0 lit/M ² shall be uniformly applied when using over porous insulation materials. Wet film thickness shall be 0.5 mm at 0.5 lit/M ² for impervious insulation surfaces including polystyrene. MAS 134 can be used only between (-)18 and (+) 82°C.	MAS 134
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5.3.8 AUXILIARY MATERIALS

5.3.8.1 Binding and Lacing Wires

Binding and lacing wire shall be annealed GS 24 SWG.

5.3.8.2 Wire Netting

Wire netting shall be with GS 24 SWG wire and 20 mm hexagonal opening.

5.3.8.3 Bands

- | | | | |
|-----|--------------------------------------|---|---|
| (a) | For securing insulation material | : | 24 SWG GS, 20 mm wide |
| (b) | For securing aluminium and GS sheets | : | 24 SWG anodised aluminium or SS 304, 20 mm wide |

5.3.8.4 Screws

Screws shall be of self-tapping type and shall be of aluminium or stainless steel for aluminium sheets and GS for GS sheets.

5.3.8.5 Pop Rivets

Pop rivets shall be of aluminium or stainless steel for aluminium sheets and GS for GS sheets.

5.3.9 APPLICATION

5.3.9.1 GENERAL

The application of insulation shall be made in a professional manner. The insulation shall be applied to all surfaces when these are at ambient temperature. Ample provision shall be made for the maximum possible thermal movement and the insulation shall be applied in a manner which shall avoid breaking or telescoping due to alternate periods of contraction and expansion. A single layer of insulation shall not be more than 75 mm thick.

5.3.9.2 Insulation shall be applied after all leak tests on equipment and piping are over and the section of the plant has been specifically released by the EMPLOYER for such work. If insulation has to be applied before the leak test, all welded and flanged joints shall be left exposed and insulated after satisfactory completion of the leak test.

5.3.9.3 All surfaces to be insulated shall be clean and dry before the insulation is applied. The surfaces shall be cleaned of all foreign material such as scale, dirt, rust and paint, by the use of steel wire brushes and steel scrapers, where necessary. Where a surface is not free of paint the CONTRACTOR shall notify the EMPLOYER of the condition for remedial action. The insulation shall be applied after remedial action, suggested by the EMPLOYER, has been taken by the CONTRACTOR. One coat of primer paint shall be applied and allowed to dry before application of insulation.

5.3.9.4 After cleaning and application of one coat of primer paint on the surface to be insulated, the insulation adhesive shall be applied for fluid operating temperatures between 200C and (-) 200C. Insulation material of required thickness shall be stuck to the surface with joints staggered. The adjoining sections shall be tightly pressed together. All the joints shall be sealed with adhesive material. Voids, if any, shall be packed with suitably cut pieces of insulation material. Vapor barrier and insulation finish shall be applied as per Para's 3.4 and 3.5 or 4.5 respectively.

5.3.9.5 For fluid operating temperatures below (-) 200C, the insulation shall be applied directly over the surface to be insulated without applying the insulation adhesive. Vapor barrier shall be applied over the insulation material. Vapor barrier and insulation finish shall be applied as per Para's 3.4 and 3.5 or 4.5 respectively.

5.3.9.6 Where multilayer insulation is provided, insulation adhesive shall be used between two layers, based on temperature criterion given in Para 4.1.4.

5.3.9.7 If aluminium or GS sheet is specified as finishing material, all joints shall be sealed with bitumastic paint and made effectively weather and water-proof. For temperatures between (-) 40 and (+) 120oC, MAS 94 may also be used as sealant. MAS 94 shall, however, not be used with polystyrene as insulation material. All flat surfaces shall be adequately sloped to prevent pools of water collecting. The sheet shall be protected internally with 2 coats of bitumastic paint.

5.3.9.8 All actions shall be taken to complete the application of finishing on exposed surfaces covered with insulation before closing the day's work. If this is not practicable, adequate precautions shall be taken to protect the insulation from weather, for example by wrapping it with polythene sheet, roofing felt or other approved material.

5.3.10 PIPES, PIPE FITTINGS, VALVES AND SPECIALITIES

5.3.10.1 All vertical pipes shall be provided with suitable insulation supports to prevent the insulation from collapsing due to its own weight. Any welding required, shall be carried out by the CONTRCATOR with the prior permission of the EMPLOYER and only under his direct supervision. Where welding is not permitted, suitable clamped supports shall be used. The insulation shall be applied starting from bottom up. Mattress type insulation materials shall be clamped from top.

5.3.10.2 All pipe fittings, valves and specialties shall be covered with the same type and thickness of insulation as specified for the adjoining pipe. On pipe fittings, insulation outside diameter shall be same as the outside diameter of adjacent pipe insulation. Unless specified otherwise, valves and specialties of sizes 100 mm NB and larger shall be provided with removable box type insulation. Box shall be fabricated from sheet material specified for adjoining pipes. Pipe insulation on adjoining flanges shall be stopped at one bolt length plus 25 mm before flange to permit removal of the bolts and nuts. The insulation shall be applied after the finish has been applied over insulation on the adjacent piping. Flanged joints shall also be insulated with removable type of boxes. Arrangement shall be similar to that for valves.

5.3.10.3 The sheets shall be installed with the longitudinal lap joints at 450 below the horizontal for horizontal pipes and the joints sealed with bitumastic paint.

5.3.10.4 On vertical pipes the sheets shall be applied working from bottom up. Each section of sheets shall have a minimum overlap of 50 mm longitudinally and circumferentially. Each circumferential joint shall be made weather-proof by securing with a band of sheet material and sealing with bitumastic paint. Longitudinal lap joints shall be fixed with screws or pop rivets at approximately 150 mm centers.

5.3.10.5 Valves shall be insulated up to and including their bonnet flange.

5.3.10.6 Insulation of pipe hanger clamps shall be as per Standard.

- 5.3.10.7 Weather hoods shall be provided for insulated piping passing through roof and external walls as per standard.

5.3.11 EQUIPMENT

- 5.3.11.1 Where the insulation material is in the mattress form, cleats in the form of wire nails or nuts or angles and flats for supporting the insulation material, shall be welded to the equipment by others. If wire nails are to be used as insulation cleats, these shall be bent and secured with the metal fabric of the mattress, after the insulation has been applied. Where insulation cleats are in the form of M6 and M10 nuts, the CONTRACTOR shall supply and install bolts of suitable length for fixing the insulation. The insulation applied to equipment shall be reinforced with wire netting. One course of wire netting shall be applied to the surface of the equipment and each layer of insulation shall be backed up with wire netting. All irregularities of the surface shall be filled and leveled over with insulating cement. All mattress joints shall be butted tightly and the mattresses shall be secured with 20 mm wide 24 SWG GS bands at 450 mm centers. After banding, all mattress edges shall be laced tightly.
- 5.3.11.2 All equipment, unless specified otherwise, shall have a smooth aluminum or GS sheet finish as specified in data sheet A, applied in a manner similar to that specified for piping. For fixing of aluminum or GS sheets, wooden spacer rings at 1000 mm centers shall be fixed to the equipment by the CONTRACTOR. All vertical and horizontal sheets shall be overlapped a minimum of 75 mm. The lapped joints of adjoining sections of sheets shall be secured with screws or pop rivets. On all equipment above 2500 mm diameter and flat surfaces, the sheet shall be further secured by circumferential bands at approximately 1000 mm centers. Each sheet joint shall be sealed with bitumastic paint. The roof sections shall overlap the side walls to prevent water seepage between insulation and the equipment wall. Side wall sheets shall be securely banded at intersections of the side wall and roof sections.
- 5.3.11.3 All equipment manholes, hatches, bolted or screwed cover plates, flanged ends etc. shall have removable box type insulation, with same thickness of insulation as for adjacent surfaces. Insulation adjoining such equipment openings shall be tapered towards these openings to permit removal of bolts, screws, heads, covers or plates with no damage to adjacent surface insulation or cover
- 5.3.11.4 Nozzles and other connections on tanks and other equipment shall be insulated in the same manner as the pipes.
- 5.3.11.5 Pump casing shall be completely insulated with removable type of boxes fabricated from the specified sheet material. Proper care shall be taken to maintain continuity of vapour barrier between static and removable portion of insulation.
- 5.3.11.6 Name plates on equipment shall not be insulated. Proper care shall be taken to eliminate seepage of moisture from such un-insulated portions into the insulating material.

5.3.12 CONTRACTION JOINTS IN INSULATION

Depending on the type of insulation material used and the operating temperature, contraction joints shall be provided for equipment or pipes to prevent rupturing or buckling when the cold surface contracts CEMENT SAND PLASTER FINISH

Where cement sand plaster finish is specified following procedure shall be followed.

5.3.13 Indoor Application

After the application of hot bitumen or CPRX compound vapor barrier, the surface shall be wrapped with GS wire netting, butting all the joints and lacing down with lacing wire. The ends of all wire loops shall be firmly twisted together with pliers, bent over and carefully pressed into the surface of insulation.

A total of 15 mm thick finishing cement sand(1:4) plaster shall be applied in two layers after a GS wire netting is stretched over the entire surface of insulation material and securely fastened down. The plaster shall be hand trowelled over the wire netting to a smooth finish. The application of finishing plaster shall be terminated, at the end of day's work, at a contraction joint.

5.3.14 Outdoor Application

After the application of the plaster as per procedure for indoor application, an additional 6 mm thick water-proofing compound Shalikota 30 or equivalent shall be applied in two layers. Outdoors, the finishing plaster shall be applied immediately after application of insulation. If this is not practicable, the CONTRACTOR shall take adequate precautions to protect the insulation from weather, e.g. by wrapping it with polythene sheet, roofing felt or other approved material.

The cement sand plaster finish shall have the following properties:

- a. A light shower of rain, falling immediately after application shall not wash off the plaster.
- b. At any time, one week or more after application, it shall not shatter if struck a sharp blow with a 0.7 Kg hammer. Such a blow may damage the finishing locally but shall not cause large pieces to break away.
- c. When set, it shall withstand prolonged exposure to the weather without additional protection.

5.3.15 DUAL TEMPERATURE INSULATION

For dual temperature application, resin-bonded glass wool or unbounded rock or slag wool thermal insulation shall be provided, depending on the lower temperature limit given in Para 3.2. Insulation thicknesses shall be as indicated in Insulation Schedule (Equipment) and Insulation Schedule (Piping). The insulation application procedure shall be same as that for cold surfaces.

5.3.16 MEASUREMENT

Measurement of insulation over equipment and piping shall be as per IS 14164.

Measurement for air-conditioning ducts shall be taken over finished insulation surface and 5% additional area shall be considered to account for reinforcement and flanged angle joints.

5.3.17 MISCELLANEOUS

Approval of the EMPLOYER shall be obtained of samples of all materials and necessary test certificates of approved national laboratories, before dispatching these to site. Insulation shall not be applied until specific release is given by the EMPLOYER.

5.3.18 DATA SHEET - A

1. AMBIENT TEMPERATURE : 40 °C		13.
2.		14.
3.		15.
4.		16.
5.		17.
6. INSULATION MATERIALS		18.
6.1 EQUIPMENT: EP/PUR/PIR/PF/LRG/U150		19.
6.2 PIPING SYSTEMS : EP/PUR/PIR/PF/LRG/ PSG/U150		20.
6.3 AIR-CONDITIONING DUCT : EP/PUR/ PIR/PF/LRG/U150		21.
6.4		22.
6.5		23.
7. INSULATION ADHESIVES : BIT/CPRX/ MAS 83		24.
8. VAPOUR BARRIERS : VB1/ALF/MAS 130		25.
9. FINISHING MATERIALS		26.
9.1 EQUIPMENT : FC/AL1/GS1/MAS 134		27.
9.2 PIPING SYSTEMS:FC/AL1/GS1/MAS 134		28.
9.3 AIR-CONDITIONING DUCT : FC/AL1/ GS1/MAS 134		29.
9.4		30. TEST CERTIFICATES FOR ALL MATERIALS REQUIRED : YES/NO
9.5		31.
		32.
		33.

10. INSULATING CEMENT MATERIAL:		34.
SAME AS THE BASIC INSULATION		35.
MATERIAL		36.

5.4 PANEL TYPE AIR FILTERS

5.4.1 SCOPE

This specification covers the design, materials, construction features, manufacture, shop inspection and testing at manufacturer's works, delivery at site, installation, testing, commissioning and carrying out performance test at site of Panel Type Air Filters.

5.4.2 CODES AND STANDARDS

The design, materials, manufacture, inspection, testing and performance of filters shall comply with all currently applicable statutes, regulations, codes and standards in the locality where the filters are to be installed. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility. In particular, the filters shall conform to the latest edition of following standards:

ASHRAE 52.1	Gravimetric and Dust - Spot Procedures for Cleaning Devices Used in General Ventilation Particulate Matter
IS 7613	Methods of Testing Panel Type Air Filters for Air-Conditioning and Ventilation Purposes
ISO 14644-1 AND 2	Cleanrooms and Associated Controlled Environments

5.4.3 GENERAL REQUIREMENTS

5.4.3.1 PRE-FILTER

Pre-filter shall contain washable synthetic fibre or High Density Polyethylene (HDPE) media having 18G Galvanised Steel Sheet (GSS) frame. The filter media shall be supported with HDPE mesh on one side and aluminium on the other side. Filter frame shall be provided with suitable handles. The gravimetric efficiency of the pre-filter as per IS 7613 with test dust G3 (fused aluminium oxide dust) shall be 90% down to particle size of 20 microns or as specified in data sheet A.

5.4.3.2 FINE FILTER

Fine filter shall contain HDPE filter media having 18G GSS frame. The filter media shall be supported with HDPE mesh on either side. Filter frame shall be provided with suitable handles. The gravimetric efficiency of the fine filter as per IS 7613 with test dust G2 (fused aluminium oxide dust) shall be 99% down to particle size of 5 microns or as specified in data sheet A.

5.4.3.3 HIGH EFFICIENCY PARTICULATE AIR (HEPA) FILTER

HEPA filter shall contain sub-micron glass fibre paper with or without aluminium separators having 18G aluminium frame. Filter media shall be designed for velocities not exceeding 1.25 metres per second. Filter frame shall be provided with suitable handles. HEPA filter shall have cold Di-Octyl-Phthalate (DOP) test efficiency of 99.97% down to particle size of 0.3 microns or as specified in data sheet A.

5.4.3.4 DATA SHEET A

SL. NO.	ITEM	UNIT	
GENERAL			
1	DESIGNATION		
2	SERVICE		AMBIENT AIR / EXHAUST AIR / RECIRCULATED AIR
3	APPLICATION		PRE-FILTER / FINE FILTER / HEPA FILTER
4	TYPE:		CASSETTE / FLANGE
5	CLEANING METHOD		CLEANABLE / NOT CLEANABLE (THROW AWAY)
DESIGN DATA			
6	TOTAL AIR FLOW RATE :	M3/Hr	TABLE IS GIVEN BELOW
7	TEMPERATURE OF AIR :	OC	AMBIENT
8	RELATIVE HUMIDITY :	%	98 % Max.
9	DUST LOADING :	gms/M3	
	EFFICIENCY		90 % DOWN TO 10 MICRONS
10	TYPE OF CONTAMINATION		RADIO ACTIVE / CORROSIVE
11	MAXIMUM FILTER FACE VELOCITY	M/sec	2.5 FOR PRE & FINE & 0.5 FOR HEPA
12	TOTAL FACE AREA OF FILTERS REQUIRED	M2	N.A.
13	PREFERRED SIZE OF EACH FILTER PANEL		mm x mm x mmTHK
14	NUMBER OF FILTER PANELS		REFER SCHEDULE - F
15	MAXIMUM ALLOWABLE PRESSURE DROP FOR DESIGN FLOW RATE IN		
16	CLEAN CONDITION	mmWC	2 MM/ 5 MM/ 25 MM WG.
17	CLOGGED CONDITION	mmWC	10 MM/ 15 MM/ 75 MM WG.

18	MOUNTING FRAME / SUPPORTING FRAME WORK FOR FILTERASSEMBLY		GSS / ALUMINIUM / SS / HOT DIP GALVANISED OR EPOXY OR SYNTHETIC ENAMEL PAINTED AUXILIARY STEEL CHANNELS OR ANGLES
19	GASKETS FOR FILTER ASSEMBLY		NEOPRENE RUBBER
20	FASTENERS		GS / SS
TESTS AND INSPECTION			
21	TESTING AT WORKS		EFFICIENCY AND PRESSURE DROP FOR ALL FILTERS AND LEAKAGE TEST FOR HEPA FILTERS
22	TESTING AT SITE		EFFICIENCY AND PRESSURE DROP, LEAKAGE AND FILTER BANK LEAKAGE

FILTER DETAILS:

SL. NO.	EQUIPMENT LIST	CFM	TR	QUANTITY	MODEL	PRE FILTER	MICRO FILTER	HEAP FILTER
1	ELECTRONIC ASSEMBLY	11000	7	1	AHU	REQUIRED	REQUIRED	REQUIRED
2	CALIBRATION LAB	1037	2	4	CSU	REQUIRED	NOT REQUIRED	NOT REQUIRED
3	CONFERENCE HALL	5255	8	2	CSU	REQUIRED	NOT REQUIRED	NOT REQUIRED

5.5 AIR WASHER

5.5.1 SCOPE

This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at manufacturer's works, delivery at site, handling at site, installation, testing, commissioning and carrying out performance test at site of Air Washers.

5.5.2 CODES AND STANDARDS

The design, materials, construction features, manufacture, inspection, testing and performance of air washers shall comply with all currently applicable statutes, regulations, codes and standards in the locality where the equipment is to be installed. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility.

5.5.3 GENERAL REQUIREMENTS

Air washer shall be spray type or rigid media pad type as specified in data sheet A.
SPRAY TYPE AIR WASHER

Spray type air washer shall consist of an air-tight chamber or casing containing air distribution plates, spray nozzles, a tank for collecting spray water, eliminators with flooding nozzles and a pump with piping, valves and specialties for re-circulating water Tank

Air washer tank shall have a minimum depth of 600 mm with 450 mm water level. The tank shall be constructed in such a way that it extends beyond the chamber or casing on the inlet end to make suction sump. Suction sump depth shall be 1000 mm minimum to accommodate level switches, suction pipe, etc. Two suction screens shall be provided in this suction sump. These suction screens may be replaced even when the air washer is operating. Both ends of the tank shall be suitably constructed to accommodate air distribution plates at the inlet and eliminator plates at the outlet. The tank shall be extended beyond the eliminator plates by minimum 500 mm. Suction sump shall be provided with adequately sized suction pipe.

Tank shall be either of RCC or carbon steel as specified in data sheet A. RCC tanks shall be provided by the EMPLOYER. Carbon steel tanks shall be provided by the CONTRACTOR.

In case of RCC tank, pipe inserts for spray pipes, suction pipe, make-up, quick fill, drain and overflow shall be provided by the EMPLOYER during the casting of tank and same shall be followed by the CONTRACTOR. The pipe inserts shall be provided with a projection of minimum 150 mm on either side of the RCC wall and with a puddle flange located in the centre of the RCC wall.

Carbon steel tanks shall be fabricated from minimum 6 mm thick plates suitably reinforced and shall be of welded construction. The inside and outside surfaces of the tank shall be epoxy painted.

5.5.4 Air Distribution Plates

The air distribution plates shall be fabricated either from 18G Galvanised Steel Sheet (GSS) or single bend PVC as specified in data sheet A. Air distribution plates shall be provided to obtain uniform air distribution throughout the spray chamber and to prevent the backlash of spray water and these plates shall have minimum 50% free area. Hot Dip Galvanised (HDG) steel angles shall be used for supporting air distribution plates. Air distribution plates shall be built up of a number of sections for easy handling.

5.5.5 Pipe Headers

The piping used shall be as per IS 1239 or IS 3589, heavy class HDG carbon steel or stainless steel SS 304 or PVC as specified in data sheet A and shall be adequately supported with HDG steel angles or channels.

5.5.6 Spray Nozzles

Spray nozzles shall be arranged either in a single bank or multiple banks as specified in data sheet A. Spray banks shall be spaced 800 to 1400 mm apart. The first and last banks of spray shall be located about 400 to 600 mm from the entering or leaving end of the air washer. Spray nozzles shall be of self cleaning type made of brass or bronze or SS tipped PVC or ABS plastic as specified in data sheet A. Spray nozzles shall be designed to produce fine atomized spray and shall be spaced to give an uniform coverage of the air washer section. The pressure drop through the nozzle shall be in the range of 1.4 to 2.4 Kg/cm².

Flooding nozzles shall be provided to clean the eliminator plates. The pressure drop through the flooding nozzle shall be in the range of 0.2 to 0.3 Kg/cm².

Each spray nozzle and flooding nozzle header shall be provided with a flow balancing valve located outside the air washer chamber or casing. Provision shall be made for pressure indicator installation on each header.

Recirculated water quantity shall vary from 0.53 M³/Hr with a single bank to 1.34 M³/Hr for multiple banks per 1000 M³/Hr of supply air quantity.

5.5.7 Eliminator Plates

The eliminator plates shall be fabricated from 24G GSS or aluminum or PVC as specified in data sheet A. The eliminator section shall have minimum six (6) bends. Spacer bars, tie rods and supports shall be of HDG steel construction. Drip tray and drain pipe shall be provided out of GSS and HDG construction respectively.

5.5.8 Suction Screens

Minimum two (2) numbers of 24G brass or GS suction screens as specified in data sheet A having 20 mesh size shall be provided. One set of spare suction screens shall be provided with each air washer.

5.5.9 Inspection Door

An air-tight inspection door of 600 mm x 700 mm size shall be provided. Inspection door shall be provided in the side wall in between the spray headers or in air distribution plates as specified in data sheet A. Inspection door provided in side wall shall be of metallic construction with glass window

and shall be epoxy painted. Inspection door provided in air distribution plates shall be of same construction as air distribution plates. The access ladder shall be provided with epoxy painting.

5.5.10 Marine Lights

Marine lights shall be provided in air washer for maintenance, if specified in data sheet A. One (1) light switch shall be provided on the exterior of the air washer to control all the fixtures. The lighting switch shall be completely pre-wired to a junction box. Lighting wire shall be carried out with PVC insulated, 600 volts grade, 2.5 mm² stranded copper conductor wires. The EMPLOYER shall provide 240V, single phase supply to the junction box.

5.5.11 Make-up and Quick Fill Water Connections

Air washer shall be provided with a make-up and quick fill water connections. For make-up connection float valve shall be backed with a isolation valve for isolation purpose. Isolation valve shall be provided on quick fill line. The make-up and quick fill connections shall be combined to form a single connection at battery limit.

5.5.12 Drain and Overflow Water Connections

Suitable drain connections with isolating valves shall be provided. An overflow pipe shall be provided and connected to the drain through drain pipe.

5.5.13 Water Level Switch

Water level switch shall be provided in air washer tank or sump, if specified in data sheet A. Level switch shall give an alarm when the water level falls below the preset low level. Level switch shall be interlocked with pump motor such that pump motor trips whenever water level falls below preset low-low level.

5.5.14 RIGID MEDIA PAD TYPE AIR WASHER

Rigid media pad type air washer shall consist of a air-tight chamber or casing of GSS or Fibre Reinforced Plastic (FRP) containing corrugated rigid media pad, a tank for collecting water and a pump with piping, valves and specialities for re-circulating water.

Rigid media pad shall be of cellulose and fibre glass that have been treated chemically with antiriot and rigidifying resins. Pad shall be cross-corrugated to maximise mixing of air and water. In the direction of air flow, depth of pad shall be 300 to 600 mm. The pad shall be arranged in tiers over which water is distributed. No atomisation of water is required. Only good distribution of water over the face of the pad is essential. Nozzles operate under comparatively low pressure compared to spray type air washer.

5.5.15 DATA SHEET - A

	SL. NO.	BIDDER ITEM		
DESIGN DATA (CONTINUED)	14.9	PRESSURE REQUIRED AT INLET OF		
		FLOODING NOZZLE HEADER	Kg/cm ² g	
	14.1 0	NUMBER OF SUCTION SCREENS		
	14.1 1	SIZE OF EACH SUCTION SCREEN L x B	mm	x
	15.	RIGID MEDIA PAD TYPE		
	15.1	DEPTH OF PAD	mm	
	15.2	OVERALL SIZE OF PAD L x B	mm	x
	15.3	METHOD OF CLEANING		
	15.4	FREQUENCY OF CLEANING	DAYS	
MATERIALS OF CONSTRUCTION	16.	TANK		
	17.	CATWALK		
	18.	AIR DISTRIBUTION PLATES		
	19.	SPRAY NOZZLES		
	20.	FLOODING NOZZLES		
	21.	INSPECTION DOOR		
	22.	ELIMINATOR PLATES		
	23.	SUCTION SCREEN		
	24.	PAD FOR RIGID MEDIA PAD TYPE		
ACCESSORIES		TO BE INCLUDED		WHETHER INCLUDED
	25.	MAKE-UP WITH FLOAT VALVE AND		
		QUICK-FILL CONNECTIONS WITH ISOLATING		YES / NO
		VALVE, ETC.		
	26.	DRAIN WITH ISOLATING VALVE AND		
		OVERFLOW CONNECTION, ETC.		YES / NO
	27.	MARINE LIGHTS		YES / NO
	28.	INSPECTION DOOR		YES / NO
	29.	SUPPORTING FRAME WORK FOR ITEMS AT		
		SL. NO. 16 TO 24 AND 27 ABOVE		YES / NO
	SL. NO.	BIDDER ITEM		
ACC ESS ORI ES (CO		TO BE INCLUDED		WHETHER INCLUDED
	30.	WATER LEVEL SWITCH WITH ALARM AND INTERLOCKING WITH PUMP		YES / NO

NTI NUE D)	31.	ACCESS LADDERS WITH HANDRAILS AND MONKEY LADDERS		YES / NO
	32.	SUCTION SUMP COVER		YES / NO

5.5.16 AIR WASHER DETAILS:

Building Name	Area (Sqm.)	H (m)	ACH	Air Qty. (CMH)	Selected (CMH)
Dining Block					
CANTEEN K-1	63.03	4	25	6303	6400
CANTEEN K-2	61.82	4	25	6182	6200

5.6 AXIAL FANS FOR VENTILATION SYSTEM

5.6.1 SCOPE

This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at manufacturer's works, delivery at site, handling at site, erection, testing, commissioning, performance testing and handing over of Axial Fans for Ventilation System.

5.6.2 CODES AND STANDARDS

The design, materials, construction, manufacture, inspection, testing and performance of axial fans shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to the latest applicable Indian or equivalent standards. Other international standards are also acceptable, if these are established to be equal or superior to the listed standards. Nothing in this specification shall be construed to relieve the VENDOR / CONTRACTOR of this responsibility.

5.6.3 CONSTRUCTION FEATURES

5.6.3.1 CASING

Casing shall be provided with suitable supports. Access door shall be provided in the casing for easy access to motor and impeller. Suitable arrangement for mounting of motors shall be provided.

5.6.3.2 IMPELLER

The impeller shall have blades of an airfoil design. Blades shall be mounted on streamlined hub. Impeller with fabricated blades are acceptable up to 450 mm impeller diameter. The impeller shall be statically and dynamically balanced. Adjustable pitch blades shall be provided if specified in data sheet A.

5.6.3.3 GENERAL

Guide vanes shall be provided on the discharge side for vane axial fans. Belt driven fans shall be provided with V- belts, V-belt pulleys and belt guards. Pulleys shall have minimum two(2) grooves to prevent start-up failure and premature belt failure. Pulleys shall be statically and dynamically balanced. Belts shall have a minimum service factor of 1.5.

Common base frame for belt driven fans shall be with adjustable rails for motors. Bolts, nuts and washers used shall be of non-corrosive material and of superior quality. Bearings shall have minimum life of 50,000 hours.

5.6.3.4 DRIVE MOTOR

Drive motor shall be rated at least 15 % higher than the power requirement at duty point or 10 % higher than the maximum power requirement at selected speed, whichever is higher. Starting torque requirements of fan shall also be considered while selecting the motor.

5.6.3.5 NOISE AND VIBRATION

Noise level produced by any rotating equipment individually or collectively shall not exceed 85 dB(A) measured at a distance of 1.5 metres from the source in any direction. The overall vibration level shall be as per zones A and B of ISO 10816-1. Balance quality requirement shall be G 6.3 conforming to ISO 1940/1.

5.6.3.6 PERFORMANCE GUARANTEES

Performance parameters to be guaranteed by the VENDOR/ CONTRACTOR and tolerances permitted shall be as indicated in data sheet A. BIDDER shall confirm acceptance of these by indicating values in data sheet B. Fan or any portion thereof is liable for rejection, if it fails to give any of the guaranteed performance parameters.

5.6.3.7 DATA SHEET – A

GENERAL			
1	DESIGNATION : AXIAL FANS FOR VENTILATION SYSTEM	5	DUTY : CONTINUOUS / INTERMITTENT 24 Hrs/Day
1.1	FOR NORMAL VENTILATION: YES/ NO	6	LOCATION IN HAZARDOUS AREA : YES / NO
1.2	FOR VENTILATION UNDER FIRE: YES/ NO	7	HAZARDOUS AREA CLASSIFICATION AS PER IS 5572 ZONE 0 / 1 / 2
2	NUMBER REQUIRED : TABLE GIVEN BELOW 1 & 2	8	
3	TAG NUMBERS: TABLE GIVEN BELOW 1&2	9	
4	LOCATION : INDOOR / OUTDOOR	10	
DESIGN DATA			
11	CAPACITY AT SUCTION CONDITIONS	15	MAXIMUM FAN SPEED
11.1	NORMAL : M3/Hr	15.1	FOR IMPELLER DIAMETER 450 mm AND LESS : 1500 RPM
11.2	MINIMUM : 11050 M3/Hr	15.2	FOR IMPELLER DIAMETER ABOVE 450 mm : 1000 RPM
11.3	MAXIMUM : F M3/Hr	16	DESIGN AMBIENT TEMPERATURE: 40 <input type="checkbox"/> C
12	FLUID HANDLED :GAS/AIR	17	ELEVATION ABOVE MEAN SEA LEVEL : 233 M

13	FLUID CONDITION AT SUCTION	18	FAN POSITION: VERTICAL/ HORIZONTAL
13.1	TEMPERATURE : 28 <input type="checkbox"/> C	19	FIRE RATING: (ONLY FOR FIRE APPLICATION)
13.2	RELATIVE HUMIDITY : 60 %	19.1	TEMPERATURE (MAX): 250 <input type="checkbox"/> C FOR
13.3	DENSITY : 1.2 Kg/M3	20	
14	STATIC PRESSURE : 35 mmWC	21	
22	TYPE : VANE AXIAL / TUBE AXIAL / PROPELLER	28	FIRE RESISTANT PAINT: YES / NO
23	SPARK RESISTANT CONSTRUCTION TYPE AS PER AMCA : A / B / C	29	FAN MOTOR ASSEMBLY- STATICALLY / DYNAMICALLY BALANCED AS PER AMCA-204: YES/NO
24	DRIVE : DIRECT / BELT	30	
25	ADJUSTABLE PITCH BLADES REQUIRED : YES / NO	31	
26	TYPE OF MOUNTING : FLOOR / WALL / IN DUCT	32	
27	PAINTING : MANUFACTURER'S STANDARD / EPOXY PAINTED	33	
MATERIALS OF CONSTRUCTION			
34	CASING : CS /	38	OUTLET CONE :
35	IMPELLER : CS / CAST AL /	39	GUIDE VANE :
36	SHAFT : EN 8 /	40	
37	INLET CONE OR BELL :	41	
ACCESSORIES			
42	FLEXIBLE CONNECTION AT FAN INLET / OUTLET : YES / NO	49	WOODEN BLOCK FOR MOUNTING : YES / NO
43	TYPE OF FLEXIBLE CONNECTION: NORMAL / FIRE PROOF	50	COMMON BASE FRAME OR SUPPORTING FRAME FOR MOUNTING: YES / NO
44	VOLUME CONTROL DAMPERS AT FAN INLET / OUTLET : YES / NO	51	NEOPRENE RUBBER PADS : YES / NO
45	INLET GUARD : YES / NO	52	FOUNDATION BOLTS: YES/NO
46	INLET CONE OR BELL AND OUTLET CONE : YES / NO	53	VIBRATION ISOLATORS : YES / NO
47	LOUVERED SHUTTERS : YES / NO	54	RIBBED NEOPRENE RUBBER PADS BETWEEN FOUNDATION BLOCK AND FLOOR FOR FLOOR MOUNTED FANS: YES / NO
48	WALL COWL WITH BIRD SCREEN: YES / NO	55	
SERVICES			
56	ERECTION : YES / NO	58	TESTING AND COMMISSIONING :

			YES / NO
57	ERECTION SUPERVISION : YES / NO	59	
ELECTRICAL			
60	MOTORS: BYCONTRACTOR/ EMPLOYER	61	STARTERS : BY CONTRACTOR / EMPLOYER
SPARES AND MAINTENANCE TOOLS AND TACKLES			
62		63.3	
63	ESSENTIAL SPARES	63.4	
63.1		63.5	
63.2		63.6	
TESTS AND INSPECTION			
64		65	
CODES AND STANDARDS			
66	FOR DESIGN, TESTING AND INSPECTION : IS 2312, IS 3588, AMCA 203, AMCA 210, AMCA 300	68	
67		69	
PERFORMANCE GUARANTEES			
70	CAPACITY AT SUCTION CONDITIONS (+) 10 % (-) ZERO M3/Hr	72	POWER CONSUMPTION : (+) ZERO (-) 10 % KW
71	STATIC PRESSURE : (+) 5 % (-) ZERO mmWC	73	
COST LOADING AND PENALTY			
74	POWER CONSUMPTION : Rs. / KW	76	

5.6.3.8 Axial Fans Details:

Sr. No.	Building Name	Area	Selected Air Qty.	Qty.	Fan
		(sqm.)	CMH	Nos.	Type
A	ADMIN BUILDING				
A.1	GROUND FLOOR				
1.1	TOILET	3.2	80	1	Propeller
1.2	PANTRY	4.1	250	1	Inline
1.3	PANTRY-1	6.2	380	1	Inline
1.4	ELECTRICAL RM	18.8	1130	1	Propeller
1.5	HOUSE KEEPIING	3.8	160	1	Propeller

1.6	TOILET - SHE	19.5	470	1	Inline
1.7	TOILET - HE	19.5	470	1	Inline
A.2	FIRST FLOOR				
2.1	PANTRY	10.5	630	1	Propeller
2.2	LUNCH RM	99.8	1340	3	Propeller
2.3	HOUSE KEEPIING	3.8	160	1	Propeller
2.4	TOILET - SHE	19.5	470	1	Inline
2.5	TOILET - HE	19.5	470	1	Inline
A.3	SECOND FLOOR				
3.1	STAFF TOI	4.8	120	1	Propeller
3.2	RECORDS RM	39.6	480	2	Propeller
B	EXECUTIVE HOSTEL				
B.1	GROUND FLOOR				
1.1	KITCHEN	10.1	1210	1	Propeller
1.2	TOILET	3.4	90	1	Propeller
1.3	ELECTRICAL RM	2.5	160	1	Propeller
1.4	TOILET	3.4	90	1	Propeller
B.2	FIRST FLOOR				
2.1	TOILET	3.4	90	1	Propeller
2.2	TOILET	3.4	90	1	Propeller
2.3	TOILET	3.4	90	1	Propeller
2.4	TOILET	3.4	90	1	Propeller
C	DINING BLOCK				
C.1	GROUND FLOOR				
1.1	MALE TOILET	19.35	470	1	Inline
1.2	ELECTRICAL ROOM	11.25	680	1	Propeller
1.3	STORE RM	2.64	70	1	Propeller
1.4	TOILET	2.52	70	1	Propeller
1.5	STATIONARY SHOP	11.25	270	1	Propeller
1.6	FEMALE TOILET	19.35	470	1	Inline
C.2	FIRST FLOOR				
2.1	MALE TOILET	19.35	470	1	Inline
2.2	FEMALE TOILET	19.35	470	1	Inline
D	STAFF				

	ACCOMODATION				
D.1	GROUND FLOOR				
1.1	KITCHEN	4.9	590	1	Propeller
1.2	WC	1.6	40	1	Propeller
1.3	KITCHEN	4.9	590	1	Propeller
1.4	WC	1.6	40	1	Propeller
1.5	KITCHEN	4.9	590	1	Propeller
1.6	WC	1.6	40	1	Propeller
1.7	KITCHEN	4.9	590	1	Propeller
1.8	WC	1.6	40	1	Propeller
D.2	FIRST FLOOR				
2.1	KITCHEN	4.9	590	1	Propeller
2.2	WC	1.6	40	1	Propeller
2.3	KITCHEN	4.9	590	1	Propeller
2.4	WC	1.6	40	1	Propeller
2.5	KITCHEN	4.9	590	1	Propeller
2.6	WC	1.6	40	1	Propeller
2.7	KITCHEN	4.9	590	1	Propeller
2.8	WC	1.6	40	1	Propeller
E	PRODUCTION & TRAINING				
E.1	GROUND FLOOR				
1.1	S MALE TOI.	34.7	840	1	Inline
1.2	PHY, SHE & STAFF TOILET	22.3	540	1	Inline
1.3	PANTRY	3.3	200	1	Inline
1.4	SHE& HE TOILETS	16.2	390	1	Inline
1.5	S FEMALE TOI.	34.7	840	1	Inline
1.6	MALE TOILET	19.2	470	1	Inline
1.7	PHY. TOI.	3.1	80	1	Inline
1.8	PANTRY	7.7	470	1	Inline
1.9	FEMALE TOILET	19.2	470	1	Inline
1.10	SERVICE ROOM	14.3	350	1	Inline
D.2	FIRST FLOOR				
2.1	S MALE TOI.	34.7	840	1	Inline
2.2	PHY, SHE & STAFF TOILET	22.3	540	1	Inline
2.3	PANTRY	7.0	430	1	Inline
2.4	STORE	10.4	260	1	Propeller
2.5	S FEMALE TOI.	34.7	840	1	Inline

2.6	MALE TOILET	19.2	470	1	Inline
2.7	PHY. TOI.	3.1	80	1	Inline
2.8	PANTRY	7.7	470	1	Inline
2.9	FEMALE TOILET	19.2	470	1	Inline
2.10	SERVICE ROOM	14.3	350	1	Inline
3.1	S MALE TOI.	34.7	840	1	Inline
3.2	PHY, SHE & STAFF TOILET	22.3	540	1	Inline
3.3	PANTRY	7.0	430	1	Inline
3.4	STORE	10.4	260	1	Propeller
3.5	S FEMALE TOI.	34.7	840	1	Inline

5.6.3.9 PROPELLER EXHAUST FAN DETAILS:

PROPELLER EXHAUST FAN	SELECTED CFM	EACH UNIT	NOS
DINING BLOCK			
DINING AREA	6500	1000	6
BOYS COMMON RM	1500	500	3
GRILS COMMON RM	1500	500	3

5.7 AIR HANDLING UNITS

5.7.1 SCOPE

This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at manufacturer's works, delivery at site, handling at site, installation, testing, commissioning and carrying out performance test at site of Air Handling Units (AHUs).

5.7.2 CODES AND STANDARDS

The design, materials, manufacture, inspection, testing and performance of AHUs shall comply with all currently applicable statutes, regulations, codes and standards in the locality where the equipment is to be installed. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility. In particular, the AHUs shall conform to the latest edition of following standards:

IS 7613	Method of Testing Panel Type Air Filters for Air-Conditioning and Ventilation Purposes
ASHRAE 33	Method of Testing - Forced Circulation Air Cooling and Air Heating Coils
ASHRAE 52.1	Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter
ARI 410	Forced-Circulation Air-Cooling and Air-Heating Coils
ARI 430	Central Station Air-Handling Units
AMCA 210	Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
ISO 14644-1 AND 2	Cleanrooms and Associated Controlled Environments
NFPA 90A	Installation of Air-conditioning and Ventilating Systems

5.7.3 CONSTRUCTION FEATURES

5.7.3.1 TYPE

The AHUs shall be draw or blow through type as specified in data sheet A. The unit shall comprise of various sections such as mixing box, pre-filters, fine-filters, cooling coil, heating coil, humidifier, fan, High Efficiency Particulate Air (HEPA) filters, etc.

5.7.3.2 CASING

Casing shall be of single skin or double skin construction as specified in data sheet A.

5.7.3.3 Single Skin Construction

AHU shall be of sectionalised construction fabricated out of 16G Galvanised Steel Sheet (GSS) or Cold Rolled Cold Annealed (CRCA) sheet.

5.7.3.4 Double Skin Construction

Double skin wall panels shall be 25 mm thick made of GSS, pressure injected with polyurethane foam insulation of density 48 Kg/M³ and K factor not exceeding 0.02W/M°C. Double skin wall panels shall be fixed to 2.5 mm thick aluminium alloy twin box section structural framework with stainless steel screws. Outer sheet of the panels shall be made of 0.8 mm thick GSS pre-plasticised or powder coated. Inner sheet shall be 0.8 mm thick plain GSS.

The entire frame work shall be mounted on a 100 mm (minimum) aluminium alloy channel base. The panels shall be sealed to the frame work by heavy duty "O" ring neoprene gaskets held captive in the framed extrusion. All panels shall be detachable or hinged. Hinges shall be made of die cast aluminium with stainless steel pivots. Handles shall be made of hard nylon and be operational from both inside and outside of the unit. Units supplied with various sections shall be suitable for on-site assembly match drilled, with bolts, nuts and continuous neoprene rubber gaskets. All fixing and gaskets shall be concealed.

Floor and roof panels shall be double skin type and shall be of same construction as the wall panels.

AHUs shall have hinged quick-opening insulated access door on fan and filter sections. Access doors shall be double skin type and shall be of same construction as the wall panels.

Four (4) lifting lugs shall be bolted to each base section for lifting or placing the AHU in place.

All connecting fasteners and related hardware and its accessories shall be in stainless steel.

Sloping condensate drain pan shall be fabricated from 18G GSS. It shall be isolated from bottom floor panel through 25 mm thick heavy duty Treated for Fire (TF) quality expanded polystyrene or polyurethane foam. Drain pan shall extend beyond the coil.

Casing shall be of air-tight construction and sufficiently rigid to exclude vibrations, throughout the working capacity range of the AHU.

5.7.4 FILTERS

5.7.4.1 Pre-filter

Each unit shall be provided with a factory assembled filter section containing air filters of washable synthetic fibre or High Density Polyethylene (HDPE) media having 18G GSS frame. The media shall be supported with HDPE mesh on one side and aluminium on the other side. Filter banks shall be easily accessible and designed for easy withdrawal and replacement of filter cells. Filter bank frame work shall be fully sealed and constructed from GSS. The efficiency of the filters shall be 90% down to particle size of 20 microns as per IS 7613.

5.7.4.2 Fine-filter

Flanged microvee filters with HDPE filter media shall be provided. The filter frame and filter bank framework shall be of 18G GSS construction with neoprene rubber gasket. The

efficiency of the filters shall be 99% down to particle size of 5 microns as per IS 7613. Preferably, fine filters shall be located at the downstream side of fan section inside the AHU.

5.7.4.3 HEPA filter

Flanged HEPA filters having cold Di-Octyl-Phthalate (DOP) test efficiency of 99.97% down to particle size of 0.3 microns, shall be located at the downstream side of fan section inside the AHU. HEPA filters made of sub-micron glass fibre paper shall be designed for velocities of 1.25 metres per second. The filter frame work shall be of aluminium and filter bank shall be of GSS construction. Three (3) mm thick neoprene rubber gaskets shall be provided to prevent any air leakage.

5.7.5 COOLING COILS AND HEATING COILS

5.7.5.1 Cooling and heating coils shall have 12.5 to 15 mm diameter tubes of minimum 24G thickness with sine wave aluminium fins firmly bonded to copper tubes assembled in zinc coated steel frame of 1.5 mm thick. Face and surface areas shall be such as to ensure rated capacity from each AHU. The coil face air velocity across the coil shall not exceed 2.54 metres per second for cooling coil and 4 metres per second for heating coil. The coil shall be pitched in the AHU casing to ensure proper drainage. Each coil shall be factory tested to 21 Kg/cm²(g) air pressure under water. Tube shall be mechanically expanded for minimum thermal contact resistance with fins. Fin spacing shall be 4 to 5 fins per cm. Coil piping shall be extended through the casing wall approximately 150 mm and provided with 1034 kPa raised face flange connection. In case, multiple coil sections are provided, the coil inlet and outlet connections shall be headered inside or outside the AHU and only one (1) common inlet and outlet connections shall be provided for the coils outside the AHU. The companion flanges with gaskets, nuts and bolts shall be provided for piping connections. Pipe extension shall be IS 1239 heavy class. A packing gland is required at the casing wall to provide an air tight seal around the opening. Coil piping connection side shall be determined by final layout and design arrangement.

5.7.5.2 Coils shall be sealed in polythene bags and packed in crates properly. Coils with damaged fins shall not be accepted.

5.7.6 FAN SECTION

5.7.6.1 Fans shall be Double Width Double Inlet (DWDI) centrifugal type. Fans shall have forward curved or backward curved blades as specified in data sheet A. The fan speed shall not exceed 1000 RPM and fan outlet air velocity shall not be more than 11 metres per second. Fan casing and impeller shall be made of galvanised steel or epoxy painted carbon steel. Fan shaft shall be made from EN 8 steel and supported in self aligning plummer block, operating at less than 75% of first critical speed with grease lubricated bearings. Impellers and pulleys shall be individually tested and precision balanced statically and dynamically. Fans shall be tested for performance at manufacturer's works as per AMCA 210 and at site.

5.7.6.2 Motors shall drive heavy duty V-belt, constant speed, fixed pitch drive sheaves, selected at 1.5 service factor with a minimum of two (2) grooves to prevent start-up slippage and premature belt failure. Motors shall be specially designed for quiet operation and motor speed shall not exceed 1440 rpm. Belts shall be of oil resistant type. Belt guard shall be provided

with enough space on motor side to fit in the largest pulley for maximum speed. Also provision shall be made for adjusting the motor side of the belt guard in relation with the motor adjustment.

In case of single skin AHU, motor shall be mounted outside the casing on slide rails for easy belt tensioning. Fan and motor shall be mounted on aluminium alloy or galvanised steel base frames. Isolation shall be provided from the AHU casing by combination spring and rubber anti-vibration mounts having a 70 to 80% vibration dampening efficiency and flame retardant, water proof neoprene impregnated flexible connection on fan discharge.

- 5.7.6.3 In case of double skin AHU, motors shall be mounted inside the casing on slide rails for easy belt tensioning. The entire fan and motor assembly shall be mounted on a common deep section aluminium alloy or galvanised steel base frame. Isolation shall be provided from the AHU casing by combination spring and rubber anti-vibration mounts having a 70 to 80% vibration dampening efficiency and flame retardant, water proof neoprene impregnated flexible connection on fan discharge.

5.7.7 MIXING BOX

Mixing box shall be complete with fresh and return air dampers. Mixing box shall be provided whenever the return air is ducted back to the AHU.

5.7.8 DAMPERS

Dampers shall be opposed blade type. Blades shall be made of double skin airfoil extruded aluminium sections with integral gasket and assembled within a rigid extruded aluminium alloy frame. All linkages and supporting spindles shall be made of aluminium or nylon, turning in teflon bushes. In case of automatic dampers, sealed ball bearings shall be provided, in place of teflon bushes. Manual dampers shall be provided with a bakelite knob for locking the damper blades in position. Linkages shall be extended for motorised operation if specified in data sheet A. Damper frames shall be sectionalised to minimise blade warping. Air leakage through dampers when in the closed position shall not exceed 1.5% of the maximum design air volume flow rate at the maximum design air total pressure.

5.7.9 GENERAL

- 5.7.9.1 Each AHU shall be provided with manual air vent at high point in cooling and heating coil and drain plug in bottom of the coil. Vent and drain shall be provided with 15 mm NB gate valves. Condensate drain line size shall be 40 mm NB.

- 5.7.9.2 Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with paint to match the finish over the adjoining shop painted surface.

(Eliminator plates, if specified in data sheet A, shall be of aluminium alloy or PVC fill with three (3) bends.

Blow through AHU shall have diffuser section at the downstream of fan. The diffuser provided shall be of 18G perforated aluminium sheet having minimum 50% free area.

Ribbed neoprene rubber pads as vibration isolators shall be provided for AHUs.)

- 5.7.9.3 Power and control cabling for fan motors and any other electric consumers inside the AHU shall be provided by the AHU CONTRACTOR and the same shall be brought outside the

AHU and terminated in junction boxes provided by the AHU CONTRACTOR. Lockable on/off push button for each motor shall be provided outside the AHU.

- 5.7.9.4 Marine lights shall be provided in AHU sections for maintenance, if specified in data sheet A. One (1) light switch shall be provided on the exterior of the AHU to control all the fixtures. The lighting switch shall be completely pre-wired to a junction box on the top of the AHU. Lighting wire shall be carried out with PVC insulated, 600 volts grade, 2.5 mm² stranded copper conductor wires. The purchaser shall provide 240V, single phase supply to the junction box.

DATA SHEET -A

	SL NO.	ITEM	UNIT	SL NO.	
GENERAL	1.	DESIGNATION : AIR HANDLING UNITS	FILTERS	15.	PRE-FILTER REQUIRED : YES
	2.	NUMBER REQUIRED : AS PER AHU TABLE		15.1	MAXIMUM FACE VELOCITY : 2.5 M/Sec
	3.	TAG NUMBERS :		15.2	MAXIMUM PRESSURE DROP AT RATED CAPACITY
	4.	TYPE : DRAW / BLOW -THROUGH		15.2.2	CLEAN CONDITION : mmWC
	5.	CASING: SINGLE SKIN / DOUBLE SKIN		16.	FINE FILTER REQUIRED : YES/NO
	6.	LOCATION : INDOOR / OUTDOOR		16.1	MAXIMUM FACE VELOCITY : 2.5 M/Sec
	7.	DUTY : CONTINUOUS / INTERMITTENT Hrs/DAY		16.2	MAXIMUM PRESSURE DROP AT RATED CAPACITY
	8.	VIBRATION ISOLATORS : YES		16.2.1	CLEAN CONDITION : 9 mmWC
	9.	COMPANION FLANGES AS PER ANSI B 16.5 CLASS WITH NUTS BOLTS AND GASKETS : YES		16.2.2	CLOGGED CONDITION : 16 mmW C
	10.	NOISE LEVEL AT A DISTANCE OF 1.5 METRES : 65 dB(A)		17.	HEPA FILTER REQUIRED : YES/ NO
	11.	MARINE LIGHTS : YES / NO		17.1	MAXIMUM PRESSURE DROP AT RATED CAPACITY
	12.	PAINTING OF FAN AND MS STRUCTURAL FRAME WORK : EPOXY PAINTED / MANUFACTURER'S STD.		17.1.1	CLEAN CONDITION : mmWC
	13.	LIMIT SWITCH: YES/ NO		17.1.2	CLOGGED CONDITION : mmWC
	14.	THERMAL BREAK: YES/ NO		17.1.3	MAXIMUM FACE VELOCITY : M/Sec
COOLING COIL	18.	COOLING CAPACITY : (AS PER AHU TABLE) TR	HUMIDIFIER	44.	TYPE : PAN HUMIDIFIER / STEAM HUMIDIFIER
	19.	APPARATUS DEW POINT TEMPERATURE : (AS PER AHU TABLE) °C		45.	CAPACITY : KW
	20.	ENTERING AIR TEMPERATURE			
	21.	DRY BULB : (AS PER AHU TABLE) °C		46.	MINIMUM NUMBER OF STEPS:
	22.	WET BULB : (AS PER AHU TABLE) °C	FAN	47.	CAPACITY : (AS PER AHU TABLE) M ³ /Hr
	23.	LEAVING AIR TEMPERATURE		48.	STATIC PRESSURE : (AS PER AHU TABLE) mmWC

	SL NO.	ITEM	UNIT	SL NO.	
	24.	DRY BULB : (AS PER AHU TABLE) °C		49.	TYPE : FORWARD / BACKWARD CURVED/CENTRIFUGAL/ PLUG TYPE
	25.	WET BULB : (AS PER AHU TABLE) °C		50.	DISCHARGE DIRECTION : TOP HORIZONTAL/BOTTOM HORIZONTAL/ VERTICAL UPWARDS/VERTICAL DOWNWARDS
	26.	NUMBER OF ROWS DEEP : 6 (MIN.)		51.	MOTOR : BY PURCHASER / VENDOR
	27.	TYPE OF COIL : CHILLED WATER / CHILLED BRINE / DX		52.	STARTER : BY PURCHASER / VENDOR
	28.	CHILLED WATER/ BRINE FLOW RATE : (SEE SHEET 5) M ³ /Hr		53.	MOTOR TO CONFORM TO : TCE.M4-203-01
	29.	CHILLEDWATER/ BRINE ENTERING TEMPERATURE : 6.67 °C		54.	MOTOR PROVIDED WITH VFD: YES /NO
	30.	CHILLED WATER/BRINE LEAVING TEMPERATURE : 12.22 °C (MAX.)	MIXING BOX	55.	MIXING BOX REQUIRED : YES /NO
	31.	CHILLED WATER/BRINE PRESSURE AT COIL INLET : 5.0 Kg/cm ² g (MAX.)		56.	FRESH AIR DAMPER REQUIRED : YES / NO
	32.	MAXIMUM PERMISSIBLE CHILLED WATER/BRINE PRESSURE DROP : 0.7 Kg/cm ²		57.	SIZE : mm x mm
	33.	ELIMINATOR PLATES REQUIRED AFTER COOLING COIL : YES / NO	MIXING BOX AND DAMPER (CONTD).	58.	RETURN AIR DAMPER REQUIRED : YES / NO
	34.	AIR PRESSURE DROP: mmWC			
HEATING COIL	35.	HEATING CAPACITY : (SEE SHEET 5) KW		59.	SIZE : mm x mm
	36.	TYPE : STEAM/HOT WATER/ELECTRIC STRIP HEATERS WITH CONTROLS IN STEPS		60.	TYPE OF FRESH AIR AND RETURN AIR DAMPER : MANUAL / PNEUMATIC / ELECTRIC
	37.	NUMBER OF ROWS DEEP :		61.	SUPPLY AIR DAMPER REQUIRED :YES
	38.	FLOW RATE : M³/Hr		62.	SIZE : mm x mm
	39.	STEAM/HOT WATER ENTERING TEMPERATURE : °C		63.	TYPE OF SUPPLY AIR DAMPER : MANUAL / PNEUMATIC / ELECTRIC
	40.	HOT WATER LEAVING TEMPERATURE: °C			
	41.	STEAM/HOT WATER PRESSURE AT COIL INLET : Kg/cm²g			

	SL NO.	ITEM	UNIT	SL NO.	
	42.	MAXIMUM PERMISSIBLE HOT WATER PRESSURE DROP: 0.7 Kg/cm ²	SPARES & MAINTENANCE TOOLS & TACKLES	64.	REFER TCE.M4-981 ' SCHEDULE OF ESSENTIAL & RECOMMENDED SPARES'
	43.	MINIMUM NUMBER OF STEPS REQUIRED FOR ELECTRIC STRIP HEATER : THREE (3)		65.	REFER TCE.M4-982 ' SCHEDULE OF MAINTENANCE TOOLS & TACKLES'
				66.	REFER TCE.M4-983 ' SCHEDULE of START-UP & COMMISSIONING SPARES'
				77.	
PERFORMANCE GUARANTEES	67.	DEHUMIDIFIED AIR QUANTITY: (AS PER AHU TABLE) M3/HR	COST LOADING & PENALTY	78.	
	68.	STATIC PRESSURE: (SEE SHEET 5) MMWC		79.	POWER CONSUMPTION; RS/KW
	69.	ENTERING DRY BULB TEMPERATURE: (AS PER AHU TABLE) ° C		80.	CHILLED WATER/BRINE CONSUMPTION: RS/M3/HR
	70.	ENTERING WET BULB TEMPERATURE: (SEE SHEET 5) ° C	TESTS & INSPECTION	81.	
	71.	LEAVING DRY BULB TEMPERATURE: (AS PER AHU TABLE) ° C		82.	
	72.	LEAVING WET BULB TEMPERATURE: (AS PER AHU TABLE) ° C		83.	
	73.	CHILLED WATER / BRINE FLOW: (AS PER AHU TABLE) CMH		84.	
	74.	CHILLED WATER / BRINE INLET TEMPERATURE: ° C			
	75.	CHILLED WATER / BRINE OUTLET TEMPERATURE: ° C			
	76.	NOISE LEVEL AT ADISTANCE OF 1.5 METRES: 65 dB(A)			

AHU DETAILS:

Sl. No	AHU for	Tag Nos.	Qty	Cooling Capacity	Entering Air temperature		Leaving Air temperature		Fan capacity	Fan Static Pressure
					DBT	WBT	DBT	WBT		
		811-AHU-	Nos	TR	°F	°F	°F	°F	CFM	mm WC
1	ELECTRONIC ASSEMBLY / CLEAN ROOM	G01	2	8.5	BIDDER TO SPECIFY				11000	125

5.8 CONDENSING UNITS FOR AIR-CONDITIONING APPLICATION

5.8.1 SCOPE

This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at manufacturer's works, delivery at site, handling at site, installation, testing, commissioning and carrying out performance test at site and handing over of Condensing Units of capacities 5 TR to 100 TR used for Air Conditioning application . Type of refrigerant shall be R 22 or R 134a.

5.8.2 CODES AND STANDARDS

The design, materials, manufacture, inspection, testing and performance of Condensing Units shall comply with all currently applicable statutes, regulations, safety codes and standards in the locality where the equipment is to be installed. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility. In particular, the Condensing Units shall conform to the latest edition of the following standards:

ASHRAE 15	Safety Code for Mechanical Refrigeration
ASHRAE 23	Methods of Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units
ANSI B 31.5	Code for Refrigeration Piping
ARI 575	Standard for Method of Measuring Machinery Sound within an Equipment Space
ISO 1940	Mechanical Vibration - Balance Quality Requirements of Rigid Rotors

5.8.3 CONSTRUCTION FEATURES

5.8.3.1 COMPRESSOR

The compressor shall be either hermetic / semi hermetic reciprocating, screw or scroll type as specified in data sheet A and shall be mounted on vibration isolators. Necessary crankcase heaters shall be provided in the compressor for capacities exceeding 10 TR.

5.8.3.2 CONDENSER

Water Cooled Condenser shall be of shell & tube type with carbon steel shell and integrally finned copper tubes as per TEMA-B.

Air Cooled Condenser shall be with copper tubes and aluminium fins with low noise fans. Speed of the fans shall not exceed 960 RPM for fans with impeller diameter above 450 mm & 1440 RPM for fans with impeller diameter 450 mm and less. The impeller shall be statically and dynamically balanced. The air cooled condenser motor shall have IP:55 or better protection.

5.8.4 REFRIGERATION PIPING AND CONTROLS

5.8.4.1 The refrigeration piping shall be complete with liquid line strainer, dehydrator, sight glass, liquid line shut-off valve, pilot solenoid valve and thermostatic expansion valve.

5.8.4.2 For refrigerants R 22 and R 134a, copper tubes conforming to IS:10773 shall be used. Fittings, flanges and pipe joints shall conform to the requirements of ANSI B 31.5.

5.8.4.3 Piping shall be designed for not less than the internal pressure given in the table.

REFRIGERANT NUMBER	REFRIGERANT NAME	MINIMUM INTERNAL DESIGN PRESSURE		
		HIGH PRESSURE SIDE (Kg/cm ² g)		LOW PRESSURE SIDE (Kg/cm ² g)
		WATER COOLED	AIR COOLED	
R 22	Monochloro difluoro methane	20	25	13/full vacuum
R 134a	Tetrafluoro ethane	13.5	17.5	8.55/full vacuum

5.8.4.4 Test pressure for piping shall be 1.1 times of design pressure. The pressure shall be gradually increased until a gauge pressure which is the lesser of one-half of the test pressure or 1.75 Kg/cm²g is attained and preliminary leak checks shall be carried out. Thereafter, the pressure shall be gradually increased in steps until the test pressure is reached. The pressure shall then be reduced to the design pressure and leakage examination shall be made. The design pressure shall be maintained for 48 to 72 hours. A pressure relief valve/device shall be provided on test pressure line having a set pressure slightly above the test pressure. Nitrogen shall be used as test medium. Oxygen or any combustible mixture

of gases shall not be used within the piping for testing. Water or water solutions shall not be used as a test medium.

5.8.4.5 Vacuum testing shall be done for medium vacuum of around 40 mm Hg absolute and held with vacuum pump in operation for at least 4 hours. Thereafter unit shall be sealed and vacuum held for at least 12 hours. Vacuum break shall be done using refrigerant and pressure raised to standing pressure in refrigerant cylinder.

5.8.4.6 Provision for interlock in the control panel shall be provided such that compressor can start only after starting the air handling fan of evaporator unit. Provision shall also be made to interlock the compressor with condenser water circulation pump or the air cooled condenser fan motor / air flow switch. Safety devices such as high/low pressure (HP/LP) cut out, hermetic motor winding thermostat etc. shall be provided. HP cut out shall be manual reset type while LP cut out shall be auto reset type.

5.8.4.7 The water cooled unit shall be factory piped with adequate charge of refrigerant and oil. The refrigerant piping and refrigerant charging for air cooled units shall be carried out at site. Refrigerant and oil shall be supplied along with the unit till the unit is handed over to the PURCHASER.

5.8.5 **ELECTRICAL**

5.8.5.1 A terminal box suitable for connecting external 3 phase, 4 wire cable shall be provided.

5.8.5.2 The unit shall be provided with single phase preventer.

5.8.5.3 The control panel shall be complete with starters for compressor and condenser fan/pump motors and shall be prewired.

5.8.5.4 The wiring between the Condensing Unit and Indoor Unit shall be carried out at site.

5.8.5.5 Control panel shall be suitable for ambient temperature of 50°C.

5.8.6 **PAINTING**

As the Condensing Units (CNU) are normally located outside, painting used shall be of corrosion resistant type and shall be as per manufacturer's standards.

5.8.7 **GENERAL**

5.8.7.1 The compressor and condenser of the condensing unit shall have a common base frame.

5.8.7.2 The condensing unit shall be mounted on suitable vibration isolators.

5.8.8 **PERFORMANCE GUARANTEES**

Performance parameters to be guaranteed by the Contractor and tolerances permitted shall be as indicated in Section C and/or Data Sheet - A. The Bidder shall confirm acceptance of these by indicating values in Data Sheet - B. Condensing Units or any portion thereof is liable for rejection, if it fails to give any of the guaranteed performance parameters.

DATA SHEET - A

SL. NO.	ITEM					
1.	DESIGNATION					
2.	NUMBERS OFFERED		2NOS			
3.	TAG NUMBERS					
4.	MAKE /MODEL NUMBER					
5.	PLACE OF MANUFACTURE					
6.	NOMINAL CAPACITY OF EACH CONDENSING					
	UNIT(CNU)	TR	8.5			
7.	CAPACITY OF EACH CNU AT SPECIFIED DESIGN CONDITION	TR	8.5			
8.	REFRIGERANT		R 134a			
9.	OVERALL SIZE OF EACH CNU L x D x H	mm	x x			
10.	CLEARANCE REQUIRED ON ALL SIDES OF EACH CNU	mm	FRONT	BACK	SIDES	TOP
11.	OPERATING WEIGHT	Kg				
12.	NOISE LEVEL AT 1.86 M DISTANCE :					
12.1	COMPRESSOR	dBA				
12.2	CONDENSER FAN(IF AIR COOLED)	dBA				
13.	NUMBER OF REFRIGERATION CIRCUITS/ CNU	Nos.				
14.	TOTAL INPUT POWER AT SPECIFIED DESIGN					
	CONDITIONS PER CNU	kW				
15.	TYPE OF VIBRATION ISOLATORS					
16.	TYPE , MAKE AND MODEL NUMBER					
17.	NUMBER OF COMPRESSORS PER CNU	Nos.	1 NO			
18.	PLACE OF MANUFACTURE					
19.	SUCTION TEMPERATURE	°C				
20.	SUCTION PRESSURE	Kg/cm ² g				
21.	CONDENSING TEMPERATURE	°C	AMBIENT			

COMPRESSOR (CONTD.)	22.	CONDENSING PRESSURE	Kg/cm ² g	
	23.	OPERATING SPEED AT SPECIFIED DESIGN CONDITION	RPM	
	24.	CAPACITY AT SPECIFIED DESIGN CONDITION PER COMPRESSOR	TR	
	25.	BKW AT SPECIFIED DESIGN CONDITION PER COMPRESSOR	BKW	
	26.	MOTOR RATING PER COMPRESSOR	kW	
	27.	CAPACITY CONTROL AVAILABLE		YES / NO
	28.	IN STEPS OF		
CONDENSER	29.	TYPE , MAKE AND MODEL NUMBER		
	30.	WATER COOLED CONDENSER		
	30.1	NUMBER OF CONDENSERS PER CNU	Nos.	
	30.2	HEAT REJECTION CAPACITY AT SPECIFIED DESIGN CONDITIONS PER CONDENSER	KCal/Hr	
	30.3	TOTAL HEAT REJECTION CAPACITY AT SPECIFIED DESIGN CONDITIONS PER CNU	KCal/Hr	
	30.4	CONDENSER COOLING WATER FOULING FACTOR	HR.SQ FT ⁰ F/ BTU	
	30.5	COOLING WATER FLOW RATE/ CONDENSER	M ³ /Hr	
	30.6	COOLING WATER INLET TEMPERATURE	⁰ C	
	30.7	COOLING WATER OUTLET TEMPERATURE	⁰ C	
	30.8	WATER VELOCITY IN TUBES	M/Sec	
	30.9	WATER SIDE PRESSURE DROP	Kg/cm ²	
	31.	AIR COOLED CONDENSER		
	31.1	NUMBER OF CONDENSERS PER CNU	Nos.	
	31.2	HEAT REJECTION CAPACITY AT SPECIFIED	KCal/Hr	
		DESIGN CONDITIONS PER CONDENSER		
	31.3	TOTAL HEAT REJECTION CAPACITY AT SPECIFIED DESIGN CONDITIONS PER CNU	KCal/Hr	

	31.4	MAXIMUM PERMISSIBLE DISTANCE BETWEEN CNU AND INDOOR UNIT	M	VERTICAL	TOTAL
	31.5	CONDENSER FANS			
	31.5.1	NUMBERS IN EACH CONDENSER			
	31.5.2	CAPACITY OF EACH FAN	M ³ /Hr		
	31.5.3	STATIC PRESSURE	mmWC		
	31.5.4	IMPELLER MATERIAL			
	31.5.5	BRAKE POWER OF EACH FAN	kW		
	31.5.6	INPUT POWER OF EACH FAN	kW		
	31.5.7	MOTOR RATING OF EACH FAN	kW		
MAKE OF ACCESSORIES	32.	HIGH AND LOW PRESSURE CUT OUTS			
	33.	THERMOSTAT			
	34.	SOLENIOD VALVE			
	35.	SINGLE PHASE PREVENTOR			
	36.	STARTERS			
	37.	VIBRATION ISOLATORS			
	38.	CONTROL PANEL			
PERFORMANCE GUARANTEE	39.	CAPACITY OF EACH CNU AT DESIGN CONDITIONS	TR		
	40.	TOTAL POWER INPUT AT DESIGN CONDITIONS	kW		
	41.	NOISE LEVEL AT 1.86 M DISTANCE FROM CNU	dBA		
GENERAL	42.	CONFIRM THAT UNITS CAN BE INSTALLED,			
		OPERATED AND SERVICED IN AVAILABLE			
		PLANT ROOM SPACE		YES/NO	
	43.	CONFIRM THAT UNITS ARE SUITABLE FOR			
		SPECIFICIED VOLTAGE AND FREQUENCY		YES/NO	
	44.	PERFORMANCE CURVE/RATING CHARTS			
		ENCLOSED.		YES/NO	

5.9 APPROVED MAKE LIST OF HVAC EQUIPMENTS

NOTE:

- All materials and products shall conform to the relevant standards and shall be of approved make and design. A list of manufacturers/ vendors is given separately herein below for guidance. The Engineer shall give the approval of a manufacturer/ vendor/ only after review of the sample/ specimen. In case the same is not available in the market or in case of change in trade name, equivalent makes/ re-designated manufacturer then an equivalent approved make shall be used with the approval of Employer/ Engineer. The complete system and installation shall also be in conformity with applicable Codes & Standards and Tender specifications.
- Only “First” class quality materials shall be used.
- Employer reserves the right to choose any of the approved make / vendors as per this list.
- In case of products not indicated in this list, bis marked products shall be preferred.
- Specification of manufacturer’s item shall be checked against tender item / specifications before selecting any product or brand name. In case of any discrepancy, tender item/ specifications shall prevail, and any such brand of item shall not be used which is not conforming to tender specifications even if it is listed in this list.
- For use of material from a bis listed/ certified manufacturer, the contractor shall furnish a copy of the BIS certificate to Employer before procuring the material.
- In case non-availability of any item/ material among approved manufacturers/ brands at a particular site/ region, alternate manufacturers/ brands conforming to BIS/ BS etc. shall be used subject to approval by Employer.
- In case of non-availability of any manufacturer among approved manufacturers at a particular site/ region, alternate manufacturer’s name shall be proposed along-with required credentials for Employer’s approval.
- In case of any item/ product neither covered in this list nor having A BIS specifications, the contractor shall submit the proposed item/ product along-with technical details/ specifications (as per bid), test certificates etc. And other credentials of the manufacturer for Employers approval.

LIST OF APPROVED MAKES FOR PRODUCTS AND MATERIALS FOR HVAC WORKS ARE INDICATED IN THE TABLE BELOW. HOWEVER, ANY OTHER MAKE WHICH IS EQUIVALENT AND MEETING THE TENDER SPECIFICATIONS ARE ALSO ACCEPTABLE WITH PRIOR APPROVAL OF THE ENGINEER

S.No.	Details of Materials / Equipment	Manufacturer
1	Variable Refrigerant Flow System	Daikin
		Hitachi
		LG
		O General
		Daikin
		Mitsubishi
		Sanyo
		Toshiba
		Voltas
		Blue Star
		Carrier
2	Air Handling Unit	Carrier
		Ciat
		Climaveneta
		Euroclima
		Novair
		Saiver
		Trane
		VTs
		Blue Star
		Carrier
		Citizen
		Edgetech
		ETA
		ETHOS
		Flaktwoods
		Nutech
		Suvidha – Saiver
		Voltas
		Zeco
3	Split Unit	O General
		Daikin
		Hitachi
		Blue Star
		Carrier
		ETA
		Voltas

4	Ductable Split Unit (with Refrigerant R-410A/R-407c)	Toshiba
		Trane
		York
		O General
		Blue Star
		Carrier
		ETA
		Voltas
5	Centrifugal Fan	Chaysol
		Comefri
		Flaktwoods
		Greenheck
		Wolter
		Blowtech
		Nadi
		Nicotra
		Kruger
		Humidin
6	Plug fans	Kruger
		Greenheck
		Wolter
7	Axial Flow Fan	Greenheck
		Nicotra
		Nuaire
		Systemair
		Wolter
		Air flow
		Humidin
		Kruger
		Nadi
		Nicotra
8	Inline / Propeller Fan / Roof extractor Fan	Chaysol
		Nuaire
		Ostberg
		Systemair
		Air flow
		Alstom
		Nadi
9	Air washer (Wetting Pad type / Nozzle type scrubber)	Ambassador
		Emerald
		Humidin
		Roots Air
		Roots Cooling

		Weather Master
10	Kitchen Scrubber (Dry Type)	Flanders Air seal
		Trion
11	GI Sheet	ESSAR
		Jindal
		Lloyd
		SAIL
		TATA
12	Factory Made Duct	Alpha duct
		Ductofab
		Nuaire Engineers
		Radiant air systems
		Rolastar
		Seven star
		Techno Aircon
		Zeco
13	Factory Made Spiral Duct	Atco
		Karthila Industries
		Seven Star
		Spiral Tubes Pvt. Ltd.
		Western Air Duct
14	Flexible duct	Atco
		Caryaire
		Seven star
		UP Twiga
15	Pre-insulated duct	ALP
		Nutech
		Radiant air systems
16	Pre-insulated Pipe	Perma pipe
		Seven Star
17	Passivation system for hydraulic systems (CHW/CDW/Hot water)	Western Air Duct
		Biocide
		Chemtex
18	Grille/diffuser/dampers	Airflow
		Air Master
		Caryaire
		Cosmic

		Cosmos
		Dynacraft
		Ravistar
19	Smoke / Fire Damper (Actuator shall be UL listed)	Greenheck
		Ruskin
		Airmaster
		Caryaire
		Cosmic
		George Rao
		Ravistar(Systemair)
20	Sound Attenuator	Greenheck
		Systemair
		Trox
		Caryaire
		George Rao
		Ravistar (Systemair)
		Unifair
21	Anchor Fastener	Fischer
		Hilti
		Power Fastener
22	Insulation	
22.1	Closed Cell Elastomeric nitrile rubber/EPDM along with adhesive	Eurobatex – Union Foam
		Aeroflex
		A flex
		Armacell
22.2	Microban Closed Cell Elastomeric nitrile rubber along with adhesive	A flex
		Armacell
22.3	Cross link polyethylene foam with adhesive	Trocellen
22.4	Fibreglass (Al. Foil Faced)	Kimmco
		Owens Corning
		Lloyd insulation
		UP Twiga
23	Acoustic insulation	
	a. Fibre glass	Kimmco
		Owens Corning
	b. Nitrile rubber with Antimicrobial property	Armacell - Armasound
		Lloyd insulation

		UP Twiga
		A Flex
		Armacell - Armasound
24	Expanded Polystyrene (TF Quality)	Beardsell
		Coolite
		Styrene Packaging
		Tosiba
25	Humidistat	Honeywell
		Invensys
		Johnson Control
		Sauter
		Siemens
26	Vibration Isolator	Cori
		Flexionics
		Kanwal Industrial Corporation
		Resistoflex
27	Flexible Pipe Connection	Mason
		Weico
28	Plug fans	Kruger
		Greenheck
		Wolter
29	HDPE Tanks	Sintax
		Local approval

TECHNICAL SPECIFICATION
COMPRESSOR WORKS

COMPRESSOR WORKS

6.1 SCOPE OF SUPPLY

6.1.1 INTRODUCTION

This section covers the requirements for compressed air generation facilities to be supplied at technical centre at Bangaluru. This system package shall be modularised / pre-assembled as much as possible, aiming for the shortest construction period.

6.1.2 EQUIPMENT AND SERVICES TO BE PROVIDED BY CONTRACTOR

The equipment to be supplied and erected under this specification are shown in the flow diagram enclosed with this specification, as detailed in section Schedule of quantities and these shall be in accordance relevant Data sheet A of this section. Any item which may not have been specifically mentioned herein but are needed to complete the equipment / system shall also be treated as included and the same shall also be furnished and erected, unless otherwise specifically excluded as indicated.

6.1.3 ENGINEERING / DESIGN

- a) Supply of engineering information for interface points with other piping.
- b) Operation philosophy and control logic for instrumentation and controls.
- c) General arrangement and equipment layout drawings of compressors, receiver and air drying plant in compressor room.
- d) P&ID of compressor system.

6.1.4 SUPPLY ALL MATERIALS TO SITE INCLUDING, BUT NOT LIMITED TO

- a) One nos (1W) motor driven, lubricated air cooled screw compressor inbuilt with refrigerant type dryer, capable of delivering 70CFM (FAD) each at a discharge pressure of 8.5 Kg/cm² (g) with associated accessories as per enclosed datasheets.

- b) One set of filters consisting of pre-filter and fine filter to restrict oil carry over to 1 mg/m³. Differential pressure gauge with root isolation valve shall be provided at appropriate locations.
- c) One no. Vertical air receiver as per enclosed datasheet with all accessories having capacity of 1 M³. Receiver shall be provided with two (2) suitably sized safety valves to relieve the full compressor discharge capacity and shall be set at a pressure 1.25 times the operating pressure. Receivers shall be provided with one no. pressure indicator and auto drain trap assembly.
- d) All instruments for the compressor as indicated (but not limited to) in attached flow diagram & data sheets required for proper operation & monitoring of the compressor along with all instrument impulse piping, fittings and erection hardware.
- e) Completely wired microprocessor based panel along with operator interface unit with LCD screen with push buttons for compressor operation and all necessary accessories shall be supplied fully wired for each compressor for load-un-load / start-stop & other controls for the compressor along with complete earthing.
- f) All instruments for the air dryer required for proper operation & monitoring of the air dryer along with all instrument impulse piping, fittings and erection hardware.
- g) Completely wired skid mounted microprocessor based panel for the air dryer for operation and monitoring along with complete earthing.
- h) Control and instrumentation cables for connection between instrument / equipment/ MCC and the control panels for the compressor & air dryer along with all cable trays, conduits, glands, termination accessories etc..
- i) One lot of base plates, foundation bolts, nuts and washers etc. required for each equipment
- j) Counter flanges with bolts, nuts, washers and gaskets for all equipment at all terminal points of equipment covered under Contractor's scope of supply.
- k) First fill of all lubricants and consumables
- l) One set of commissioning and start – up spares. (Price for the same shall be included in the total quoted price only).

- m) One set of recommended spares for 2 years of trouble free operation. (Contractor shall list the recommended spares and furnish the unit rates separately)
- n) One set of recommended maintenance tools and tackles. (Contractor shall list the same and furnish the unit rates separately)
- o) Painting
- p) Installation, operation and maintenance manual for the complete system

6.1.5 OTHER SERVICES BY CONTRACTOR

- a) Necessary in-house Inspection
- b) Supervision of Erection
- c) Erection, Testing, Commissioning and Start-up at site
- d) Performance Testing of Equipment
- e) Training of Employer's personnel
- f) Documentation.

6.1.6 EQUIPMENT & SERVICES TO BE PROVIDED BY CONTRACTOR.

The following are the equipment and services that shall be provided contractor:

- a) Supply & laying of power cable up to the vendor panel shall be done by electrical works contractor.
- b) Earthing pits and the earthing cables from the compressor control skid /dryer control panel to the earthing pits.
- c) All inter-connecting piping with valves, fitting & specialities, as indicated on flow diagram TCE.10106A-6047-PI-60684.
- d) Civil construction, buildings, equipment foundations by civil contractor.
- e) Electrical trenches and drain by civil contractor.

6.2 CODES AND STANDARDS

All equipment, systems and works covered under this specification shall comply with all currently applicable statutes, regulations, standards and safety codes in the locality where the equipment will be installed. All equipment and systems shall comply in all respects with requirements of latest editions of codes and standards as indicated in this specification.

In the event of any conflict between the codes and standards referred to in the specification and the requirements of this specification, the more stringent of this requirement shall govern.

- a) ASME SEC. VIII DIV.1-2015 - Boiler and Pressure Vessel Code
- b) IS 5456:2006 Code of Practice for Testing of Positive Displacement Type Air Compressors and Exhausters
- c) IS 6206:2012 Guide for Selection, Installation and Maintenance of Air Compressor Plants with Operating Pressures up to 10 bar (g)
- d) IS 7938:1976 Air Receivers for Compressed Air Installation
- e) IS 11780:1986 Code for Selection and Testing of Rotary Screw Air Compressors (Oil Flooded)
- f) ISO 8573:1: 2001 Compressed Air Contaminants and purity classes

6.3 SPECIFIC REQUIREMENTS / INSTRUCTION TO CONTRACTOR

- 6.3.1 All equipment supplied shall have capacities not less than those specified in the in the specification and necessary test certificates shall be furnished in this regard. However, if the CONTRACTOR feels that higher capacity equipment is required meet guarantee requirements, he should offer the same and substantiate the same by calculations.
- 6.3.2 Any conflict between the requirements of this section and related specification, codes, standards and other documents, shall be referred to Project Manager's for clarification.
- 6.3.3 Fabrication of package unit equipment shall be executed in a controlled manner. This means that all executed checks, tests and inspections are documented in the manufacturing report
- 6.3.4 Equipment design shall be aimed at maximum standardization of components and subassemblies to ensure lowest possible inventory of replacement of parts.
- 6.3.5 The equipment within the package unit shall be easily accessible for operation and maintenance.
- 6.3.6 The motor rating indicated in the bid shall be final and the CONTRACTOR is not permitted to change this after the award of contract.

- 6.3.7 If required, vibration isolators, mounting / installation structural frames for all equipment shall be part of the CONTRACTOR's scope of work.
- 6.3.8 The CONTRACTOR shall quote unit rates for each type of equipment viz. Compressors, dryers and receivers etc. so that if Employer desires to add or delete the same from CONTRACTOR's scope of work, then the total price shall be adjusted based on the unit rates furnished by the CONTRACTOR.
- 6.3.9 One compressors (1W+0S) of 70 CFM(FAD) capacity each are in operation at present.
- 6.3.10 The scope of work shall also include guarantee for trouble free operation of the complete system and equipment/accessories therein for a period of 18 months from the date of supply at site OR 12 months from date of successful commissioning of the system, whichever is earlier.
- 6.3.11 This guarantee shall also include overall performance guarantee of the entire` system to achieve design conditions stated in specification along with all necessary safety and statutory requirements.
- 6.3.12 During the guarantee period the CONTRACTOR shall rectify free of cost of all defects which may develop due to faulty design, material, construction and workmanship inclusive of free replacement of defective parts.
- 6.3.13 During the guarantee period the parts of the equipment requiring repairs or replacement shall be fitted at site by the CONTRACTOR such that the functioning of the system is not compromised for any reason whatsoever.
- 6.3.14 All expenses involved in fulfilling the above guarantee obligations like replacement of spares, consumables, deputation of service experts, their travel/lodging/boarding shall be borne by the CONTRACTOR.
- 6.3.15 Damages occurred to ceiling/floors/walls or any other parts of the building construction/maintenance shall be made good free of cost with approved fire rated materials failing which, the cost shall be debited to the CONTRACTOR.

6.4 SPECIFIC ELECTRICAL REQUIREMENT

- 6.4.1 Electric supply for motors covered under this package shall be made at 415 V, 3 phase by EMPLOYER.
- 6.4.2 CONTRACTOR shall carryout all interconnecting control cabling inside the compressed air system panel. Necessary cable conduits / trays shall be provided by CONTRACTOR.
- 6.4.3 Control cables shall be stranded copper conductor PVC insulated and extruded PVC inner sheathed, galvanised steel stripwire armoured overall extruded PVC outer sheathed conforming to latest IS.
- 6.4.4 Employer will provide only power supply (415 V, 3 Ph) at one point. Further distribution to each panel / motor shall be by CONTRACTOR. Any further stepping down of supply shall be done by CONTRACTOR inside the control panel.
- 6.4.5 CONTRACTOR to include supply and installation of Star-Delta feeder for the compressor in the compressor panel.
- 6.4.6 The Star-Delta feeder shall include the starter, over-load relay, CTs ammeter and all necessary auxiliary relays, controls and on/off/trip indications on the panel.
- 6.4.7 Earthing for all equipment shall be by EMPLOYER.

6.5 SPECIFIC REQUIREMENT OF I & C SYSTEM

6.5.1 This specification shall be read in conjunction with the data sheets, enclosed as part of of this Section.

6.5.2 I&C SYSTEM FOR COMPRESSOR

6.5.2.1 The Air Compressor Package Unit shall be supplied complete with all instruments and control equipment/systems, both field and panel mounted. It shall include but not be limited to the following :

- (a) Pressure indicators as per data sheet for :
 - i. Discharge of each compressor
 - ii. Each air receiver pressure
 - iii. Lube oil pressure
- (b) Pressure Switches as per data sheet for Lube oil pressure low.
- (c) Pressure transmitter as per data sheet for Pressure transmitter on each air receiver for:
 - i. Air receiver pressure high & low alarms
 - ii. Loading/unloading of each air compressor
 - iii. Auto start/stop action of each compressor
- (d) Thermometers as per data sheet or :
 - i. Air temperature for inter stage of each compressor (where multistage compressors are required).
 - ii. Air temperature at the discharge of each compressor.
 - iii. Air temperature in outlet of the dryer
- (e) Temperature Switches as per data sheet No. for :
 - i. Air temperature at discharge of each compressor high
 - ii. Air temperature after cooler high
 - iii. Lube oil temperature high
- (f) Safety Relief valves as per data sheet for air receiver pressure very high.

6.5.2.2 Control Panel

Microprocessor based control panel shall be provided for compressor. It shall be provided with operator interface unit (OIU) with 4 line LCD display. It shall display all the process parameters and alarms on the screen. Alarms shall be provided with audible and visual

indication. Push button shall be provided for start/stop operation of the dryer. All logic and interlocks for sequential operations shall be programmed in the controller unit.

The panel shall be prefabricated type with enclosure protection of IP 52 as per IS 13947. The panel shall be made of CRCA cold rolled sheet of 2mm thickness. The panel shall be painted with exterior colour 631 of IS-5 & interior paint shall be glossy white. 3 pin receptacle for 230 V AC, 1P, 50 Hz shall be provided inside the panel. All internal wiring shall be carried out with 1100V grade, stranded tinned copper conductors with PVC insulation. The panel shall be provided with a proper earthing bus made of copper securely fixed along the inside base of the panels. This bus shall be typically of 25 mm wide and 6 mm thick of copper.

- (a) Each compressor unit shall be provided with necessary controllers for the safe & reliable operation of the compressor.
- (b) A two position selector switch shall be provided on the control panel for selection of the compressor AUTO/MANUAL
- (c) Each compressor panel shall be provided with a three position selector switch marked Auto-Off-On for the following functions :
 - i. Auto - The compressor shall be selected as 'Working' in load / unload mode.
 - ii. Off Stops the respective motor.
 - iii. On For manual start of the respective compressor by push buttons with load / unload regulation.
- (d) Pushbuttons shall be provided on the front facia of the control panel for manual start/stop operation of the compressor. An emergency stop pushbuttons shall also be provided.
- (e) One potential free contact will be made available at the terminals of the each compressor control panel for remote alarm under trip condition.
- (f) The control system shall permit operation of each compressor in either of the following two regulations:

- i. Continuous Run-Load-Unload Regulation.
 - ii. Automatic Start-Stop Regulation.
- (g) Under continuous Run-Load-Unload Regulation, the drive motor shall run continuously while the compressor shall be loaded at pre-set (adjustable) cut-in pressure as the receiver pressure falls and unloaded at a higher pre-set (adjustable) cut-out pressure, as the receiver pressure rises. With automatic Start-Stop Regulation, the drive motor shall automatically start at pre-set (adjustable) cut-in pressure as the receiver pressure falls and automatically stop at a pre-set (adjustable) higher cut-out pressure as the receiver pressure rises.
- (h) With either system, the compressor shall always be unloaded when the drive motor starts. The unloaders shall keep the compressor unloaded till the drive motor comes to full speed.
- (i) Following are the minimum alarm annunciation required to be provided on the operator interface unit screen. In addition to the alarms mentioned below vendor shall provide the necessary alarms for safe operation of compressors:
- i. Tripping of individual air compressors
 - ii. Each air receiver pressure high
 - iii. Each air receiver pressure low
 - iv. Lube oil pressure low
 - v. Air temperature at discharge of inter stage of each compressor high
 - vi. Air temperature at discharge of each compressor high
 - vii. Air temperature after each after cooler high
 - viii. Lube oil temperature high
- (j) 1 no. of hooter shall be provided on the panel for the sound identification of the Alarm condition. Facility for the Test / Acknowledge / Reset for Alarms shall be provided on the PLC panel.
- (k) All inter cubical and internal wiring for the panel shall be carried out with 1100V grade, stranded tinned copper conductors with PVC insulation.

6.5.2.3 The panel shall be provided with a proper earthing bus made of copper securely fixed along the inside base of the panels. These buses shall be typically of 25 mm wide and 6 mm thick of copper.

6.5.2.4 Operator Interface Unit

Unless otherwise specified all set points, control parameters, alarm limits and timers shall be adjustable through the Operator Interface Unit (OIU) with suitable password protection.

- (a) It shall also provide following facilities:
 - i. Selection of particular control sequences and actions
 - ii. Display and acknowledgement of alarms with an alarm log giving individual status.
 - iii. Provide data storage
 - iv. Provide data downloading facility
- (b) Alarms shall be raised on the OIU as described above.

6.5.2.5 INSTRUMENT POWER SUPPLY

The power supply made available for instrumentation system for both compressor shall be 230V AC. Converters or power supply units required to derive the necessary operating voltages other than 230V AC for the instrumentation system shall be in the scope of contractor. MCBs shall be provided in the panel for each power supply distribution feeder to field & panel mounted instruments and PLC.

6.5.2.6 CABLES

Cabling from control panels to electrical panel and cabling between instruments & panels supplied by the Contractor shall be by Contractor. Necessary cable trays, conduits shall be provided by contractor. The specifications for the cables shall be as per data sheet.

6.5.2.7 INSTALLATION & COMMISSIONING

CONTRACTOR's scope of work includes, erection of instruments and control panel, instrument cabling, loop checking and commissioning. All instruments shall be erected in such a manner that they are easily read and maintenance can be carried out easily without shutting down the plant. Prior to guarantee run of the plant, all the instruments shall be recalibrated and the results shall be recorded. Erection of instruments shall be carried out as

per the CONTRACTOR's instrument installation drawings after getting Project Manager's / Employer's approval.

6.5.2.8 TESTING & INSPECTION

All the instruments & panels shall be tested and calibrated at manufacturer's works in an approved manner. Inspection shall be carried out in the presence of Employer's inspector. All test certificates for testing instruments shall have calibration certificates from approved test house, valid for minimum 6 months.

6.6 **GUARANTEES AND PERFORMANCE REQUIREMENT**

6.6.1 GENERAL

The compressed air system shall perform satisfactorily to meet the guarantee requirements specified to the entire satisfaction of the EMPLOYER / ENGINEER.

6.6.2 COMPRESSED AIR SYSTEM

- i. The CONTRACTOR shall guarantee the capacities of various equipment as specified in this section and schedule of quantities.
- ii. Allowable tolerances on capacity (FAD) of compressors: (-) Zero
(+) Anything
- iii. Allowable tolerances on discharge pressure at compressor outlet: (+) 0.5 bar
(-) Zero
- iv. Allowable tolerances on dew point temperature at atmospheric pressure of compressed air at battery limit shall be: (-) Anything, (+) Zero
- v. Allowable noise level measured at a distance of 1.5 metres from the source in any direction: (+) Zero, (-) Anything
- vi. The above allowable tolerance requirements are excluding instrument tolerances.

6.6.3 POWER CONSUMPTION

- Tolerance on Power consumption: (+) Zero
(-) Anything

6.7 ACCEPTANCE TEST

- 6.7.1 After the entire installation work has been completed, the CONTRACTOR shall make all required adjustments until all guaranteed performance requirements are met. All instruments, services required for the above tests shall be furnished by the CONTRACTOR. The test reports shall be handed over for EMPLOYER's approval before handing over the plant.
- 6.7.2 If the stipulated performance requirements are not fulfilled, the CONTRACTOR shall make good the deficiency by providing it in every case, by altering and/ or replacing the parts or the whole equipment / system free of charge to the EMPLOYER immediately. All rejected equipment shall be removed from the site at CONTRACTOR's expense.

6.8 PAINTING

All the non-insulated exposed carbon steel surfaces of equipment and piping shall be painted as indicated below:

- 6.8.1 Surface preparation – Removal of dust, dirt, oil, grease, scale and other foreign material by manual or power tools.
- 6.8.2 Primer – 2 coat of red oxide primer (conforming to IS: 2074) with minimum dry film thickness (DFT) 25 microns per coat.
- 6.8.3 Finish – 2 coat of synthetic enamel (conforming to IS: 2932) with minimum dry film thickness (DFT) 25 microns per coat.

6.9 TENDER EVALUATION AND PENALTY FACTOR

- 6.9.1 Tender Evaluation
- a) The CONTRACTOR shall comply with all systems / parameters wherever they are specified in specification and in data sheets A . Evaluation factor as indicated in para below for power consumption shall apply. The evaluation factor shall be applicable to the differential power consumption of all installed equipment, calculated with the lowest quoted parameter as the base. The CONTRACTOR shall indicate under section schedule of quantities the guaranteed power consumption for each equipment separately.
- b) Deviation from the specifications, if acceptable to the EMPLOYER insofar as practicable will be converted to rupee value and added to the bid price to compensate for the deviation from the specification. In determining the rupee value of the deviations, the EMPLOYER will use the parameters consistent with those specific in the documents and specifications and other information as necessary and available to the EMPLOYER.

6.10 MAINTENANCE REQUIREMENTS

- 6.10.1 In order to carry out preventive maintenance, it should be possible to readily disassemble, repair, re-assemble the equipment in the shortest period and to attend to any defect by a minimum disassembly.
- 6.10.2 The CONTRACTOR shall furnish one complete set of any special maintenance tools required for normal maintenance of equipment. The prices for the same shall be indicated in– Schedule of prices and delivery.
- 6.10.3 The CONTRACTOR shall confirm that space shown for the equipment is adequate from point of view of access, easy maintenance and for day to day operation.
- 6.10.4 All system must have convenient maintenance characteristics including :
- Minimum disturbance to production during preventive maintenance.
 - Easy access to replacement part which can be installed by personnel with minimum skill.

6.11 SUMMARY OF DATA TO BE FURNISHED ALONG WITH BID AND AFTER ACCEPTANCE OF PURCHASE ORDER

The CONTRACTOR shall ensure the following documentation are prepared and submitted to EMPLOYER for his review / record.

6.11.1 ALONG WITH BID

<u>Sl. No.</u>	<u>Details</u>
1.0	Description of the systems offered along with catalogues, leaflets, drawings, etc.
2.0	All data sheet B of the tender specification, duly filled in.
3.0	Confirmation on layout drawing enclosed for locations of equipment & provision of space for operation & maintenance.
4.0	Performance curves / rating charts used for selection of equipment for all the systems shall be furnished along with the bid, with the duty points duly marked on them.
5.0	Bar chart schedule indicating the date of completion of various activities so as to complete the contract within

<u>Sl. No.</u>	<u>Details</u>
	the time frame stipulated in the tender specification.
6.0	All section Schedule of quantities duly filled in.
7.0	Electrical load list indicating rating and quantity.

6.11.2 After Award of Contract

<u>Sl. No.</u>	<u>Details</u>
1.0	Instrument list with tag numbers, Makes and Model nos., Service, Type of instrument
2.0	Data sheets & catalogues for instruments & cables.
3.0	Following drawings for Control Panels for both compressor & air dryer:
	i. Drawings and data sheets for all equipment as listed in various data sheet enclosed with specification.
	ii. Front facia layout of showing all instruments with cut-outs, bezel dimensions, construction details, foundation details, interior G.A. drawings
	iii. Internal wiring diagrams indicating termination details of each component
	iv. Bill of Material (B.O.M) indicating tag No., quantity, service & model no. of each controller/PLC module/instrument/item.
4.0	Catalogues for PLC system and Operator Interface Units
5.0	Writeup on the controls provided for the compressor & dryer
6.0	List of annunciation
7.0	QAP for all the items.

<u>Sl. No.</u>	<u>Details</u>
8.0	‘As Built’ drawings
9.0	Instruction manual for installation and start-up.

6.11.3 FINAL DOCUMENTS

6.11.3.1 CONTRACTOR shall submit the copies of operation and maintenance manuals well before the despatch of the equipment. The manual shall be in sufficient detail with step by step instructions to enable others to inspect erect, commission, maintain, dismantle, repair, reassemble and adjust all parts of the equipment. Each manual shall also include a complete set of approved as built drawings together with performance / rating curves / charts of the equipment, maintenance schedule and test certificates wherever applicable.

6.11.3.2 Quality assurance documentation specific for the project.

6.11.3.3 PIPING MATERIAL SPECIFICATION

	BUTT WELDING
SW	SOCKET WELDING
CS	CARBON STEEL
SS	STAINLESS STEEL
CI	CAST IRON
CL	CLASS
ERW	ELECTRIC RESISTANT WELDED
EFW	ELECTRIC FUSION WELDED
SMLS	SEAMLESS
PE	PLAIN ENDS
BE	BEVELLED ENDS
TE	THREADED ENDS
SO	SLIP-ON
WN	WELDING NECK
LJ	LAP JOINT
RF	FLANGED RAISED FACE
FF	FLANGED FLAT FACE
SCH	SCHEDULE
GALV	GALVANISED
IBR	INDIAN BOILER REGULATION
EPDM	ETHYLENE PROPYLENE DIENE MONOMER
U-PVC	UNPLASTICISED POLYVINYLCHLORIDE
C-PVC	CHLORINATED POLYVINYLCHLORIDE
HDPE	HIGH DENSITY POLYETHYLENE
NPT	AMERICAN STD. PIPE THREAD (NATIONAL PIPE TAPER)
Gr	GRADE
TOE	THREADED ONE END
TBE	THREADED BOTH END
PSE	PLAIN SMALL END
BLE	BEVELLED LARGE END
THK	THICKNESS

NOTES:

1. SPECIFIC REQUIREMENTS GIVEN IN PIPING DRAWINGS OR IN ISOMETRICS SUPERSEDES REQUIREMENTS GIVEN HERE.
2. USE PTFE TAPE FOR THREADED JOINTS FOR TEMPERATURE $\leq 200^{\circ}\text{C}$

SERVICE : : COMPRESSED AIR											
DESIGN	TEMP. ° F / ° C		60			CORR. ALL. inch / mm			1.5		
	PR. psig / kg / cm ² g		10			FLANGE FACING			RF, CONC. SERR. FINISH (NOTE-5)		
NOM. PIPE SIZE	mm	15	20	25	32	40	50	65	80	100	150
OUTSIDE DIA.	mm	21.8	27.3	34.2	42.9	48.8	60.8	76.6	89.5	115	166.5
CLASS/ THICKNESS	mm	HV Y CL	HVY CL	HVY CL	HVY CL	HVY CL	HVY CL	HVY CL	HVY CL	HVY CL	HVY CL
LINE JOINT	≤ 40	< 40 - SW TO ANSI B16.11									
	≥ 50	> 50 - BW TO ANSI B16.25									
MAINTENANCE JOINTS	ALL	FLANGED. TO BE KEPT MINIMUM									
ITEM	NOMINAL PIPE SIZE RANGE inch / mm		MATERIAL SPECIFICATION				DIMENSION AL STANDARD		REMARKS		
PIPES	≤ 150		CS, IS 1239 PT-1 (GALVANISED)				IS 1239 PT-1		ERW, GALVANISED, ≤ 40 – PE, ≥ 50 - BE		
	> 150		CS, IS 3589 Gr. FE 410 (GALVANISED)				IS 3589		ERW, GALVANISED		

PIPE NIPPLE		15 TO 40	CS, IS 1239 PT-1 (GALVANISED)	IS 1239 PT-1	TYPE-E, POE- TOE,PBE,TBE,SCH TO MATCH PIPE
B.W. FITTINGS	ELBOWS, CAPS, REDUCERS,TEES	> 40 TO 150	ASTM A 234 Gr. WPB (GALVANISED)	ANSI B 16.9	SCH 40, SMLS
	ELBOWS, CAPS, REDUCERS,TEES	> 150	ASTM A 234 Gr. WPBW (GALVANISED)	ANSI B 16.9	SCH MATCH TO PIPE THICKNESS, WELDED (SEE NOTE -1)
S.W . FITTINGS		≤ 40	ASTM A 105 (GALVANISED)	ANSI B 16.11	3000CL.
SWAGES(ECC/CONC)		15 TO 100	ASTM A 234 Gr. WPB (GALVANISED)	MSS SP 95	PSE & BLE,THICKNESS TO MATCH PIPE
BRANCH CONNECTION		ALL			SEE BRANCH CONNECTION CHART
FLANGES		≤ 150	ASTM A 105 (GALVANISED)	ANSI B 16.5	SO, 150 CL
		200 TO 300	IS 2062 Gr. A (GALVANISED)	ANSI B 16.5	SO, 150 CL
		≥ 350	IS 2062 Gr. A (GALVANISED)	ANSI B 16.5	SO, 150 CL LIGHT WEIGHT (SEE NOTE-2)
BLIND FLANGES		≤ 150	ASTM A 105 (GALVANISED)	ANSI B 16.5	150 CL
		200 TO 300	IS 2062 Gr. A (GALVANISED)	ANSI B 16.5	150 CL
		≥ 350	IS 2062 Gr. A (GALVANISED)	ANSI B 16.5	150 CL LIGHT WEIGHT (SEE NOTE-2)
MACHINE / STUD BOLTS		ALL	ASTM A 307 GR.B (GALVANISED)	ANSI B 18.2.1	CL. 2A
HEAVY HEX. NUTS		ALL	ASTM A 194, Gr.2 (GALVANISED)	ANSI B 18.2.2	CL.2B REF NOTE 2
GASKETS		ALL	NOTE-4	ANSI B 16.21 CL.150	SELF-CENTERING RING, 2 MM THK. (NOTE-5)

UNIONS		≤ 40	ASTM A 105 (GALVANISED)		ANSI B 16.11	SW 3000 CL	
THREADED FITTINGS		≤ 40	ASTM A 105 (GALVANISED)		ANSI B 16.11	3000 CL	
						NPT / IS 554 (TAPER) AS REQUIRED	
TYPE OF VALVE	SIZE RANG E	MATERIAL		PRESSUR E RATING	TYPE OF ENDS	SPECIFICATI ON OR	REMARKS
	inch / mm.	BODY	TRIM	ANSI/ IS		-	
CHECK (LIFT TYPE) GATE GLOBE	≤ 40	ASTM A 105	13% Cr. STEEL	800	SW	-	
BALL	15 TO 40	ASTM A 105	SS 304	150	TE	-	SCREWED, TWO PIECE, REGULAR PORT TYPE WITH PTFE SEAT, SCREWED
BALL	≥ 50	ASTM A 216 Gr.WCB	SS 304	150	RF	-	FLANGE END, TWO PIECE, REGULAR PORT TYPE WITH PTFE SEAT , FLANGED ENDS
CHECK (DUAL PLATE)	≥ 50	SG IRON	DISC: ASTM A 216 GR. WCB, SEAT:EPDM	150	WAFER	-	
NOTES:							
1. USE FLAT END COVERS INSTEAD OF CAPS FOR SIZE ≥ 200							
2. NUT SHALL BE ALONG WITH WASHER.							
3. GASKETS SHALL BE OF ASBESTOS FREE NBR DULY REINFORCED WITH ARMID FIBRES							
4. USE FLAT FACE FLANGES & FULL FACE GASKETS WITH CAST IRON FLANGED VALVES.							
5. PRIOR TO WELDING OF GALVANISED PIPING, GALVANISING SHALL BE LOCALLY REMOVED FOR A LENGTH OF 50 mm FROM EACH END. EXTERNAL SURFACE SHALL BE COATED WITH ZINC-RICH PAINT AFTER COMPLETION OF WELDING OPERATION.							

BRANCH CONNECTION CHART

SIZE	BRANCH															
inch / mm																
RUN	15	20	25	32	40	50	65	80	100	150						
15	T															
20	RT	T														
25	RT	RT	T													
32	RT	RT	RT	T												
40	RT	RT	RT	RT	T											
50	H	H	H	H	H	S										
65	H	H	H	H	H	S	S									
80	H	H	H	H	H	S	S	S								
100	H	H	H	H	H	S	S	S	S							
150	H	H	H	H	H	S	S	S	S	S						

LEGEND :

T - EQUAL TEE

H - HALF COUPLING

SL - SOCKOLET

S - STUB -IN

SR - STUB-IN WITH R-PAD

RT - REDUCING TEE

TL -THREADOLET

WL - WELDOLET

N - NIPOLET

6.12 SPECIFICATION FOR AIR COMPRESSORS

6.12.1 SCOPE

This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at manufacturer's works, delivery at site, handling at site, erection, testing, commissioning, performance testing and handing over of Air / Gas Compressors and Accessories.

6.12.2 CODES AND STANDARDS

The design, materials, construction, manufacture, inspection, testing and performance of the air/ gas compressors and accessories shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to the latest applicable Indian or equivalent standards. Other international standards are also acceptable, if these are established to be equal or superior to the listed standards. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility.

The following are some of the important codes and standards relevant to this specification.

- a) API 617 Centrifugal Compressors for Petroleum, Chemical, and Gas Service Industry Services
- b) API 618 Reciprocating Compressors for Petroleum, Chemical, and Gas Industry Services
- c) API 619 Rotary Type Positive Displacement Compressors for Petroleum, Chemical, and Gas Industry Services
- d) API 672 Packaged, Integrally Geared Centrifugal Air Compressors for Petroleum, Chemical, and Gas Industry Services
- e) ASME SEC. Boiler and Pressure Vessel Code VIII DIV.1
- f) TEMA Standards of the Tubular Exchanger Manufacturers Association
- g) IS 2825 Code for Unfired Pressure Vessels
- h) IS 5456 Code of Practice for Testing of Positive Displacement Type Air Compressors and Exhausters

- i) IS 6206 Guide for Selection, Installation and Maintenance of Air Compressor Plants with Operating Pressures up to 10 bars
- j) IS 7938 Air Receivers for Compressed Air Installation IS 11780 Code for Selection and Testing of Rotary Screw Air Compressors (Oil Flooded)
- k) IS 13124 Reciprocating Gas Compressors - Technical Supply Conditions

6.12.3 DESIGN AND CONSTRUCTION FEATURES

The compressor shall be of reciprocating or centrifugal or screw type as specified in data sheet A.

6.12.4 RECIPROCATING COMPRESSORS

a) Frame

The frame shall be a single casting and robust in construction. It shall be provided with sufficiently large and easily removable inspection doors so that the bearings and other parts are readily accessible for checking and adjustments. Inspection doors shall be dust-proof and oil-tight.

b) Cylinder

The cylinder shall be made of cast iron or stainless steel or as specified in data sheet A. The cylinder heads and barrels shall be provided with cooling water jackets. The design of jackets shall be such that low air discharge temperature and minimum carbon formation are ensured. The water jackets shall be so constructed that the flow of water is uniform throughout the cooling surface and no stagnant water pockets are formed. The walls of the cylinder shall have sufficient thickness suitable for maximum working pressure and temperature and shall be suitable for re-boring. It shall be provided with liberally sized valve openings and streamlined passages. The internal surface of the cylinder shall be highly polished to reduce wear of the piston rings.

c) Piston and Piston Rod

The piston shall be of such a design and construction that the piston rings exert equal pressure at all points of the cylinder bore. The piston rod shall be designed to take up the full thrust acting on the piston. The piston rings for non-lubricated type compressor shall be of self-lubricating type. Piston speed shall be maximum 300 M/Min for large capacity compressors and 350 M/Min for small capacity compressors.

d) Cross Head

The cross head shall be of solid box type with the faces ground to work closely with the groove of the guides. The cross head pin shall be case hardened and ground.

e) Connecting Rod and Crank Shaft

The connecting rod shall be of I cross-section providing adequate strength and rigidity. The crank shaft shall be adequately designed so as to ensure smooth running, without vibrations. It shall be accurately finished to size and shall have sufficient length so as to be fitted to main bearing and flywheel.

f) Flywheel

The flywheel shall be designed such that it is well balanced and is of sufficient weight to give an even turning moment. The wheel shall be of robust construction. The spokes shall have oval cross-section and the boss shall have split construction such that the wheel runs true with the shaft. The flywheel shall be suitable for type of power transmission i.e. flat belt, V-belt, direct coupling etc. between the driver and compressor.

g) Main Bearings

The main bearings shall be of robust construction assuring long bearing life and shall have sufficiently large diameter and adequate length. The bearing at the crank pin end of connecting rod shall be fitted with bronze lined with best quality white metal. The bearing at the cross head end shall be fitted with a bushing made of bronze. The bearings shall be made in halves and shall have forced feed lubrication.

h) Valves

The valves shall have straight and uniform lift and maximum effective area so as to ensure low air velocity and minimum valve clearance. The valve plate discs shall be heat treated, tempered and ground and the valve seat shall be case hardened. The valve springs shall be capable of effecting quick opening and closing and shall also provide the required cushioning effect. The valve design shall be such that the valve can be easily removed for checking and maintenance.

i) Lubrication

(i) Frame Lubrication

Frame lubrication for small compressors with motor rating upto 55 kW shall be of splash type. The pressurised i.e. forced feed system shall be used for compressors with higher motor rating. In case of force feed lubrication, the oil pump shall be either driven by crank shaft of the compressor or shall be separately driven. The pump shall draw the oil from the adequately sized oil well

(ii) Cylinder Lubrication

For lubricated type of compressors, multi plunger pump or metering pump shall be used for cylinder lubrication. In case of non-lubricated type air compressors, a wiper ring shall be provided such that the crank case oil is not carried to the cylinder along with the piston rod.

6.12.5 SCREW COMPRESSORS

a) Casing

Casing shall be of barrel type made of cast iron or fabricated steel for moderate pressure applications, cast steel or stainless steel for high pressure applications or as specified in data sheet A. For water injected applications the casing shall be of stainless steel or as specified in data sheet A. Casing shall have built-in air passages either as cast or machined.

b) Rotors

Rotors shall be of asymmetric profile. The material of construction of rotors shall be as specified in data sheet A. The rotors shall be dynamically balanced before and after mounting

timing gears and thrust collars. The rotors shall be ultrasonically tested. For non-lubricated screw compressors rotors shall be lined with PTFE.

c) Gears

Gear pair shall be used to step up speed of the compressor. Helical gear hardened to minimum 55 RC shall be used. Gear shall be shrink fit on drive shaft and shall mesh with pinion mounted on extended portion of male rotor. Gears shall be designed as per AGMA standards.

d) Bearings

The rotors shall be carried in heavy duty ball and roller bearings to take radial and axial loads or journal bearings with thin babbitt metal lining.

e) Air- Oil Separator

In case of lubricated screw compressors, high efficiency air-oil separation system shall be provided to ensure removal of oil.

6.12.6 ACCESSORIES

Accessories such as intake filter, silencer, inter-coolers, after -coolers, oil-coolers, receivers, control cabinet etc. shall be supplied to make the system complete in all respects.

6.12.7 INTAKE FILTER

The intake filter shall be generally as per IS 6206. The type of intake filter shall be as specified in data sheet A. The filter shall be designed to retain particles of one (1) micron and above with ninety-seven (97) percent efficiency. In case of cloth filter, the filter element may be of nylon, polypropylene or woollen cloth attached to the wire netting .

6.12.8 INTER-COOLERS

For multi stage compressors, inter-coolers shall be provided. These shall be of shell and tube type, with removable tube bundles. The tubes shall have sufficient thickness to withstand the operating pressure and shall be carefully expanded into the tube sheets. Capacity of inter-coolers shall be twenty (20) percent more than the compressor capacity or as specified in data sheet A. Design pressure shall be twenty-five (25) percent more than the working pressure or

as specified in data sheet A. The material of construction and design shall be as specified in data sheet A.

6.12.9 AFTER-COOLERS AND OIL-COOLERS

The construction features, design etc. shall be as per inter-coolers described above. Capacity of after-coolers and oil-coolers shall be twenty (20) percent more than the compressor capacity or as specified in data sheet A. Design pressure shall be twenty-five (25) percent more than the working pressure or as specified in data sheet A.

6.12.10 RECEIVERS

Receivers shall generally conform to IS 7938. Receivers shall be provided with two (2) suitably sized safety valves to relieve the full compressor discharge capacity individually and shall be set at a pressure 1.25 times the operating pressure. The material of construction and design shall be as specified in data sheet A.

6.12.11 MOTOR RATING

Motor shall be of suitable rating considering compressor power requirements. Motor rating shall be calculated as follows:

- (a) If compressor shaft input power requirement is 100 KW and above,

$$\text{Motor rating in KW shall be} = 1.10 \times \frac{\text{SKW}}{\eta_t}$$

- (b) If compressor shaft input power requirement is less than 100 KW,

$$\text{Motor rating in KW shall be} = 1.12 \times \frac{\text{SKW}}{\eta_t}$$

Where,

SKW = Shaft Power at selected speed in KW

η_t = Efficiency of transmission

6.12.12 CAPACITY CONTROL

Capacity control shall be achieved either by speed variation or at constant speed as specified in data sheet A. In case where capacity control is to be achieved at constant speed, following methods are generally available. Data sheet A shall be referred for method to be actually employed.

- (a) Automatic start-stop of the compressor

- (b) Automatic load-unload of the compressor
- (c) Throttling of suction valve
- (d) By-passing air or gas from delivery to suction inlet
- (e) Increasing clearance volume by a clearance pocket
- (f) Variable filling using a by-pass valve.
- (g) Movable inlet guide vanes.

6.12.13 DUAL TYPE CONTROL

Capacity control by start-stop and load-unload of compressors is also known as ‘dual type control’, and same is described below.

The dual type control system shall permit operation of each compressor in either of the following two regulations :

- (a) Continuous Run-Load-Unload Regulation.
- (b) Automatic Start-Stop Regulation.

Under continuous Run-Load-Unload Regulation, the drive motor shall run continuously while the compressor shall be loaded at pre-set (adjustable) cut-in pressure as the receiver pressure falls and unloaded at a higher pre-set (adjustable) cut-out pressure, as the receiver pressure rises. With automatic Start-Stop Regulation, the drive motor shall automatically start at pre-set (adjustable) cut-in pressure as the receiver pressure falls and automatically stop at a pre-set (adjustable) higher cut-out pressure as the receiver pressure rises.

With either system, the compressor shall always be unloaded when the drive motor starts. The unloaders shall keep the compressor unloaded till the drive motor comes to full speed.

Compressor shall be provided with one selector switch having three positions marked AUTO-OFF-ON for the following functions :

- (a) OFF -Stops the motor.

- (b) AUTO -Keeps the compressor(s) in load / unload mode as selected by master selector switch. Starts the motor of the compressor in start-stop regulation as selected by master selector switch.
 - (c) ON -For manual start up by push buttons with load /unload regulation.
-
- a) Pressure switches shall be provided to monitor receiver pressure of compressor, one for load-unload control and the other for start-stop control considering two (2) steps regulation for load-unload mode. In case number of steps are more as indicated in data sheet A, number of pressure switches provided shall be sufficient to meet the requirement.
 - b) Pressure switches with alarm initiating contacts shall be provided for the receiver
 - c) high and low pressures.
 - d) The dual control units shall be complete with pressure switches, solenoid valves, control air tubing, air filter (if required) and other accessories as required for the afore-mentioned operations.
 - e) For centrifugal compressors anti-surge control shall also be provided to protect compressor from surging.
 - f) One potential free contact shall be made available for each compressor for remote alarm under trip condition and a common contact for compressor auto start.
 - g) Green and red lamps shall be provided to indicate motor running and stop conditions respectively.
 - h) Motors shall be provided with motor winding over-heat sensors and bearing temperature sensors for alarm indication and to trip the motor.
 - i) For compressors driven with turbine, the required turbine control and instrumentation shall be provided.
 - j) For air / gas compressors, depending on the hazardous area classification, motors and instrument enclosures shall be explosion-proof certified for the specific area.

6.12.14 NOISE AND VIBRATIONS

- a) Noise level produced by any rotating equipment individually or collectively shall not exceed 85 dB(A) measured at a distance of 1.5 metres from the source in any direction.
- b) The overall vibration level shall be as per zones A and B of ISO 10816-1. Vibration dampening pads if required, shall be provided.

6.12.15 PERFORMANCE GUARANTEES

Performance parameters to be guaranteed by the CONTRACTOR and tolerances permitted shall be as indicated in data sheet A. CONTRACTOR shall confirm acceptance of these by indicating values in data sheet B. Compressor or any portion thereof is liable for rejection, if it fails to give any of the guaranteed performance parameters.

DATA SHEET A: AIR COMPRESSORS

GENERAL	1. DESIGNATION : COMPRESSORS FOR	DESIGN DATA (CONTD.)	19.2 FOR INTER-COOLER, AFTER-COOLER
	COMPRESSED AIR SYSTEM		AIR
	2. NUMBER REQUIRED : 1 (1W + 0S)		20. COOLING WATER QUALITY : NA
	3. TAG NUMBERS :		21. COOLING WATER INLET TEMPERATURE: NA
	4. LOCATION : INDOOR / OUTDOOR		22. MAXIMUM COOLING WATER OUTLET TEMPERATURE: NA
	5. OPERATION : CONTINUOUS / INTERMITTENT 12 Hrs/Day		23. COOLING WATER PRESSURE AT AT INLET: NA
	6. TYPE OF DRIVE : ELECTRIC MOTOR /		24. MAXIMUM ALLOWABLE COOLING WATER PRESSURE DROP IN THE COMPRESSOR, INTER-COOLER, AFTER-COOLER AND OIL- COOLER : NA
	7. APPLICABLE STANDARDS : IS 6206 / IS11780		
	8. SITE DATA :		
DESIGN DATA	9.		25. COMPRESSOR FRAME LUBRICATION :
	10. TYPE : OIL INJECTED AIR - COOLED SCREW COMPRESSOR		SPLASH / PRESSURISED
	11. FLUID TO BE COMPRESSED : AIR		26. TYPE OF CAPACITY CONTROL :
	12. CAPACITY (FAD) : 70 CFM		BY SPEED VARIATION / AT CONSTANT SPEED
			27.
			28.

	15. SUCTION PRESSURE : AMBIENT	DUAL TYPE DUAL CONTROLS	29.
	16. SUCTION TEMPERATURE - AMBIENT		30. ADJUSTABLE RANGE FOR PRESSURE SWITCHES : 6.0 TO 9.0 Kg/ cm ²
	17. DISCHARGE PRESSURE: 8.5 Kg/ cm ² (g)		31. EXPECTED SETTING OF PRESSURE SWITCHES FOR : (NOTE-3)
	18. MAXIMUM COMPRESSOR SPEED : * RPM		31.1 AUTO LOAD-UNLOAD REGULATION :
	19. COOLING MEDIUM : FOR COMPRESSOR : AIR		(a) LOAD : 7.5 Kg / cm ² (g)
			(b) UNLOAD : 8.5 Kg / cm ² (g)
DUAL TYPE CONTROLS (CONTD.)	31.2 AUTO START-STOP REGULATION:		31.4 HIGH RECEIVER PRESSURE
	(a) START : 7.5 Kg/ cm ² (g)		ALARM : 9.35 Kg/ cm ² (g)
	(b) STOP : 8.5 Kg/ cm ² (g)		32. NUMBER OF STEPS FOR LOAD - UNLOAD REGULATION : 2 / 3 / 4 /
	31.3 VERY LOW RECEIVER PRESSURE ALARM : 6.8 Kg/ cm ² (g)		49. CASING : CI IS 210 OR ASTM A 278 CL
	40 / FABRICATED STEEL ASTM A 353 / CAST STEEL ASTM A 216 GR WCB NORMALIZED / CAST SS ASTM A 743 AND 744 CA6-NM	MATERIALS OF CONSTRUCTION FOR SCREW COMPRESSORS	50. ROTOR BODY : CI ASTM A 395 / FORGED STEEL AISI 1030-1045 / CAST ALUMINIUM ASTM B 26 ALLOY 355 OR C 355
			51. SHAFT : FORGED STEEL AISI 1030-1035/ FORGED SS ASTM A151 TYPE 410 SS
COMPRESSOR ACCESSORIES	52. INTAKE FILTER TYPE : PAPER /	INTER-COOLERS / AFTER-COOLERS / OIL-COOLERS DESIGN DATA	69. DESIGNATION : INTER-COOLERS / AFTER-COOLERS
	52.1 MATERIAL OF CONSTRUCTION		70. TAG NUMBERS FOR INTER-COOLERS :
	CASING : MS / ALUMINIUM		71. AFTER-COOLERS REQUIRED : YES / NO
	53. SILENCER REQUIRED : YES		
	54. DRIVE PULLEYS WITH V-BELT AND		72. TAG NUMBERS FOR AFTER-COOLERS :
	BELT GUARDS REQUIRED : YES		73. CAPACITY OF :
	55. COUPLINGS AND COUPLING GUARDS REQUIRED : YES		73.1 INTER-COOLERS : 70 CFM
	FOR DIRECT COUPLED COMPRESSORS		73.2 AFTER-COOLERS : 70 CFM
	56. SLIDE RAILS FOR MOTOR REQUIRED: YES		74. TYPE : *
	57. CONTROL CABINET REQUIRED : YES		75. TYPE OF FLOW : COUNTER-CURRENT
	58. IMPULSE TUBING : COPPER /		76. OPERATING PRESSURE FOR AFTER

	ADMIRALITY BRASS AS PER BS EN 1057		COOLERS :
	EXCEPT FOR EDDY CURRENT TEST/		76.1 AIR SIDE: 7.0 (MAX.)Kg/ cm ² (g)
	STAINLESS STEEL		76.2 WATER SIDE : NA
	59. MOTOR BY : CONTRACTOR /		77. DESIGN PRESSURE FOR AFTER-
	EMPLOYER		COOLERS
	60. STARTER BY : CONTRACTOR /		77.1 AIR SIDE : *
	EMPLOYER		77.2 WATER SIDE : NA
	61.		78. MAXIMUM ACCEPTABLE OUTLET AIR
	62.		TEMPERATURE : 40 ⁰ C (NOTE-2)
	63.		79. ALLOWABLE PRESSURE DROP OF AIR
	64.		THROUGH AFTER-COOLER :
	65.		0.2 Kg/ cm ²
	66.		80. DESIGN CODE : ASME SEC. VIII DIV. 1 AND TEMA
	67.		
	68.		81. CORROSION ALLOWANCE : 1.5 mm
INTER-COOLERS/AFTERCOOLERS/ OIL-COOLERS – M O C	82. SHELL : CS SA 106 GR B / IS 2002 /	RECEIVER DESIGN DATA	90. DESIGNATION : RECEIVER FOR AIR COMPRESSOR
	83. TUBES : COPPER/ ADMIRALITY BRASS		91. NUMBER REQUIRED: ONE (1 W) / ONE(1W)
	AS PER BS EN 1057 EXCEPT FOR EDDY CURRENT TEST / SS 316		92. TAG NUMBERS : LATER
	84. TUBE SHEETS : CS / BRASS		93. TYPE : HORIZONTAL / VERTICAL /
	85. TUBE SUPPORT PLATES : IS 2062 /		CYLINDRICAL WITH WELDED DISHED ENDS
	86.		94. OPERATING PRESSURE : 7.5 Kg/ cm ² (g)
INTER-COOLERS / AFTER-COOLERS ACCESSORIES	87. MOISTURE AND OIL SEPARATOR WITH AUTO DRAIN TRAP TO BE PROVIDED WITH EACH INTER- COOLER AND AFTER-COOLER TO DISCHARGE MOISTURE AND OIL TO DRAIN		95. DESIGN PRESSURE : 10 Kg / cm ² (g)
			96. DESIGN TEMPERATURE : 60 ° C
			97. NOMINAL VOLUME : 1.0 M ³
			98. DIMENSIONS :
			98.1 HEIGHT TAN TO TAN : * mm
			98.2 DIAMETER : * mm
	87.1 TYPE OF MOISTURE AND OIL SEPARATOR : CENTRIFUGAL/ DEMISTER PAD / BAFFLE		99. APPLICABLE CODE : ASME SEC VIII DIV 1

			100. CORROSION ALLOWANCE : 1.5 mm
	87.2 TYPE OF AUTO DRAIN TRAP : / BALL FLOAT / SOLENOID OPERATED / ELECTRONIC LEVEL CONTROLLED		101. SHELL AND DISHED END MATERIAL : IS 2002 /IS 2062
	88. MATERIAL OF CONSTRUCTION OF MOISTURE AND OIL SEPARATOR		102. INTERNAL PAINTING : BLACK BITUMINOUS
	88.1 BODY/ SHELL : ASTM A 216 Gr. B		103. INSULATION : YES / NO
			104. SKIRT REQUIRED : LEG SUPPORT
			105.
	89. MATERIAL OF CONSTRUCTION OF AUTO DRAIN TRAP	RECEIVER ACCESSORIES	106. MANHOLE WITH COVER FOR INSPECTION AND CLEANING REQUIRED : YES
	89.1 BODY : ASTM A 216 Gr. B		
	89.2 TRIM : BRONZE /SS		
MISCELLANEOUS	109. ALL THE VALVES, SPECIALITIES INSTRUMENTS AND ACCESSORIES REQUIRED : YES	SPARES AND MAINTENANCE TOOLS AND TACKLES	
	110. COUNTER FLANGES FOR ALL THE CONNECTIONS AT BATTERY LIMITS WITH NUTS, STUDS, BOLTS, GASKETS AND WASHERS REQUIRED : YES /NO		124. ESSENTIAL SPARES
			124.1
			124.2
			124.3
	110.1 FLANGES : REF. PIPING MATERIAL SPECIFICATION - GRADE GA		124.4
	111. FOUNDATION BOLTS FOR ALL THE EQUIPMENT REQUIRED : YES /NO		
	112. ERECTION BY CONTRACTOR :YES/ NO		
PAINTING	115. PRIMER : EPOXY	TESTS AND INSPECTION	126. PERFORMANCE TEST AT SITE REQUIRED : YES
	115.1 NUMBER OF COATS : 2		
	115.2 DRY FILM THICKNESS : 25 µ COAT		127. APPLICABLE STANDARDS : IS 5456 / API 618 / API 617 / API 672 / API 619 / IS 11780 /
	116. FINISH PAINT : EPOXY		
	116.1. NUMBER OF COATS : 2		128.
	116.2 DRY FILM THICKNESS : 50 µ COAT		129.
COMPANION SPECIFICATIONS	117.	PERFORMANCE GUARANTEES	130. CAPACITY OF EACH COMPRESSOR : 70CFM (FAD)
	118.		131. DISCHARGE PRESSURE : 8.5 Kg/cm ² (g)
	119. :		132. POWER CONSUMPTION :

			(+) 0 (–) * KW
	120.		133. TEMPERATURE OF AIR AT OUTLET OF AFTER COOLER
	121.		134. COOLING WATER FLOW RATE : NA
	122.		
PERFORMANCE GUARANTEES (CONTD.)	135.		139.
	136.		140.
	137.		141.
	138.		142.
LIST OF SUB-VENDORS FOR BOUGHT-OUT AND CRITICAL ITEMS	143. BEARINGS	SKF / FAG	
	144. MOTORS	CG / BB / KEC	
	145. TURBINE	---	
	146. ENGINE	----	
	147. COUPLINGS	FENNER	
	148. V- BELTS	FENNER	
	149. VALVES & SPECIALITIES		
	150. AUTO DRAIN TRAPS	SPIRAX	
	151. VIBRATION DAMPENING PADS	DUNLOP	
	152. CONTROL PANEL & INSTRUMENTS	RITTAL / PERO PRESIDENT / ENCLOTEK	
	153. MCC	*	
	<u>NOTES</u>		
	1. * VENDOR TO SPECIFY 2. CONTRACTOR TO CONFIRM. THE SAME SHALL BE CONSIDERED IN AIR DRIER DESIGN. 3. COMPRESSOR SHALL BE PROVIDED WITH BOTH ON/OFF REGULATION AND LOAD / UNLOAD REGULATION. A TOGGLE SWITCH SHALL BE PROVIDED TO SELECT THE MODE OF REGULATION. HOWEVER THE MOTOR SHALL BE SUITABLE FOR CONTINUOUS OPERATION DUTY.		

6.13 SPECIFICATION FOR WELDED UNFIRED PRESSURE VESSEL

6.13.1 SCOPE

This specification covers the general design, preparation of detailed fabrication drawings for review and approval, supply of materials, fabrication, stage-wise inspection, final inspection,

testing, packing, forwarding, transportation and delivery at site of welded unfired pressure vessels.

6.13.2 CODES AND STANDARDS

- a) The design, materials, fabrication, inspection, testing and performance of welded unfired pressure vessels shall comply with all currently applicable design codes and standards, statutes, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to the latest applicable Indian or equivalent standards. Other international standards are also acceptable, if these are established to be equal, or superior to the listed standards. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.
- b) If statutory approvals are specified in data sheet A, the VENDOR shall be responsible for obtaining all approvals on design, materials, stage-wise inspection, final inspection and testing of the vessel.

6.13.3 MATERIALS

- 6.13.3.1 All materials used in the fabrication of pressure vessels shall be as specified in the data sheets. Equivalent materials are acceptable only when approved by the EMPLOYER in writing.
- 6.13.3.2 All plates shall be ultrasonically tested as follows :
 - (a) For nominal thickness 20 mm and higher when used for fabrication of dished ends
 - (b) For nominal thickness 40 mm and higher when used for fabrication of shells
 - (c) For nominal thickness 50 mm and higher when used for blind flanges
 - (d) All thicknesses, when used for body flanges
- 6.13.3.3 The VENDOR shall ensure that code mandatory requirements of impact testing are met in accordance with the minimum design temperatures specified in the data sheets.
- 6.13.3.4 Any non-pressure parts such as cleats, pads at support lugs or legs, wear plates at saddles and pads at pipe supports etc., welded directly on to the pressure parts, shall be of the same material as the pressure parts.
- 6.13.3.5 Reinforcement pads at nozzles and other load bearing locations shall be of the same material and nominal thickness as the pressure part.
- 6.13.3.6 Material for skirt in case of alloy steel vessels and columns shall be the same as that of pressure part at least for a minimum length of 500 mm from bottom tan-line.

6.13.4 ALLOY STEEL PROTECTIVE LINING AND CLADDING

- 6.13.4.1 Lining is defined as loose strip lining and bush lining. Cladding may be by weld deposit overlay or explosion bonding or roll bonding.
- 6.13.4.2 Clad plate or lining shall conform to the following requirements :

- (a) Clad plate thickness shall be minimum 3 mm, unless specified otherwise.
- (b) Clad plate made either by the explosion bonding process or reduction roll bonding process is acceptable.
- (c) Clad plate shall meet the ASME code requirements of SA263, SA264, SA265 including bond test or AD-Merkblatter W-8. The shear bond test shall be executed as per SA264, Figure 1. Ultrasonic inspection shall be carried out in accordance with SA 578, acceptance level S-6.
- (d) For the purpose of ensuring that cladding thickness of reduction roll-bonded clad plates is not less than 3 mm, each plate shall be inspected at the mill using a "coating gauge". Plates shall be scanned on at least three edges and one across the width of the plate. Thickness shall be plotted at points not more than 600 mm apart. The VENDOR shall furnish a mill certificate, showing an outline of the plate and the points at which readings were taken together with the results.
- (e) Instead of lining, weld deposit overlay may also be considered.
- (f) At weld deposit overlay or clad-restoring welds, at least the same chemical composition shall be present at 3 mm depth, to be analysed by the welding procedure qualification in advance.
- (g) Weld deposit overlay and clad-restoring welds shall be dye penetrant tested and crack-free.
- (h) Weld deposit overlay and clad-restoring welds as a minimum, shall be qualified as per ASME Section IX.

- 6.13.4.3 Alloy steel lining shall not be used when cladding is specified. Alloy steel lining, when specified, shall be so designed that the distance between attachments does not exceed 150 mm.
- 6.13.4.4 The minimum required thickness of pressure parts shall exclude cladding or lining.
- 6.13.4.5 Cladding or lining requirements discussed in this specification are using low and high alloy steels only. For cladding or lining using non-ferrous and other materials, when specified, the VENDOR shall furnish on his drawings all details, including Welding Procedure Specification (WPS), for review and approval.

6.13.5 MINIMUM THICKNESS

- 6.13.5.1 The thicknesses of the pressure parts as shown in the data sheets or drawings are the minimum acceptable thicknesses after manufacture, even though the code may permit a lesser thickness. The minimum acceptable thickness includes specified corrosion allowance.

6.13.5.2 The VENDOR shall be responsible for proper selection of plate thickness considering the fabrication and forming allowances, mill under-tolerances etc., to meet the minimum thickness requirements as specified.

6.13.6 SHELLS

Shell courses shall be of the largest possible dimensions to minimise the number of weld seams.

6.13.7 HEADS AND REDUCING SECTIONS

- a) Heads shall be of 2:1 ellipsoidal or equivalent ellipsoidal type (crown radius $R = 0.9D$, knuckle radius $r = 0.17D$), unless specified otherwise, where D is the inside diameter of the shell.
- b) Reducing sections or conical bottoms shall have a knuckle radius of $r = 0.06D$, unless specified otherwise. However, knuckle radius shall not be less than 50 mm.
- c) Dished ends shall be seamless or 100% radiographed when made from more than one piece.

6.13.8 AGITATOR ASSEMBLY

- a) Agitator assembly shall be complete with drive motor, mechanical seal with seal housing, bearings, gear box, agitator shaft with impellers, foot-step bearing with support, rigid coupling between agitator shaft and gear box output shaft with spool piece, flexible couplings between gear box and drive motor, suitable base plate and supporting structure for agitator drive arrangement and necessary fasteners etc. so as to make it complete in all respects.
- b) Drive motor and gear box shall be mounted on a common base frame and duly coupled and aligned through flexible couplings.
- c) Agitator shaft and gear box output shaft shall be coupled through a rigid coupling with split ring locking arrangement in order to ensure that agitator shaft does not fall into the vessel during operation.
- d) Agitator, shaft and impeller assembly shall be statically and dynamically balanced.
- e) The VENDOR shall obtain necessary approvals from the seal manufacturer regarding arrangement of assembly and application of API cooling plan etc. for the mechanical seal.
- f) The gear box shall be rated for heavy duty agitator service, continuously working for 24 hours a day and shall be suitable to withstand static and dynamic loads and bending moment on the gear box due to agitator shaft.
- g) Drive motor and gear box unit shall be provided with a suitable lifting eye hook.
- h) There shall be no oil spillage from gear box on to the vessel.

- i) Base frame shall be provided with suitable lifting lugs suitably designed for lifting complete agitator assembly.

6.13.9 NOZZLES AND MANHOLES

- a) Nozzles fabricated from plates are acceptable for sizes larger than 250 mm NB in case of carbon and low alloy steels and 150 mm NB in case of high alloy steels. However, this is to be done with prior approval and subject to all welds being 100% radiographed.
- b) All nozzle sizes and quantities indicated in the data sheets are tentative and for bid purpose only. Final sizes and quantities are subject to confirmation during review of drawings. The CONTRACTOR shall include and confirm in his BID, that changes, to the extent of one size lower or higher for each nozzle and quantities plus or minus one number for each size, are acceptable at no extra cost to the EMPLOYER.
- c) All nozzles with butt-welding end connections shall have edge preparation as per ANSI B16.25 suitable for connected piping inside diameter. Such nozzles shall have 100 mm extra stub length with pipe caps for hydrotest purpose.
- d) All nozzles of sizes 40 mm NB and below shall be gusseted as per the companion specification
- e) All openings in pressure parts shall be compensated for the area of opening as per code. Minimum width of pad shall be 50 mm.
- f) All load bearing areas in pressure parts shall be verified for buckling and local stresses. Adequate reinforcement shall be provided.
- g) Nozzle and manhole necks shall be flush with the inside surface of vessel, unless specified otherwise. Inside edges of manholes shall be smooth and rounded-off with a radius of 3 mm.

6.13.10 FLANGES

- a) Unless specified otherwise, all nozzles shall be provided with rated flanges only, from consideration of interchangeability, as per the dimensional standards indicated in the data sheets.
- b) Bolt holes shall straddle the main vessel axes, unless specified otherwise.
- c) All flanges on nozzles shall be of forged construction with integral hubs. Plate or plate type forged flanges are not acceptable in place of forged flanges with integral hubs.
- d) All slip-on type flanges of sizes larger than 50 mm NB and girth flanges shall be provided with adequate venting arrangement during welding.

- e) Girth flanges, if made out of multiple plates, shall be a maximum of three segments. All welds shall be 100% radiographed. Pre-heating and postweld heat treatment shall be carried out as per code.
- f) Companion flanges specified with alloy steel liner shall be supplied with 100 mm long alloy steel stub ends with butt-welding edge preparation to suit connected pipe thickness.
- g) When companion flanges are of welding neck type, the same shall be to suit bore of connected pipe. However, this information shall be provided by the EMPLOYER, during review of drawings.
- h) Blind flanges and covers intended for inspection or access openings shall be provided with adequate arrangement to facilitate opening and closing without undue effort.
- i) Unless specified otherwise, seating surfaces for non-metallic gaskets shall have stock or serrated finish. For other types of gaskets, the type of finish shall be furnished by the VENDOR on the drawings for review and approval.
- j) When flanges specified are of tongue and groove or male and female type, groove or female face shall be on the nozzle flanges and tongue or male face on the companion flanges.

6.13.11 SUPPORTS

- a) All skirt supports shall have at least one access opening and adequate vent holes at the top of skirt.
- b) Skirt shall be provided with adequate holding and climbing rungs inside, above and below the skirt opening. Details shall be furnished by the VENDOR on the drawings for review and approval.

6.13.12 MISCELLANEOUS

- a) The sizing of vessel internals shall be such that all removable parts can be removed through manholes.
- b) Wherever applicable and unless specified otherwise in data sheets all support rings, bolting bar for internals such as trays, tower packings, downcomers etc. shall be in the scope of the VENDOR.
- c) Internal baffles, tray support beams of other internals spanning a chord or diameter of the vessel shall be provided with a means for allowing differential expansion between the part and the vessel shell.

- d) Unless specified otherwise, baffles or weir plates shall not be welded directly to the shell or dished end of the vessel. These shall be bolted to the support attachments which are welded to the shell or dished end.
- e) The CONTRACTOR shall include two (2) numbers stainless steel name plates in his scope. This requirement is exclusive of manufacturer's name plate. The details on name plate shall be furnished during review of drawings.
- f) Lifting lugs shall be provided for all vessels. Details are subject to review and approval.
- g) Earthing cleats as per companion specification shall be provided at the approved locations.
- h) All pads at nozzles, supports etc. shall be provided with a tell-tale hole at the bottom-most location, which shall be tested with air at 1.0 kg/cm²(g) and checked with soap solution for leakage. Such tell-tale holes shall be plugged after satisfactory testing.
- i) For insulated or fire proofed vessels, insulation or fire proofing supports as per enclosed companion specification shall be provided by the VENDOR.
- j) Wherever platforms and ladders are specified in the data sheets, necessary supports shall be provided by the VENDOR as per details which shall be made available during review of drawings.
- k) Where materials are “free issue” as indicated in the enquiry specification or data sheet, the CONTRACTOR shall furnish along with the technical BID, a firm Bill of Materials (BOM) of all “free issue” items and also indicate cutting and wastage allowances both accountable and unaccountable.

6.13.13 ANCHOR BOLTS

Anchor bolts are not included in the scope of supply of the VENDOR, unless specified otherwise in the data sheets.

6.13.14 FABRICATION

- a) All welders, WPS and Procedure Qualification Records (PQR) shall meet the
- b) requirements of the specified code irrespective of pressure service or non-pressure service.
- c) Before welding, edges shall be checked in order to ascertain the absence of flaking, irregularities or serious defects.
- d) Stainless steel and high alloy steel fabrication shall have independent set of tools, grinding wheels and wire brushes etc.
- e) Welding shall be executed by qualified welders.

- f) Butt-welds shall have full penetration. Single sided welds shall be chipped back to sound metal and rewelded from the other side. Wherever chipping is not possible, root run shall be by TIG. Backing strip shall not be used without prior approval.
- g) Openings, reinforcing pads and attachments shall clear longitudinal and circumferential weld seams.
- h) Circumferential welds shall be situated 100 mm above or below the support rings and packing support rings meant for supporting internals, if specified.
- i) Circumferential and longitudinal weld seams shall clear saddles and support lugs. Longitudinal seams, in case of horizontal vessels, shall be at least 150 mm above saddle wear plate.
- j) Nozzle and reinforcement pads, where applicable, shall be set-in type and attached to the vessel by full penetration welds.
- k) Skirt to vessel heads joints shall have continuous flat-faced weld matching with outer diameter of the vessel. The width of the weld shall be equal to skirt thickness and height of weld shall be twice the width.
- l) All welds shall be deburred, free from under cuts, overlap ridges and valleys.
- m) No welding shall be carried out after stress relieving and/or postweld heat treatment. All flange faces shall be suitably protected against oxidation during heat treatment.

6.13.15 FIELD ERECTION

- a) Where size or shape of vessel makes it impossible to ship it in one piece for erection by others, the VENDOR shall ship largest shop fabricated sections suitable for shipment and ease of handling for field erection and assembly. Fabrication and erection shall be completed at the site by the VENDOR.
- b) All pieces shall be shop fit-up into sections and each sections shall be fit to adjacent section and all pieces shall be match marked.
- c) The width of permissible gap during fit-up shall be in accordance with approved drawings and welding procedures and shall generally be 3 mm maximum with a tolerance of plus 0.8 mm to minus 0.0 mm.
- d) Flame cut edges shall be ground by the VENDOR as required to remove slag, detrimental discoloration and non-uniformity of edges.

- e) All radiographic requirements for welds completed in shop shall be made by the VENDOR before the parts of section leave the shop.

6.13.16 PAINTING

All carbon steel exteriors shall be descaled, edges deburred and wire brushed. Subsequently, all such surfaces shall be painted with two coats of red oxide primer.

6.13.17 ESSENTIAL AND RECOMMENDED SPARES

The CONTRACTOR shall include following essential spares in his scope of supply :

- a) Two (2) gaskets as spares for each nozzle
- b) Three (3) gaskets as spares for body flanges
- c) 10% spare fasteners of each size and length. However, the minimum quantity shall be four (4) for each size and length.

SHOP INSPECTION REQUIREMENTSUNFIRED PRESSURE VESSELS																													
SERIAL NO.	DESCRIPTION	VISUAL EXAMINATION	DIMENSIONS	MATERIAL TEST CERT.	CORRELATION	IDENTIFICATION AND	ULTRASONIC TEST	WELDING QUALIFICATION	FIT UP	BACKCHIP - PT	PT / MT	RADIOGRAPHY	COUPON TEST	PRODUCTION WELD	OVALITY, THINNING	HEAT TREATMENT	SURFACE FINISH	HYDROSTATIC LEAK TEST	PNEUMATIC LEAK TEST	HARDNESS TEST	SPARK, ADHESION TEST	THICKNESS CHECK	OUT TESTS	OPERATION AND RUN					
1	MATERIAL FOR PRESSURE PARTS, FLANGES, PADS, LUGS	D	D	C	D	D																							
2	FORMED SHELLS, HEADS	D	D								D				D	C													
3	BUTT, GROOVE WELDS ON PRESSURE PARTS, , FLANGES , PADS, LIFTING LUGS	D	D			B	A/ C	D	D	B	B	B	B																
4	FILLET WELDS ON ABOVE MATERIALS	D	D				A/ C				D								D										
5	OVERLAY WELDS	D	D			D	A/ C				A																		
6	INTERNAL SUPPORTS WELDING IF ANY	D	D																										
7	INTERNAL FITTINGS, IF ANY	D	D																										
8	COMPLETED VESSEL	A	A													C	A	A	B										
9	MOUNTED AGITATORS, IF ANY	A	A	C	D	B	C/ A				B												A						
10	LININGS, IF ANY	A																		A	A	A							
11	COATINGS, IF ANY	A																				A							
A - WITNESSED BY TCE. B - WITNESSED BY TCE IF REQUIREMENT IS SPECIFIED. C - RECORDS VERIFIED BY TCE WHEREVER APPLICABLE. D - A OR C, AT TCE'S DISCRETION WHEREVER APPLICABLE.		1 - ALL STAGES SHALL BE CHECKED 100 % BY VENDOR AND RECORDS THEREOF SHOWN TO TCE. 2 - WITNESSING BY TCE MAY BE 100 % OR ON RANDOM SAMPLES. 3 - THIS DOCUMENT SHALL BE READ IN CONJUNCTION WITH INSPECTION REQUIREMENTS MENTIONED IN RELEVANT TECHNICAL SPECIFICATIONS. 4 - THE PRESSURE GAUGES AND INSTRUMENTS FOR MEASURING CRITICAL PARAMETERS SHALL HAVE VALID CALIBRATION CERTIFICATE TRACEABLE TO NATIONAL LABORATORY.																											
		SHEET 1 OF 1																											

SHOP INSPECTION REQUIREMENTS ROTATING MACHINES-MECHANICAL																										
SERIAL NO.	DESCRIPTION																									
		LINING TESTS																								
		NPSH TEST FOR PUMPS																								
		ROUTINE TESTS																								
		TYPE TESTS																								
		STRIP DOWN																								
		VIBRATION, NOISE, TEMPERATURE RISE, PERFORMANCE / OPERATION																								
		STATIC / DYNAMIC BALANCING ALIGNMENT/CLEARANCE																								
LEAK TEST																										
SURFACE FINISH																										
HEAT TREATMENT																										
ULTRASONIC TEST																										
RADIOGRAPHY																										
PT / MT																										
POURING																										
IDENTIFICATION AND CORRELATION																										
MATERIAL TEST CERT.																										
DIMENSIONS																										
VISUAL EXAMINATION																										
1	MATERIALS FOR PRESSURE PARTS, SHAFTS, IMPELLER / LOBES	D		C	D	D		B	B	C																
2	MACHINED SHAFT, IMPELLER / LOBES						B				D															
3	ROTOR ASSEMBLY													D												
4	MOTORS	D	D													B	D									
5	COMPLETED ITEM	A	A									D	D		A	A	D			B						
6	LININGS, IF ANY	A																		A						
LEGEND: A - WITNESSED BY TCE. B - WITNESSED BY TCE IF REQUIREMENT IS SPECIFIED. C - RECORDS VERIFIED BY TCE WHEREVER APPLICABLE. D - A OR C, AT TCE'S DISCRETION WHEREVER APPLICABLE.		NOTES: 1 - ALL STAGES SHALL BE CHECKED 100 % BY VENDOR AND RECORDS THEREOF SHOWN TO TCE. 2 - WITNESSING BY TCE MAY BE 100 % OR ON RANDOM SAMPLES. 3 - THIS DOCUMENT SHALL BE READ IN CONJUNCTION WITH INSPECTION REQUIREMENTS MENTIONED IN RELEVANT TECHNICAL SPECIFICATIONS. 4 - THE PRESSURE GAUGES AND INSTRUMENTS FOR MEASURING CRITICAL PARAMETERS SHALL HAVE VALID CALIBRATION CERTIFICATE TRACEABLE TO NATIONAL LABORATORY.																								

SHOP INSPECTION REQUIREMENTS AIR FILTERS															
SERIAL NUMBER	DESCRIPTION	VISUAL EXAMINATION	DIMENSIONS	MATERIAL TEST CERTIFICATE	INITIAL RESISTANCE CHARACTERISTIC TEST IN CLEAN CONDITION	DUST HOLDING CAPACITY TEST	EFFICIENCY TEST	PRESSURE DROP TEST IN SATURATED CONDITION	FILTER TO FRAME SEAL - LEAK TEST						
1	CABINET / FILTER FRAME			C											
2	FILTER MEDIUM	A	A	C											
3	DUST FOR EFFICIENCY TEST			C											
4	AIR FILTER ASSEMBLY	A	A		A ^x	A	A ^y	A ^x	A						
LEGEND: A - WITNESSED BY TCE. B - WITNESSED BY TCE IF REQUIREMENT IS SPECIFIED. C - RECORDS VERIFIED BY TCE WHEREVER APPLICABLE. D - A OR C, AT TCE'S DISCRETION WHEREVER APPLICABLE		NOTES: 1 - ALL STAGES SHALL BE CHECKED 100 % BY VENDOR AND RECORDS THEREOF SHOWN TO TCE. 2 - WITNESSING BY TCE MAY BE 100 % OR ON RANDOM SAMPLES. 3 - THIS DOCUMENT SHALL BE READ IN CONJUNCTION WITH INSPECTION REQUIREMENTS MENTIONED IN RELEVANT TECHNICAL SPECIFICATIONS. 4 - THE PRESSURE GAUGES AND INSTRUMENTS FOR MEASURING CRITICAL PARAMETERS SHALL HAVE VALID CALIBRATION CERTIFICATE TRACEABLE TO NATIONAL LABORATORY.													
		SHEET 1 OF 1													

SHOP INSPECTION REQUIREMENTS AIR DRYING PLANTS																		
SERIAL NUMBERS	DESCRIPTION	VISUAL EXAMINATION	DIMENSIONS	MATERIAL TEST CERTIFICATE	IDENTIFICATION AND CORRELATION	ULTRASONIC TEST	WELDING QUALIFICATIONS	FIT UP	BACK CHIP - PT	PT / MT	RADIOGRAPHY	HYDROSTATIC LEAK TEST	PNEUMATIC LEAK TEST	OPERATION TEST	PERFORMANCE TEST	SIMULATED PERF. TEST	TYPE TESTS	ROUTINE TESTS
1	ADSORBER, FILTER, COOLERS / CHILLERS, HEAT EXCHANGERS, CONDENSER, MOISTURE SEPARATOR AND OTHER FABRICATED ITEMS	A	A	C	D	B	C/A	D	D	B	B	A	B					
2	BLOWER / COMPRESSOR	A	A	C									C		A			C
3	VALVES - TWO WAY , FOUR WAY, SAFETY	D	D	C								D		D				C
4	PIPES AND FITTINGS	A	A	C	A													
5	INSTRUMENTS, DEW POINT APPARATUS, VALVE ACTUATOR			C										D				C
6	HEATER			C											D			C
7	MOTORS > 30 KW / < 30 KW	D	D														C	A/C
8	CONTROL PANEL	A	A	C										A				A
9	COMPLETE ASSEMBLY	A	A										A			A		
10	MISC., SUCH AS SILICA JEL																	C
LEGEND: A - WITNESSED BY TCE. B - WITNESSED BY TCE IF REQUIREMENT IS SPECIFIED. C - RECORDS VERIFIED BY TCE WHEREVER APPLICABLE. D - A OR C, AT TCE'S DISCRETION WHEREVER APPLICABLE.		NOTES: 1 - ALL STAGES SHALL BE CHECKED 100 % BY VENDOR AND RECORDS THEREOF SHOWN TO TCE. 2 - WITNESSING BY TCE MAY BE 100 % OR ON RANDOM SAMPLES. 3 - THIS DOCUMENT SHALL BE READ IN CONJUNCTION WITH INSPECTION REQUIREMENTS MENTIONED IN RELEVANT TECHNICAL SPECIFICATIONS. 4 - THE PRESSURE GAUGES AND INSTRUMENTS FOR MEASURING CRITICAL PARAMETERS SHALL HAVE VALID CALIBRATION CERTIFICATE TRACEABLE TO NATIONAL LABORATORY.																
		SHEET 1 OF 1																

6.14 SPECIFICATION FOR LOW VOLTAGE INDUCTION MOTORS

6.14.1 SCOPE

The specification covers the design, material, constructional features, manufacture, inspection and testing at the VENDOR'S/his SUB-VENDOR'S works, delivery to site and performance testing of Low Voltage induction motors rated up to 1000V.

6.14.2 CODES AND STANDARDS

The design, material, construction, manufacture, inspection, testing and performance of induction motors shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the applicable standards specified in data sheet A1 latest revision as on the date of offer. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility. In case of conflict between the standards and this specification, this specification shall govern.

6.14.3 DRIVEN EQUIPMENT

- a) When this specification forms part of the driven equipment specification, information not given in the Data Sheet-A will be governed by the driven equipment specification.
- b) Motors shall be capable of satisfactory operation for the application and duty as specified in the motor Data Sheet-A and as specified for the driven equipment.

6.14.4 PERFORMANCE AND CHARACTERISTICS

- i) Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under either of the following supply conditions as specified in Data Sheet-A1.

	<u>Supply Condition</u>	
	I	II
Variation of supply voltage from rated voltage	+/- 6%	+/-10%
Variation in supply frequency from rated frequency	+/-3%	+/- 5%
Combined voltage and frequency variation	+/- 6%	+/-10%

- ii) Motors shall be suitable for the method of starting specified in the Data Sheet-A.
- iii) The minimum permissible voltage shall be 85% of the rated voltage during motor starting

- iv) Motors shall be capable of starting and accelerating the load with the applicable method of starting, without winding temperatures reaching injurious levels, when the supply voltage is in the range of 85% of the rated motor voltage to maximum permissible voltage specified in Data Sheet-A1.
- v) The locked rotor current of the motor shall not exceed 600% of full load current (subject to tolerances as per the applicable standard) unless otherwise specified.
- vi) Motors shall be capable of developing the rated full load torque even if the supply voltage drops to 70% of the rated voltage. The pull out torque of the motor shall be atleast 205% of full load torque.
- vii) Motors when started with the driven equipment coupled shall be capable of withstanding at least two successive starts from cold conditions & one start from hot condition without injurious heating of windings. The motors shall also be suitable for three equally spread starts per hour under the above referred supply conditions.
- viii) Motors shall be of Energy Efficient type if specified in Data sheet-A1. Category of Energy efficiency shall be as mentioned in data sheet-A1

6.14.5 INSULATION

- i) The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate.
- ii) Insulation of VFD controlled Motors shall be designed to withstand a dv/dt of 0.1 micro sec rise from 10 % to 90 % of steady voltage and a maximum peak of 1600 volts as per NEMA standard MG1 Part 31.40.4.2

6.14.6 TEMPERATURE RISE

- i) The temperature rises shall not exceed the values given in IS 12802. Under extremes of supply condition (clause 4.1 above), the temperature rise shall not exceed the value indicated in IS by 10°C.
- ii) For motors specified for outdoor installation heating due to direct exposure to solar radiation shall be considered.

6.14.7 CONSTRUCTIONAL FEATURES

- i) All windings shall be of Copper.
- ii) Motors weighing more than 25 kg. shall be provided with eyebolts, lugs or other means to facilitate safe lifting.

6.14.8 BEARINGS

- i) Unless otherwise specified in data sheet-A, motor bearings shall not be subjected to any external thrust load.

- ii) Unless otherwise specified, motor bearings shall have an estimated life of atleast 40,000 hrs.
- iii) The bearings shall permit running of the motor in either direction of rotation.
- iv) When forced oil lubrication or water cooling is required, prior approval from the Employer shall be obtained.
- v) It shall be possible to lubricate the bearings without dismantling any part of the motor.
- vi) On line Greasing shall be provided for motors of 15kW and above.
- vii) VFD controlled Motors shall have their bearings insulated to prevent motor shaft currents from entering the bearing race.

6.14.9 TERMINAL BOX

- i) Terminal boxes shall have a degree of protection of atleast IP 55 for out door applicable
- ii) Unless otherwise approved, the terminal box shall be capable of being turned through 3600 in steps of 900.
- iii) Terminals shall be of stud type & the terminal box shall be complete with necessary lugs, nuts, washers.
- iv) When single core cables are to be used the gland plates shall be of non magnetic material.
- v) Sizes of terminal boxes and lugs shall be as given in Table-I, unless specified otherwise in data sheet A
- vi) TABLE-I

415 V MOTORS - SIZES OF CABLES, STUDS, TERMINAL LUGS & TERMINAL BOXES

(TO BE PROVIDED ON MOTORS BY VENDOR)

Sr. No.	Motor Rating (kW)	1100V Al Conductor, armoured PVC/XLPE Cable Cores x mm²
1	Upto 3	3x4
2	3.1 – 7.5	3x6
3	7.6 – 15	3x16
4	16 – 25	3x35
5	26 – 40	3x70

6	41 – 55	3x120
7	56 – 70	3x185
8	71 – 85	3x240
9.	86 – 110	3x400
10	111 – 200	3x1Cx500

6.14.10 PAINT AND FINISH

All motor parts exposed directly to atmosphere shall be finished and painted to produce a neat and durable surface which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, all rust, sharp edges and scale removed and treated with one coat of primer and finished with two coats of grey enamel paint.

6.14.11 HEATING DURING IDLE PERIODS

Motors rated above 30 kW shall have space heaters suitable for 240V, single phase, 50 Hz, AC supply. Space heaters shall have adequate capacity to maintain motor internal temperature above dew point to prevent moisture condensation during idle period. The space heaters shall be placed in easily accessible positions in the lowest part of the motor frame.

6.14.12 ACCESSORIES

- i) Two independent earthing points shall be provided on opposite sides of the motor, for bolted connection of the EMPLOYER'S earthing conductors as specified in data sheet-A. These earthing points shall be in addition to earthing stud provided in the terminal box.
- ii) Except when otherwise specified, the motors shall be provided with a bare shaft extension having a key slot and a key at the driving end.

6.14.13 TESTS

- i) All Motors shall be subjected to all the routine tests as per applicable standard in the presence of the EMPLOYER's representative.
- ii) Type tests Certificates shall be furnished for motors below 37kW. If type tests have not been carried out on similar Motors, or if the type test reports submitted are not found in order, then VENDOR shall carry out these tests without any extra cost to the Employer.
- iii) Following Type tests shall be performed in the presence of the EMPLOYER's representative for motor rating of 37kW and above, one of each rating:

- Temperature rise test
- Full load test to determine efficiency, power factor and slip
- Momentary overload test
- Test for vibration severity of motor
- Test for Noise level of motor
- Overspeed test
- Pull out torque measurement (Direct/ Calculations)
- Starting torque measurement (Direct/ Calculations)

iv) For other type tests, certificates shall be provided for similar rating of the motors.

v) Type and routine tests, as specified in the distribution schedule, shall be furnished for the EMPLOYER's approval.

vi) All the meters, instruments, devices used for the testing purpose shall be properly calibrated by standard authorised agencies which shall be traceable to National standards. For each such instrument proper validity of calibration shall be documented by Vendor.

2.0 DATASHEET: MOTOR

1.0	GENERAL		
1.1	APPLICATION:		FAN
1.2	NUMBER OF UNITS:		(*)
1.3	TYPE OF MOTOR		SQUIRREL CAGE (Energy efficient – EFF-1) type.
1.4	SUPPLY SYSTEM FAULT LEVEL	MVA	38MVA,50kA
1.5	SUPPLY NEUTRAL – TYPE OF EARTHING		EFFECTIVELY EARTHED SYSTEM
2.0	RATING		
2.1	RATED OUTPUT		kW (*)
2.2	RATED VOLTAGE		415V
2.3	NUMBER OF PHASES & FREQUENCY:		3 PHASE, 50 Hz
2.4	VOLTAGE AND FREQUENCY VARIATION		Voltage variation - +/-10%, Frequency Variation - +/-3%, Combined - 10%
2.5	SYNCHRONOUS SPEED		RPM(*)
3.0	DUTY		
3.1	TYPE OF DUTY(CLAUSE		(*)

	10.2 OF IS 325 OR CL9.3 OF IS 4722)		
3.2	POWER REQUIRED BY LOAD		(*)
4.0	METHOD OF STARTING:		D.O.L.
5.0	INSULATION		
5.1	CLASS OF INSULATION:		F WITH TEMP. RISE CLASS-B
5.2	PEF AMBIENT TEMPERATURE		45 °C
5.3	TEMPERATURE RISE BY		
5.3.1	BY THEROMOMETER METHOD		65 °C
5.3.2	BY WINDING RESISTANCE METHOD		75 °C (CLASS B)
6.0	INSTALLATION		
6.1	LOCATION		Indoor/Outdoor (*)
6.2	HAZARDOUS AREA DIVISION (IS: 5572 OR EQUIVALENT:)		NOT APPLICABLE
6.3	ATMOSPHERE		REFER SEC.B
7.0	ENCLOSURE		
7.1	TYPE OF COOLING (IS 6362)		TEFC
7.2	DESIGNATION OF DEGREE OF PROTECTION (IS 4691)		IP 55
8.0	MAIN TERMINAL BOX		
8.1	LOCATION AS SEEN FROM NON- DRIVE END		RIGHT/LEFT/TOP (*)
8.2	RATING 1, SHORT TIME CURRENT: DURATION: 2. DYNAMIC		(*) 50kA (RMS) 0.25 SECS kA (PEAK)
8.3	EXTERNAL CABLE DETAILS		(#)
8.3.1	TYPE		
8.3.2	SIZE AND NUMBER OF CORES		
8.4	EARTHING CONDUCTORS		
8.4.1	MATERIAL		Copper Insulated cable
8.4.2	SIZE		(#)

9.0	MISCELLANEOUS REQUIREMENT		
9.1	SHAFT ORIENTATION:		HORIZONTAL/VERTICAL/HOLLOW VERTICAL (*)
9.2	MOUNTING SYMBOL (IS :2253 OR EQUIVALENT)		(*)
9.3	ROTATION AS SEEN FROM NON-DRIVEN END		CLOCKWISE/ANTICLOCKWISE(*)
9.4	TYPE OF BEARING		DRIVE END/NON DRIVE END(*)
9.5	WHETHER BED PLATE REQUIRED		YES/NO (#)
10.0	COLOUR SHADES OF PLANT IF SPECIAL		Light Gray – Shade 631 of IS-5. Special varnishing and painting treatment to be given as the atmosphere is highly corrosive.
11.0	CTS FOR DIFFERENTIAL PROTECTION REQUIRED		NO
11.1	\$ CT PARTICULARS A) 3 CTS, ONE IN THE NEUTRAL LEAD OF EACH PHASE B) RATIO C) CLASS P. S. D) KNEE POINT VOLTAGE E) MAX. R. C. T. SECONDARY WINDING, F) MAX. EXCITING CURRENT AT 1/2 KPV G) CLASS OF INSULATION		NOT APPLICABLE
11.2	VIBRATION PADS REQUIRED		(#)
12.0	TEMPERATURE DETECTORS / INDICATORS		
12.1.1	EMBEDDED TEMPERATURE DETECTORS FOR WINDING REQUIRED		NO
12.1.2	EMBEDDED TEMPERATURE DETECTORS FOR BEARINGS REQUIRED		NO
12.1.3	BEARING THERMOMETERS FOR DRIVING END & NON DRIVING ENDS REQUIRED		NO
12.1.4	THERMISTERS FOR		YES FOR MOTORS ABOVE 110 kW

	MOTORS REQUIRED		AND VFD DRIVEN MOTORS
13.0	SPACE HEATERS FOR MOTORS REQUIRED		YES FOR MOTORS ABOVE 30 KW

NOTES:

7. DETAILS MARKED THUS (*) WILL BE DECIDED AND INTIMATED BY THE CONTRACTOR BASED ON DRIVEN EQUIPMENT CHARACTERISTICS
2. DATA MARKED THUS (#) WILL BE INTIMATED TO VENDOR AFTER PLACEMENT OF ORDER.

1.	INDUCTION MOTORS – THREE PHASE	IS-325	BS EN-60034-1	IEC-60034-1
2.	ROTATING ELECTRICAL MACHINES	IS-4722		
3.	SINGLE PHASE INDUCTION MOTOR	IS-996		
4.	CODE OF PRACTICE FOR CLIMATE PROOFING		BS EN-60034-5	IEC-60034-5
5.	DESIGNATIONS FOR TYPES OF CONSTRUCTION AND MOUNTING ARRANGEMENTS OF ROTATING ELECTRICAL MACHINES	IS-2253	BS EN-60034-7	IEC-60034-7
6.	TERMINAL MARKING FOR ROTATING ELECTRICAL MACHINERY	IS-4728	BS EN-60034-8	IEC-60034-8
7.	DESIGNATION OF METHODS OF COOLING FOR ROTATING ELECTRICAL MACHINES	IS-6362	BS EN-60034-6	IEC-60034-6
8.	DEGREE OF PROTECTION PROVIDED BY ENCLOSURE FOR ROTATING ELECTRICAL MACHINERY	IS-4691	BS EN-60034-3	IEC-60034-3
9.	GUIDE FOR TESTING THREE PHASE INDUCTION MOTORS	IS-4029	BS EN-60079-1	IEC-60034-1
10.	MEASUREMENT AND EVALUATION OF VIBRATION OF ROTATING ELECTRICAL MACHINES	IS-12075	BS EN-60034-14	IEC-60034-14
11.	CLASSIFICATION OF HAZARDOUS AREAS FOR ELECTRICAL INSTALLATION	IS-5572	BS EN-60079-10	IEC-60079-10
12.	DESIGNATION OF SLIDE RAILS FOR ELECTRIC MOTOR	IS-2968	BS EN-60034-1	
13.	PERMISSIBLE LIMITS FOR NOISE LEVEL FOR	IS-12065	BS EN-	IEC-60034-

	ROTATING ELECTRICAL MACHINES		60034-9	9
14.	GUIDE FOR TESTING INSULATION RESISTANCE OF ROTATING MACHINE	IS-7816		
15.	TEST PROCEDURES FOR MEASUREMENT OF LOSS TANGENT ANGLE OF COIL AND BAR FOR MACHINE WINDING - GUIDE	IS-13508		
16.	IMPULSE VOLTAGE WITHSTAND LEVEL			IEC-60034-15
17.	INDUCTION MOTORS - ENERGY EFFICIENT	IS-12615		
18.	TEMPERATURE RISE MEASUREMENT OF ROTATING ELECTRICAL MACHINES	IS-12802		
19.	TYPE OF DUTY AND CLASSES OF RATING ASSIGNED TO ROTATING ELECTRICAL MACHINES	IS-12824		
20.	ADJUSTABLE SPEED ELECTRICAL POWER DRIVE SYSTEM- EMC REQUIREMENTS AND SPECIFIC TEST METHODS.		BS-EN-61800	IEC-61800
21.	DIMENSIONS AND OUTPUT SERIES FOR ROTATING ELECTRICAL MACHINES.	IS-1231	BS-4999-141	IEC-60072-1
22.	ELECTRICAL APPARATUS FOR EXPLOSIVE GAS ATMOSPHERE – CLASSIFICATION OF HAZARDOUS AREA.	IS-5571	BS-EN-60079	IEC-60079-10
23.	TEMPERATURE RISE MEASUREMENT OF ROTATING ELECTRICAL MACHINES	IS-12802		

NOTE : EQUIPMENT, ASSOCIATED ACCESSORIES, COMPONENTS/PARTS, RAW MATERIAL AND TESTS SHALL IN GENERAL CONFORM TO IS.

DATASHEET : PRESSURE INDICATORS

PRESSURE INDICATORS DATA SHEET				SH 1 OF 1	
FEATURES	MANUFACTURER :	*	25 HOUSING : DIE CAST ALUMINIUM	<input checked="" type="checkbox"/>	
	MODEL NO. :	*	26 PRESSURE ELEMENT : SS 304	<input checked="" type="checkbox"/>	
	1 PRESSURE ELEMENT : BOURDON	<input checked="" type="checkbox"/>	27 POINTER : ALUMINIUM	<input checked="" type="checkbox"/>	
	2 TYPE : DIRECT READING <input checked="" type="checkbox"/> RECEIVER <input type="checkbox"/>	<input checked="" type="checkbox"/>	28 MOVEMENT : SS 304	<input checked="" type="checkbox"/>	
	3 MOUNTING : PIPE <input checked="" type="checkbox"/> FLUSH <input type="checkbox"/>	<input checked="" type="checkbox"/>	29 SOCKET : SS 304	<input checked="" type="checkbox"/>	
	4 DIAL SIZE : 150mm(6") <input type="checkbox"/> 4 1/2" <input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	30 DIAL : ALUMINIUM ; RING : ALUMINIUM	<input checked="" type="checkbox"/>	
	5 DIAL COLOUR : WHITE NUMERALS : BLACK	<input checked="" type="checkbox"/>	31 GLASS : SHATTER PROOF	<input checked="" type="checkbox"/>	
	6 POINTER : MICROMETER ADJ	<input checked="" type="checkbox"/>	32 CAPILLARY AND ARMOUR :	<input checked="" type="checkbox"/>	
	7 FRONT RING : SCREWED	<input checked="" type="checkbox"/>	33 DIAPH. SEAL/BODY :	<input checked="" type="checkbox"/>	
	8 ACCURACY : \pm 0.5% OF SPAN	<input checked="" type="checkbox"/>	34 SYPHON :	<input checked="" type="checkbox"/>	
	9 OVERRANGE PROTECTION : 1.5 TIMES	<input checked="" type="checkbox"/>	35 SNUBBER : SS 304	<input checked="" type="checkbox"/>	
	10 MAX. PRESSURE		36 PROCESS : 1/2" NPT (M)	<input checked="" type="checkbox"/>	
	ENCLOSURE	11		37 PROCESS(DIAPH. SEAL):	<input checked="" type="checkbox"/>
12			38 LOCATION : BOTTOM <input checked="" type="checkbox"/> BACK <input type="checkbox"/>	<input checked="" type="checkbox"/>	
13			39		
14 CASE : IP 67 AS PER IS 13947		<input checked="" type="checkbox"/>	40		
15 CASE COLOUR : GREY <input type="checkbox"/> BLACK <input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	41		
16 BLOW OUT DISC : REQ.		<input checked="" type="checkbox"/>	42		
17			43		
SUPPLY/SIGNAL		18		44 NAME PLATE : FIXED / SS	<input checked="" type="checkbox"/>
		19		45 SNUBBER : REFER NOTE 5	<input checked="" type="checkbox"/>
		20		46	
		21		47 METAL TAGS - SS	<input checked="" type="checkbox"/>
		22		48 MOUNTING BRACKET	<input checked="" type="checkbox"/>
		23		49 CHEMICAL DIAPHRAGM	<input checked="" type="checkbox"/>
	24		50 ARMoured CAPILLARY	<input checked="" type="checkbox"/>	
	CODES & STD.	51 IS 3624			<input checked="" type="checkbox"/>
52 ASME PTC 19.2				<input checked="" type="checkbox"/>	
53 IS 2147				<input checked="" type="checkbox"/>	
SPARES	54				
	55				
	56				
TESTS	57 CALIBRATION / HYDRO TEST (1.5 TIMES OF MAX. PR.)			<input checked="" type="checkbox"/>	
	58 CERTIFICATES OF TEST HOUSE EVALUATION FOR ACCURACY, REPEATABILITY & RELIABILITY			<input checked="" type="checkbox"/>	
	59 VENDOR TO SUBMIT ALL TEST CERTIFICATES FOR CONSULTANT / PURCHASER'S REVIEW & RECORDS			<input checked="" type="checkbox"/>	
DWG.	60 VENDOR TO SUBMIT DATA SHEETS, DRAWINGS AND MANUALS FOR THE EQUIPMENT FOR APPROVAL			<input checked="" type="checkbox"/>	
	61				
NOTES	1. BIDDER TO SUBMIT LIST OF INSTALLATIONS AND COMMISSIONS FOR THE MAKE & TYPE OF GAUGE OFFERED AND USERS' CERTIFICATES				
	2. *BIDDER TO FURNISH DETAILS ;				
	3. VOID				
	4. ALL ACCESSORIES SHALL BE SUPPLIED UNLESS OTHERWISE AS SPECIFICALLY BROUGHT OUT IN BILL OF MATERIAL IN THE FOLLOW UP SHEETS.				
	5. VENDOR TO PROVIDE SNUBBER FOR SERVICES WHERE PULSATIONS ARE ENCOUNTERED.				

DATASHEET : PRESSURE SWITCHES

GEN.	MANUFACTURER :	*	25	HOUSING :DIE CAST ALUMINIUM	✓	
	MODEL NO. :	*		26		
FEATURES	1 TYPE : INDICATING <input type="checkbox"/> NON-INDICATING <input checked="" type="checkbox"/>	✓	MATERIAL	27 MOVEMENT :SS 304	✓	
	2 SENSING ELEMENT: BOURDON	✓		28 PRESSURE ELEMENT : SS 304	✓	
	3 MOUNTING : FIELD <input checked="" type="checkbox"/> PANEL/RACK <input type="checkbox"/>	✓		29 SOCKET : SS 304	✓	
	4 SWITCH TYPE : MICROSWITCH	✓		30 GLASS :	✗	
	5 SWITCH DIFF.: ADJUSTABLE	✓		31 DIAPH SEAL/BODY :	✗	
	6 SET PRESSURE : EXT. TAMPERPROOF ADJ.	✓		32 CAPILLARY AND ARMOUR :	✗	
	7 OVERRANGE PROTECTION :1.5 TIMES MAX. PR.	✓		33		
	8 SCALE : REQ.	✓		34		
	9 ACCURACY : \pm 1% OF SPAN	✓		35		
	10			CONNECTIONS & DIMENSIONS	36 PROCESS : 1/2" NPT (M)	✓
11		37 AIR CONN. (RECEIVER TYPE) :	✗			
12		38 LOCATION : BOTTOM	✓			
13		39 CONDUIT : 1/2" NPT (F)	✓			
ENCLOSURE	14 CASE : IP 67 AS PER IS 13947	✓	40 CHEMICAL DIAPHRAGM PROCESS			
	15 CASE COLOUR : GREY <input type="checkbox"/> BLACK <input checked="" type="checkbox"/>	✓	41 CONNECTION :		✗	
	16		42 CAPILLARY :		✗	
	17		43			
SUPPLY/SIGNAL	18 INPUT SIGNAL : PROCESS <input checked="" type="checkbox"/>	✓	ACCESSORIES (REF NOTE 4)		44 NAME PLATE /METAL TAG :REQUIRED,SS	✓
	19 SWITCH CONTACTS :SPDT	✓			45 MOUNTING BRACKET :	✗
	20 SWTCH RATING :NOTE-6	*		46 SYPHON :	✗	
	21			47 BLOCK & BLEED VALVE : REQUIRED	✓	
	22			48 CHEMICAL DIAPHRAGM :	✗	
	23			49 ARMDOURED CAPILLARY :	✗	
	24			50		
DOSES & STD.	51			✓		
	52					
	53					
SPARES	54					
	55					
	56					
TESTS	57 CALIBRATION TEST / HYDRO TEST / CONTACT RATING TEST / ACCURACY TEST / REPEATABILITY			✓		
	58					
	59					
	60 VENDOR TO SUBMIT ALL TEST CERTIFICATES FOR CONSULTANT / PURCHASER'S REVIEW AND RECORDS			✓		
DWG.	61 VENDOR TO SUBMIT DATA SHEET, CONTACT DEVELOPMENT WITH TERMINAL DETAILS,		}	✓		
	62 DRAWINGS AND MANUALS FOR THE EQUIPMENT FOR APPROVAL					
NOTES	1. BIDDER TO SUBMIT LIST OF INSTALLATIONS AND COMMISSIONS FOR THE MAKE & TYPE OF INSTRUMENT OFFERED AND USER'S CERTIFICATE					
	2. * BIDDER TO STATE					
	3. VOID					
	4. ALL ACCESSORIES SHALL BE SUPPLIED UNLESS OTHERWISE AS SPECIFICALLY BROUGHT OUT IN BILL OF MATERIAL IN THE FOLLOW UP SHEETS.					
	5. VENDOR TO PROVIDE SNUBBERS FOR ALL SERVICES WHERE PULSATIONS ARE ENCOUNTERED.					
	6. RATING SHALL BE SUITABLE TO THE CIRCUIT VOLTAGE LEVEL IN WHICH IT IS WIRED.					

DATASHEET : PRESSURE RELIEF VALVE

GEN.	1	MANUFACTURER :	*	MATERIAL	30	BODY	CS	-304	-316	-H	-M	
	2	MODEL NO. :	*		31	BONNET	CS	-304	-316	-H	-M	
TYPE	3	TYPE :	CONVENTIONAL <input checked="" type="checkbox"/>	32	CAP	CS	-MS	-304	-316			
	4		THERMAL <input type="checkbox"/>	33	GUIDE	304	-316	-631	-H	-M		
	5		BALANCING BELLOWS <input type="checkbox"/>	34	DISC	304	-316	-630	-H	-M		
	6			35	SPINDLE	304	-316		-H	-M		
	7	BONNET :	OPEN <input type="checkbox"/>	36	STEM	304	-316	-410	-H	-M		
	8		CLOSED <input checked="" type="checkbox"/>	37	BELLOWS	304	-316					
	9	CAP :	SCREWED <input type="checkbox"/>	38	SPRING	CS	-304	-316				
	10		BOLTED <input checked="" type="checkbox"/>	39	NOZZLE	-CS	304	-316	-H	-M		
	11			40	BOLTS :	CS						
	12			41	NUTS :	CS						
ENCLOSURE	13	OVER PRESSURE	10 % <input checked="" type="checkbox"/>	42	NOZZLE STELLTING	YES <input type="checkbox"/>	NO <input checked="" type="checkbox"/>					
	14		25 % <input type="checkbox"/>	43	SPRING PLATING :	YES <input type="checkbox"/>	NO <input checked="" type="checkbox"/>					
	15	BLOW DOWN PRESSURE	5 % <input checked="" type="checkbox"/>	44	IF YES :	CADMIUM	<input type="checkbox"/>					
	16		10 % <input type="checkbox"/>	45		NICKEL	<input type="checkbox"/>					
	17	LIMIT SWITCHES :	WEATHER PROOF <input type="checkbox"/>	46		ALUMINISED	<input type="checkbox"/>					
	18		EXPLOSION PROOF <input type="checkbox"/>	47	BODY BONNET GASKETS :	METAL	<input type="checkbox"/>					
	19			48		PTFE	<input type="checkbox"/>	*				
	20			49		CAF	<input type="checkbox"/>					
	21			50	BONNET CAP GASKETS :	METAL	<input type="checkbox"/>					
	ACCESSORIES	22	LEVER :	PACKED <input type="checkbox"/> OPEN <input checked="" type="checkbox"/>	51		PTFE	<input type="checkbox"/>	*			
23			RIGHT <input type="checkbox"/> LEFT <input type="checkbox"/>	52		CAF	<input type="checkbox"/>					
24		LIFT INDICATOR :	YES <input type="checkbox"/> NO <input checked="" type="checkbox"/>	53	FLANGED		INLET	OUTLET				
25		DRAIN PLUG :	YES <input type="checkbox"/> NO <input checked="" type="checkbox"/>	54	RF SERRATED							
26		TEST GAG :	NO <input type="checkbox"/> YES <input checked="" type="checkbox"/>	55	RF SF / FF		RF	RF				
27		STEAM JACKETING :	YES <input type="checkbox"/> NO <input checked="" type="checkbox"/>	56	150/300/600 LBS					*		
28		LIMIT SWITCHES :	YES <input type="checkbox"/> NO <input checked="" type="checkbox"/>	57	BW/SW TYPE NPT/BSP							
29				58	THREADED NPT/BSP							
CODES&STD	59	WEATHER PROOF DIN 40040 /IS - 2147										
	60	EXPLOSIONP ROOF EN 50014 EN 50020 / IS - 2148										
	61	SIZING FORMULAE API RP 520 / ASME SECTION VIII DIV - 1 / IBR										
	62											
SPARES	63											
	64											
	65											
TESTS	66	PERFORMANCE <input checked="" type="checkbox"/> CALIBERATION <input checked="" type="checkbox"/> BODY + SEAT HYDRO TEST <input checked="" type="checkbox"/>										
	67	PNEUMATIC BODY + SEAT <input type="checkbox"/> DIMENSIONS <input checked="" type="checkbox"/> VISUAL <input checked="" type="checkbox"/> HYDRO PNEUMATIC TESTS TC <input type="checkbox"/>										
	68	MATERIAL TC <input checked="" type="checkbox"/> PERFORMANCE & CALIBERATION TC <input checked="" type="checkbox"/> NDT** TESTING TC <input type="checkbox"/> DEGREE OF PROTECTION TC <input checked="" type="checkbox"/>										
DWG	69	DIMENSIONAL REPORT <input checked="" type="checkbox"/>										
	70											
NOTES	* BIDDER TO STATE											
	**NDT(NON DESTRUCTIVE TEST)-RADIOGRAPHY <input type="checkbox"/> ULTRASONIC FLAW DETECTION(US FD) <input type="checkbox"/> DYE PENETRANT(DP) <input type="checkbox"/>											
	EDDY CURRENT <input type="checkbox"/>											
	H - HASTELLOY - C											
	M - MONEL											
	TC - TEST CERTIFICATES											

DATASHEET : TEMPERATURE SWITCH

GEN.	MANUFACTURER :		*	25	HOUSING : DIE CAST ALUMINIUM	<input checked="" type="checkbox"/>	
	MODEL NO. :		*		26		<input type="checkbox"/>
FEATURE	1	TYPE :NON-INDICATING	<input checked="" type="checkbox"/>	MATERIAL	27	SOCKET : SS 304	<input checked="" type="checkbox"/>
	2	MOUNTING :FIELD	<input checked="" type="checkbox"/>		28	MOVEMENT : SS 304	<input checked="" type="checkbox"/>
	3	THERMOWELL WITH HEX. HEAD : SEE NOTE 3	<input checked="" type="checkbox"/>		29	THERMOWELL : SS 304	<input checked="" type="checkbox"/>
	4	CONSTRUCTION :TAPERED	<input checked="" type="checkbox"/>		30	CAPILLARY :	<input type="checkbox"/>
	5	ACCURACY : $\pm 2^{\circ}\text{C}$	<input checked="" type="checkbox"/>		31	GASKET : CAF	<input checked="" type="checkbox"/>
	6	SCALE : REQD.	<input checked="" type="checkbox"/>		32	GLASS :	<input type="checkbox"/>
	7	SWITCH TYPE : MICROSWITCH	<input checked="" type="checkbox"/>		33	BULB :	<input type="checkbox"/>
	8	SWITCH DIFF. : ADJUSTABLE	<input checked="" type="checkbox"/>		34		<input type="checkbox"/>
	9	SET PRESSURE : EXTERNAL TAMPERPROOF ADJ.	<input checked="" type="checkbox"/>		35		<input type="checkbox"/>
	10	OVER RANGE PROTECTION : 150% OF SPAN	<input checked="" type="checkbox"/>		36	THERMOWELL PROCESS CONN : 1 1/2" FLANGED	<input checked="" type="checkbox"/>
	11	AMBIENT TEMP. COMPENSATION : REQD.	<input checked="" type="checkbox"/>		37	TYPE : SCREWED(M33x2) <input type="checkbox"/> SW <input type="checkbox"/> FLANGED	<input type="checkbox"/>
	12	ACTUATING ELEMENT : BIMETALLIC	<input checked="" type="checkbox"/>		38	FLANGE : RF ANSI 150 CLASS <input checked="" type="checkbox"/> 300 <input type="checkbox"/>	<input checked="" type="checkbox"/>
ENCLOSURE	13		<input type="checkbox"/>	CONNECTIONS & DIMENSIONS	39	BULB CONN. : CONDUIT CONN.:1/2" NPT(F)	<input checked="" type="checkbox"/>
	14	HOUSING : IP 67 AS PER IS 13947	<input checked="" type="checkbox"/>		40	BULB FITTING :	<input type="checkbox"/>
	15	HOUSING COLOUR : GREY <input type="checkbox"/> BLACK <input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		41	BULB DIA. TO MATCH BORE OF TW	<input type="checkbox"/>
	16		<input type="checkbox"/>		42	LOCATION : BACK <input type="checkbox"/> BOTTOM <input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	17		<input type="checkbox"/>		43	CAPILLARY LENGTH :	<input type="checkbox"/>
SUPPLY/SIGNAL	18	SWITCH CONTACTS : SPDT	<input checked="" type="checkbox"/>	ACCESSORIES	44	NAME PLATE : REQUIRED	<input type="checkbox"/>
	19	SWTCH RATING :	*		45	MOUNTING BRACKET :	<input type="checkbox"/>
	20		<input type="checkbox"/>		46	METAL TAG : SS	<input checked="" type="checkbox"/>
	21		<input type="checkbox"/>		47		<input type="checkbox"/>
	22		<input type="checkbox"/>		48		<input type="checkbox"/>
	23		<input type="checkbox"/>		49		<input type="checkbox"/>
	24		<input type="checkbox"/>		50		<input type="checkbox"/>
CODES & STD.	51	ASME PTC 19.3, HEAD:					<input checked="" type="checkbox"/>
	52	IS 13947					<input checked="" type="checkbox"/>
	53						<input type="checkbox"/>
SPARES	54						<input type="checkbox"/>
	55						<input type="checkbox"/>
	56						<input type="checkbox"/>
	57						<input type="checkbox"/>
TESTS	58	CALIBRATION / MATERIAL TEST / ACCURACY TEST / BORE CONCENTRICITY : $\pm 5\%$ OF WALL THK.					<input checked="" type="checkbox"/>
	59	HYDROSTATIC TEST FOR TW 1.5 TIMES MAX. PR./CONTACT RATING TEST					<input checked="" type="checkbox"/>
	60	VENDOR TO SUBMIT ALL TEST CERTIFICATES FOR CONSULTANT/PURCHASER'S REVIEW & RECORD					<input checked="" type="checkbox"/>
	61	IBR CERTIFICATES					<input type="checkbox"/>
DWG.	62	VENDOR TO SUBMIT DATA SHEETS, DRAWNGS AND MANUALS FOR THE EQUIPMENT FOR APPROVAL					<input checked="" type="checkbox"/>
	63	VENDOR TO SUBMIT CALCULATIONS FOR IMMERSION LENGTHS FOR APPROVAL					<input checked="" type="checkbox"/>
NOTES	1. BIDDER TO SUBMIT LIST OF INSTALLATIONS AND COMMISSIONS FOR THE MAKE & TYPE OF INSTRUMENT OFFERED AND USERS' CERTIFICATES.						
	2. * BIDDER TO STATE						
	3. BAR STOCK ASSEMBLY.						
	4. VOID						
	5. RATING SHALL BE SUITABLE TO THE CIRCUIT VOLTAGE LEVEL IN WHICH IT IS WIRED.						

DATASHEET : PRESSURE TRANSMITTER

62.	MANUFACTURER :	*
63.	MODEL NO.:	*
64.	<u>FEATURES:</u>	
65.	TYPE: INDICATING <input checked="" type="checkbox"/> SMART TYPE <input type="checkbox"/>	
66.	ELECTRIC (TWO WIRE) <input checked="" type="checkbox"/>	
67.	MOUNTING : FIELD <input checked="" type="checkbox"/> RACK <input type="checkbox"/>	
68.	EXTERNAL ZERO AND SPAN ADJ. :REQUIRED	
69.	ACCURACY : $\pm 0.1\%$ OF SPAN	
70.	OVER RANGE PROTECTION : 130% OF SPAN	
71.	LOCAL DISPLAY : LCD REQUIRED.	
72.	QUANTITY: 3 Nos	
73.	TAG NOS.: LATER	
74.	SERVICE: AIR	
75.	ENCLOSURE PROTECTION	
76.	CASE : EX PROOF ZONE __ GR._____	
77.	WEATHER PROTECTION: IP 65 AS PER IS 13947	
78.	CASE COLOUR : GREY <input type="checkbox"/> BLACK <input type="checkbox"/>	*
79.	POWER SUPPLY / SIGNAL:	
80.	OUTPUR SIGNAL: 4 TO 20 mA	
81.	POWER SUPPLY: 230 VAC / 24 V DC	*
82.	HART COMMUNICATION PROTOCOL: NOT REQUIRED	
83.		
84.	MATERIAL OF CONSTRUCTION	
85.	HOUSING: DIE CAST ALUMINIUM <input checked="" type="checkbox"/> SS 316 <input type="checkbox"/>	
86.	SENSING ELEMENT : SS 316	
87.	BODY: ALUMINIUM ALLOY	
88.	CAPILLARY AND ARMOUR: NOT REQUIRED	
89.	SYPHON:	
90.	CONNECTION & DIMENSIONS	
91.	PROCESS CONNECTION: THREADED <input checked="" type="checkbox"/> FLANGED <input type="checkbox"/>	
92.	THREADED PROCESS CONNECTION: $\frac{1}{2}$ "NPT (M) <input checked="" type="checkbox"/> $\frac{1}{4}$ "NPT (M) <input type="checkbox"/> 1" NPT(M) <input type="checkbox"/> 3/8 INCH BSP <input type="checkbox"/>	
93.	FLANGED PROCESS CONNECTION: FLANGE RATING : FLANGE SIZE :	
94.	PROCESS CONNECTION LOCATION: BOTTOM <input checked="" type="checkbox"/> BACK <input type="checkbox"/>	

95.	CABLE ENTRY: ½” NPT (F) <input checked="" type="checkbox"/>	
96.	ACCESSORIES (REFER NOTE 3)	
97.	NAME PLATE / METAL TAG : REQUIRED, SS	
98.	MOUNTING BRACKET: REQUIRED	
99.	CAPILLARY :NA	
100.	CABLE GRAND : REQUIRED	
101.	CHEMICAL SEAL :NA	
102.	ALL INSTALLATION HARDWARE: REQUIRED	
103.	SYPHON: NA	
104.	ISOLATION & DRAIN VALVES : REQUIRED	
105.	CODES AND STANDARDS (REFER NOTE 2)	
106.	WEATHER PROOF – IS 13947 PART I	
107.	EXPL. PROOF–IS 2148/ BS EN 50014/ BS EN 50020	
108.		
109.	<u>TESTS :</u>	
110.	CALIBRATION : REQUIRED	
111.	HYDRO TEST : REQUIRED	
112.	LEAK TEST: REQUIRED	
113.	OVER RANGE TEST: REQUIRED	
114.	REPEATABILITY: REQUIRED	
	DRAWINGS / DOCUMENTS	
1.	THE VENDOR SHALL SUBMIT CATALOGUES, DATA SHEET AND ERECTION SKETCH FOR REVIEW AND COMMENTS BY EMPLOYER/ PROJECT MANAGER.	
2.	THE VENDOR SHALL SUBMIT INSTRUCTION MANUAL FOR RECORDS.	
	<u>TEST CERTIFICATES</u>	
1.	VENDOR SHALL SUBMIT ALL ROUTINE TEST CERTIFICATES FOR EMPLOYER/PROJECT MANAGER'S REVIEW.	
2.	VENDOR SHALL SUBMIT TYPE TEST CERTIFICATES FOR PROTECTION CLASS.	
	<u>Notes :</u>	
	1.0 * CONTRACTOR TO FURNISH DETAILS	
	2.0 THE CONTRACTOR SHALL INDICATE ALL APPLICABLE CODES AND STANDARDS.	
	3.0 ALL ACCESSORIES SHALL BE SUPPLIED AS APPLICABLE.	

TECHNICAL SPECIFICATION
ELECTRICAL WORKS

ELECTRICAL WORKS

7.1 INTRODUCTION – ELECTRICAL

- 7.1.1 Followings CPWD Specification for Electrical shall take precedence over provisions of relevant I.S. Codes.
- CPWD specification for electrical works part I internal 2013
 - CPWD general specifications for electrical works - part ii (external) 1994
 - CPWD general specifications for electrical works part-iv substation 2013
- 7.1.2 All Electrical works shall be carried out in accordance with the provisions of National Electrical Code 2011 and Central Electricity Authority 2010.
- 7.1.3 Refer following Detailed Technical specifications for items which are not covered in above mentioned CPWD Specifications. This specification is to be read along with SLDs and BOQs. In case of any conflict in specification, BOQ spec/ description will be followed.

7.2 HIGH VOLTAGE METAL ENCLOSED SWITCHGEAR

7.2.1 Scope

Supply, Manufacturing , installation, testing commissioning of integrated cubicle type metal clad, form 3 a, floor mounted and draw out type free standing, front operated indoor type 33 kV switchgear as per following specifications :

7.2.1.1 General

The switchgear enclosure shall conform to degree of protection IP -52.

The switchgear shall be made from MS sheet steel 2 mm thick (CRGO) and shall be folded and braced as necessary to provide a rigid support for all components.

The switchgear assembly shall form a continuous dead front line up of free standing vertical cubicles. Each cubicle shall have a lockable front hinged door and a removable bolted back cover. All covers and doors shall be provided with neoprene gaskets. Suitable arrangement for lifting of each cubicle shall be provided. Design and construction of the switchgear shall be such as to permit extension at either end.

Vacuum Circuit breaker shall be provided with surge arresting device for protection against lightning and switching over voltage. Two separate and distinct connections to earth shall be provided for each surge arrestor.

Suitable earthing trolley/ truck shall be provided separately for each substation.

7.2.1.2 Breaker Compartment

Vacuum Circuit Breaker shall be mounted in draw out truck with front plate which covers the cubicle when the breaker is in service position. Draw out mechanism shall be horizontal type. This front plate shall be provided with view glass to facilitate observation of mechanical ON/OFF indication of Circuit breaker, Spring charged / discharged indication and operation counter. Necessary orifice shall be provided for manual charging of the springs. ON/OFF push button for opening and closing of the

circuit breaker shall also be provided. The draw out truck shall have two positions for the circuit breaker VIZ isolated / Test & Service.

7.2.1.3 Bus Bar Compartment

Bus bars of rectangular cross section of copper conductor supported by cast epoxy insulator to withstand full short circuit currents upto 18kA for 33 kV system shall be provided at the rear. Bus bar chamber shall be provided with inter panel barriers with epoxy cast seal off bushings.

7.2.1.4 CT and Cable Compartments

At the rear of the panel sufficient space shall be available to accommodate three numbers epoxy CT's of double core and two numbers three core cable termination. The cable entry shall be from the top / bottom.

7.2.1.5 Separate Compartments

Circuit breakers, instrument transformer, bus bars, cable etc shall be housed in a district different compartments as required for form 3 a, compartmentalization. All relays, switches, lamps, etc. comprising the control, indication and protective devices shall be housed in a separate compartment on the front of the cubicle.

7.2.1.6 Technical Particulars of Vacuum Circuit Breaker

S.NO.	DESCRIPTION	33 kV
A	Rated Current	630 A
B	Rated Voltage	36 kV
C	Rated Frequency	50Hz
D	Rated Short Circuit breaking Current	18 kA
E	Rated short circuit making current (kAP)	66 kA
F	Insulation level (kV rms/kVP)	70 kV / 170 kV

7.2.1.7 Isolating Contacts

The breaker isolating contacts shall consist of two parallel flat silver plated copper bars with ball point contacts to give a vertical tolerance of ± 10 mm.

7.2.1.8 Low Voltage Plug and Socket Connector

A twenty pin plug and socket connection along with flexible leads shall be provided to connect control instrumentation and interlock circuits on the breaker truck and in the panel. The plug and socket assembly shall be suitably interlocked with the truck positions like service and test/isolated position.

7.2.1.9 Interlocks and Safety Devices

The following interlocks shall be provided:

- The truck cannot be moved from either test to service position or vice versa, when the circuit breaker is 'ON'.

- b) The circuit breaker cannot be switched 'ON' when the truck is in any position between test and service position.
- c) Front part of the truck cannot be removed when the breaker in 'ON' position.
- d) The truck cannot be inserted when the earthing switch is 'ON'.
- e) The low voltage plug and socket cannot be disconnected in any position except test/isolated position.
- f) The truck cannot be moved inside the panel, when the LT plug and socket is disconnected.
- g) Earthing switch cannot be switched 'ON' when the truck is inside the panel.

7.2.1.10 Safety Devices

The following Safety devices shall be provided for the safety of the operating personnel:

- a) Individual explosion vents shall be provided for breaker chamber/bus bar/cable chambers on the top of the panel to let out the gases under pressure generated in case of fault inside the panel.
- b) Cubicle with front plate to withstand the pressure for internal arc fault as per PEHLA recommendation.
- c) Circuit breaker and sheet metal enclosure shall be fully earthed.
- d) Self locking shutters shall be provided which shall close automatically when the truck is withdrawn to 'Test position' and no separate padlocking of the shutter shall be required.

7.2.1.11 Protective Earthing

The earthing connection between the truck and the cubicle shall be by means of sliding contacts so that the truck is earthed in the isolated position when inserted and remains earthed when the truck is pushed further into the connected position or when the truck is being withdrawn until the truck has moved part the isolated position.

7.2.1.12 Current Transformer

General Requirements

Accommodation shall be provided in the circuit breaker panel, to mount one set of dual ratio CT. Access to the CTS for cleaning, testing or changing shall be from the front, back or top of the panel.

Rating

Dual ratio CTS of suitable burden (but each not less than 15 VA) shall be preferred with 5 amps secondaries.

Instrument Security Factor (ISF) of each CT shall not be more than 5.

The CTs shall conform to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast robust to withstand thermal and dynamic stresses during short circuits. CT terminals shall be shorting type. Current & voltage circuits shall be laid in separate wire ways. Secondary terminals of CTS shall be brought out to a suitable terminal block which will be easily accessible for terminal connections. Test terminal block shall be provided in the front side of the panel for testing purpose.

CT'S shall have 2 Nos. of cores for following application:

Core -1 for metering

Core -2 for over current & earth fault protection.

Class of accuracy for winding

Metering class 0.5

Protection class 5P10

7.2.1.13 Potential Transformers

The potential transformers shall be confirming to IS 3156/ IEC 60185. The primary windings of the potential transformers shall be insulated and shall be of the cast rest in type.

Potential transformer (PT'S) shall be mounted on a draw out trolley and housed in separate metal compartment and shall have control fuses on the H.V. side and a miniature circuit breaker on the L.V. side of the windings. HT HRC Control fuses shall be confirming to IS – 9385/ IEC –60282. Miniature Circuit breaker shall comply with IS – 8828/ IEC – 60898.

Padlocking facilities shall be provided for both service and isolated position.

The potential transformer shall be as specified below:

Ratio	:	33000 / $\sqrt{3}$ / 110/ $\sqrt{3}$ / 110 V 110 V
V A Burdan	:	100 V A for 100/ $\sqrt{3}$ and 110 V winding
Class	:	CL –1 for both the windings.
Basic Insulation level	:	Same as mentioned for VCB in clause - 6.
Over voltage factor	:	1.2 Continuous

Single phase PT'S shall be used and shall be connected in Star/ Star.

7.2.1.14 Protection and Tripping Arrangement

Protection

All protection relay shall be numeric type of approved make.

The protection and tripping arrangement of circuit breaker shall be Provided as per BOQ & as mentioned below:-

- Numeric type instantaneous short circuit protection Device No.50 Range 500 – 2000% shall be provided on all phases.
- Numeric type back up over current protection for Phase faults Device No.51 Range 50 – 200% shall be provided on all phases.

Numeric type ground fault protection Device No.50G. CT's. Range 20 – 80% shall be provided.

Surge Arrestor

Lockout and trip supervisory relays etc shall be provided with manual reset facility. Auxiliary relay for transformer fault.

7.2.1.15 Control Wiring

The control wiring shall be carried out with 1.5/2.5 sq. mm. PVC insulated copper conductor cables. The wiring shall be securely fixed and neatly arranged to enable easy tracing of wires. Identification PVC ferrules shall be fitted to all wire terminals to render easy identification and facilitate checking in accordance with IS 5578 and 11353.

7.2.1.16 Metering Instrument Panel Accessories

Metering

Digital type Trivector meter of approved make (Smart demand controller) shall be provided on the incomer feeder. Specification of the meter shall be as follows:

Accuracy	:	Class 0.5, compliant to revenue class certification.
	:	Real time measurement per phase & average
	:	V, I, PF, kW, kVAR, kVA
	:	Peak demand, sliding window. Protected.
	:	V & I unbalance, Phase reversal
	:	Time of Use (TOU)

Power Quality Measurement:

:	Total Harmonics
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Logging & recording for all measurements:

:	Interval or event-based, 32 channel measurement & recording
:	Event logging
:	“Bust” data recording
:	Min/ Max recording

Alarming	:	Over & under measurement detection by 24 set point functions.
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Multiport

Communication:	One each of RS 485 and RS 232 ports.
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7.2.1.17 Instrument Panels

The instrument panel shall be part of the housing. Relays, meters and instruments shall be mounted as per general arrangement drawings to be submitted by the vendors. They shall be of flush mounting type.

7.2.1.18 Instrumentations

- Digital type Voltmeter of class 1.0 accuracy and 96 x 96 mm square in size as per IS-1248 shall be provided at incomer panel, with selector switch. The instrument shall be calibrated for the ranges specified.
- Digital type Ammeter of specified range to class 1.0 accuracy and 144 x 144 sq mm in size as per IS - 1248 shall be provided at both incomer and outgoing panels along with necessary selector switches.
- Digital type frequency meter class of 1.0 accuracy conforming to IS:1248 shall be provided at incomer panel.
- Digital type Power factor meter of class of 1.0 accuracy conforming to IS : 1248 shall be provided at incomer panel.

The following minimum indication lamps shall be provided in the front of cubicle.

Breaker open / closed / tripped, spring charged, trip circuit healthy and control supply healthy. Lamps shall be clustered LED type and trip circuit supervision scheme shall be of continuous supervision type.

After meeting all necessary control and indication requirements 2 nos. NO and 2 nos.. NC auxiliary of the breaker shall be made available for the Employer, wired up to terminal block.

Separate MCB's shall be provided for lamps, heaters and other instrumentation etc. on each panel.

Anti-condensation space heaters suitable for operation on 240 V single phase, 50 Hz A.C. for each cubicle and with thermostat control one incandescent lamp with switch and 3 pin 5 amps plug socket.

7.2.1.19 Inspection and Testing

After manufacturing of switchgear panels tests shall be carried out on the equipment as per relevant IS and Electricity Regulations.

7.2.1.20 Quality Assurance

Vendor shall submit in substantial detail a quality assurance plan indicating all activities step by step at various manufacturing/fabrication stages to meet the requirement of this specification and various standards/regulations/practices to enable comprehensive assessment of its merits and reliability.

7.3 LOW VOLTAGE SWITCHGEAR

7.3.1 Scope

This Section covers the detailed requirements of medium voltage switch Panel for 433V, 3 phase 50 Hz 4 wire system. These shall be branded and/or assembled/fabricated from a factory of repute. All switchgears shall be fully rated at an ambient of 50° C.

Type of Panel

The medium voltage switch board panel shall comprise of any one of the following types of switchgears or combination thereof as specified.

Air Circuit breakers draw out or fixed type, Switch Disconnecter Fuse Units fixed type, MCCBs of suitable Ics ratings. MCCBs shall invariably be Current Limiting type. Features like Double Break, Positive Isolation functions shall be preferred.

The Panel shall be indoor type having incoming sectionalization and outgoing switchgears as specified. The design shall be cubical type. The degree of enclosure protection shall be IP 42 as per IS: 13947 (Part-I).

7.3.2 LT Panel

7.3.2.1 General Construction

- a) The switchboard shall be floor mounted free standing totally enclosed and extensible type of uniform height not more than 2400mm. The switch board shall be dust & vermin proof and shall be suitable for the climate conditions as specified. The design shall include all provisions for safety of operation and maintenance personnel. The general construction shall conform to IS: 8623/1993 for factory assembled switch board.

- b) LT Panels shall be provided with a metal sill frame made of structural steel channel section properly drilled for mounting the Switchgear along with necessary mounting hardware. Hardware shall be zinc plated and passivated, Provided with cable entry facilities at top/bottom as per layout requirement with 3mm thick removable gland plates on breaker panels and 2 mm thick removable gland plates on other panels with necessary cable glands. For 1-core cables, these plates shall be non-magnetic.
- c) Switchgear shall be provided with gaskets all round the perimeter of adjacent panels, panel and base frame, removable covers and doors,
- d) Provided with busbars running at the top, as required, all along the length of the switchgear in a separate sheet steel enclosure.

7.3.2.2 Cubical Type Panels

Cubical type panels shall be fabricated out of sheet steel not less than 2.0 mm thick. Wherever necessary, such sheet steel members shall be stiffened by angle iron frame work. General construction shall employ the principle of compartmentalization and segregation for each circuit. Unless otherwise approved, incomer and bus section panels or sections shall be separate and independent and shall not be mixed with sections required for feeders. Each section of the rear accessible type panel shall have hinged access doors at the rear. Overall height of the panel shall not exceed 2.4 meters. Operating levers, handle etc. of highest unit shall not be higher than 1.7 meters. Multi-tier mounting of feeder is permissible. The general arrangement for multi tier construction shall be such that the horizontal tiers formed present a pleasing and aesthetic look. The general arrangement shall be approved before fabrication. Cable entries for various feeders shall be either from top or bottom. Through cable alleys located in between two circuit sections ,either in the rear or in the front of the panel. All cable terminations shall be through gland plates. There shall be separate gland plate for each cable entry so that there will not be dislocation of already wired circuits when new feeders are added. Cable entry plates shall therefore be sectionalized. The construction shall include necessary cable supports for clamping the cable in the cable alley or rear cable chamber.

Cubicle panels with more than 1000 Amps BUS shall be made of tested structural modular sections.

7.3.2.3 Bus Bar and Connections

The bus bars shall be of Copper/Aluminum of high conductivity electrolytic quality and of adequate section. Current density shall not exceed 130 amps for Copper /sq. cm. The bus bar system may comprise of a system of main horizontal bus bars and ancillary vertical bus bars run in bus bar alleys on either side of which the circuit could be arranged with front access cable entries. In the case of rear access, horizontal bus system shall run suitably either at the top or bottom. All connections to individual circuits from the bus bar shall preferably be solid connections; however flexible connections shall also be permitted as per recommendations of the Panel Manufacturer. All bus bars and connections shall be suitably sleeved / insulated with heat shrinkable PVC with approved manner.

The insulation shall be non-inflammable and self-extinguishing and in fast colours to indicate phases. The joints shall be insulated in such a way as to provide for accessibility of contact bolts for maintenance. Joints shall be covered with removable moulded shrouds made out of fibreglass-reinforced polyester.

7.3.2.4 Incomer I Termination

Incomer termination shall be suitable for receiving bus trunking /underground cables. Cable terminations shall invariably be through terminal blocks (Polyamide or superior) or brought out solid terminals.

7.3.2.5 Instruments

All voltmeters and ammeters shall be flush mounted of size minimum 96 mm conforming to class 1,5 of IS: 1248 for accuracy. All voltmeters shall be protected with MCB. They shall be suitable for semi-flush with only flanges projecting on vertical panels.

7.3.2.6 Indicating Lamps

On all the incomers of M.V panels, ON/OFF indicating LED lamps shall be provided and shall be suitable for operation on AC supply. Phase indicating LED lamps shall be associated with necessary ON/OFF toggle switch.

7.3.2.7 Small Wiring

All small wiring for Controls, Indication etc, shall be of with suitable FRLS/HFFR (halogen free fire retardant) copper conductor cables. Wiring shall be suitably protected within switch board. Runs of wires shall be neatly bunched, suitably supported and clamped. Means shall be provided for easy identifications of the wires. Where wires are drawn through steel conduits, the works shall conform to CPWD General Specifications for Electrical works (Part I- Internal) - 2005 and IS:732 as the case may be. Identification ferrules shall be used at both ends of the wires. All control wiring meant for external connections are to be brought out of terminal board.

7.3.2.8 Operational Requirements

The indoor type LT panel shall conform to the following: -

The panel shall comprise of incomers, outgoing feeders and bus coupler as specified. The incomer shall be either a double break / contact repulsion MCCB or an Air Circuit Breaker. The bus coupler shall be either a circuit breaker or a double break / contact repulsion MCCB, ACB, switch disconnector fuse unit as specified. The outgoing feeders shall be circuit breakers/MCCBs as specified.

Bus bars for phase and neutral shall have a rating as specified in SLD and BOQ.

The entire switch panel shall be cubical type generally conforming to 18:8623/1993 for factory assembled switch board.

The incomer panel shall be suitable for receiving bus trunking or LT cable of size specified either from top or from bottom.

All incoming AIRCIRCUIT BREAKER/MCCB shall have suitable adjustable tripping current and the time delay settings.

The entire panel shall have a common earth bar of size as specified with two terminals for earth connections.

7.3.2.9 Rating and Requirements

Air Circuit Breaker*

All Air Circuit Breakers shall be 3/4 pole with minimum 50 KA breaking capacity (35 MVA at 433V) conforming to IS: 13947 (Part-II). Rated current shall be as per capacities specified. The equipment shall be complete with the following: -

- a) Necessary circuit breaker carriage with 3 position (isolate, test, service) draw-out mechanism.

- b) Necessary isolating plugs and sockets.
- c) Necessary mechanism interlock and automatic safe shutters gear with arrangement for pad locking.
- d) Necessary independent manual spring mechanism with mechanical On/Off indication as well as electrical On/Off indication,
- e) Necessary bus bars with bolted type neutral links.
- f) ACB shall be provided with microprocessor based releases having built in over load, short circuit & earth fault protection. Microprocessor release shall be EMI (electro magnetic induction)/EMC(electro magnetic compatible) certified.
- g) Necessary set of auxiliary switches.
- h) Necessary set of CTs with ratios as specified.
- i) Necessary identification, metering requirements as specified i/c. ON/OFF indication lamps, selector switches, fuses, ammeter, voltmeter etc.
- j) In case of 4 pole breaker neutral shall be fully rated with adjustable settings from 50% to 100% of In.
- k) ACB terminals shall be suitable/suitably brought out for direct aluminum termination as per IS 13947 Part-II.
- l) Provided with 'red', 'green' and 'amber' indicating lamps to indicate 'closed' 'open' and 'auto-trip' conditions of the circuit breaker when breaker operation is controlled by a control switch.
- m) All indicating lamps shall be clustered LED type, with in-built short circuit, surge protections etc. Adequate number of contacts shall be provided to have remote annunciation of the breaker feeders:

Breaker 'ON'

Breaker 'OFF'

Breaker 'TRIP'

Breaker 'Service'

Breaker 'Test'

Note: Wherever fixed type circuit breakers are required, it shall be clearly specified.

MCCB/ MCB etc:

MCCBs : All MCCBs shall be current limiting type with features of load line reversibility and suitable for Horizontal/Vertical mounting without any derating. Beyond 300 Amps capacity MCCBs shall have positive isolation and preferably double break / contact repulsion & double insulation features. The MCCBs shall invariably be used with terminal spreaders.

- a) The MCCBs shall conform to the latest applicable standards (IS: 13947).
- b) MCCBs in AC circuits shall be of TP/TPN/FP construction arranged for simultaneous manual closing and opening. Operating mechanism shall be quick-make, quick-break and trip-free type. The ON, OFF and TRIP positions of the MCCB shall be clearly indicated and visible to the operator. Operating handle for operating MCCBs from door of board shall be provided.

- c) The instantaneous short circuit release shall be so chosen by the CONTRACTOR as to operate at a current in excess of the peak motor inrush current and a range of settings shall be provided for the EMPLOYER 'S / ENGINEER'S selection.
- d) MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes relevant to circuit ratings.
- e) Minimum no. of additional auxiliary contacts (for Employer's use) shall be provided.
- f) MCCBs shall incorporate time delay devices to ensure that it will tolerate harmless transient overload unless this is well in excess of 25% of its rated value for a sustained period.

MCBs: Miniature circuit breakers for use on motor space heater control circuits shall comply with the requirements of applicable standards, unless otherwise mentioned in Data Sheet.

CONTACTORS: Motor starter contactor shall be of the electromagnetic type rated for uninterrupted duty as defined in applicable standards.

Main contacts of motor-starter contactors shall be of silver plated copper.

Contactors shall be of the double break, non-gravity type.

Direct-on-Line Starters/Star Delta Starters : Starters shall be suitable for Class AC 3 utilisation category as specified in applicable standards.

7.3.3 Lightning and Surge Voltage Protection

7.3.3.1 Scope

This specification describes the electrical and mechanical requirements for a high energy Transient Voltage Surge Suppressor (TVSS). The specified TVSS/SPD system shall be connected in parallel to the facility's electrical all main incoming panels. It shall provide effective high energy surge current diversion, and shall be suitable for application in ANSI/IEEE C62.41 Category A, B and C environments or IEC 61643-1 Class I, II and III

7.3.3.2 Codes & Standards

The specified system shall be designed, manufactured, tested and installed in compliance with the following codes and standards:

IEC 61643-1: Surge Protective Devices connected to low voltage power distribution systems.

Underwriters Laboratories: (UL 1449, 2nd edition) Standard for Transient Voltage Surge Suppressors. International Standards Organization (ISO) Company certified ISO9001 for manufacturing, design and service and the applicable portions of the American National Standards Institute and Institute of Electrical and Electronic Engineers standards (ANSI/IEEE 1100, C62.11, C62.41, C62.45)

7.3.3.3 Electrical Requirements

- a) Nominal system operating voltage

The single phase TVSS system shall be suitable for installations operating between 220VAC and 240VAC.

The three phase TVSS system shall be suitable for installations operating between 380VAC to 415VAC, Star (Y) Configuration: 3 Phase 4 Wire Plus Ground or Delta Configuration: 3 phase 4 wire including Ground.

b) **Maximum Continuous Operating Voltage (MCOV):**

The maximum continuous operating voltage of the complete TVSS, as well as all components in the suppression path shall be greater than 125% of the nominal system operating voltage to ensure the ability of the system to withstand temporary RMS over voltages (swell conditions).

c) **Operation Frequency:**

The operating frequency range of the system shall be 50 or 60 Hz.

d) **Protection Modes:**

Note: L = Line, G = Ground, N = Neutral

The SPD shall provide protection in all modes (L-N or L-L, L-G and N-G where applicable)

7.3.3.4 Surge Current Capacity:

Location	Class	Surge Current
Main Service Entrance	Class C	200/400 KA
Main Distribution Feeders	Class B	100/160 KA
Sub distribution Panels	Class A	50 KA

7.3.3.5 Short-circuit Withstand Capability:

The TVSS shall be able to carry the power short circuit current until it is interrupted by external over-current disconnect or by the backup over current protection. The minimum Short Circuit Withstand of the TVSS shall be according to the table below:

Class	Minimum Short Circuit Withstand Capability
Class C	200KA
Class B	35 to 65KA
Class A	14KA

7.3.3.6 Over current Protection (fusing)

All components, including suppression, filtering, and monitoring components, shall be individually fused at the component level with the fuses rated so as not to impede maximum specified surge current capacity. The fuse shall be capable of opening in less than one millisecond and clear both high and low impedance faults.

7.3.3.7 Clamping Voltage:

The TVSS shall able to clamp the voltage:

System Voltage	Max Let Through Voltage
120, 120/208 or 120/240	400 volts
208, 240, 277, 230/400 or 277/480	800 volts
346, or 346/600	1200 volts
480	1500 volts
600	2000 volts

7.3.3.8 Response Time:

Typical response time of all suppression components shall be <0.5 ns.

7.3.3.9 Noise Attenuation

The filter shall provide insertion loss with a maximum of 40dB to 50dB from 10 kHz to 100 MHz with data obtained utilizing the 50 ohm Insertion Loss Methodology from MIL-STD-220A.

7.3.3.10 Environmental Requirements

Operating Temperature :- 40⁰ C to +85⁰ C (-40⁰ to +187⁰ F)

Relative humidity : - 0% to 95%

Audible Noise:- The unit shall not generate any appreciable noise. 40 DB for RFI and EMI noise attenuation

Operating Altitude: 0 to 14,000 feet above sea level.

Magnetic Fields: The unit shall not generate any appreciable magnetic fields and shall suitable for use directly inside computer rooms.

Connection type- Parallel

Protection lvl in kV – based on level of protection

Status indication – LED type dry contacts

7.3.3.11 Instruments & Relays

a) Indicating instruments

All electrical indicating instruments will be 96 mm square, with 240-degree scale (Taut band type). They shall be suitable for semi-flush with only flanges projecting on vertical panels.

Instruments shall have accuracy class of 1.0 or better. The design of the scales shall be such that it can read to a resolution corresponding to 50% of the accuracy class index. KWH meter mentioned in the SLDs shall have pulse output to be integrated with the BAS system and an accuracy class of 1.

b) Protective relays

Protective relays shall conform to standard requirements. Type of relays either static or electro-mechanical which meet the various performance requirements are considered acceptable.

All static relays shall be adequately protected against external voltage surges and

noise signals. In addition to this, all the input circuit of static relays will include their own auxiliary current and voltage transformers with screened windings. Where auxiliary interposing transformers are not feasible in the input circuit, relays would have special surge suppression circuits to suppress external noise and surges.

Output elements of all static relays shall consist of electro-mechanical relays only.

Relays shall have at least the following electrically independent output contacts for the following purposes:

- Tripping circuit
- Remote / local annunciation

If the main relay does not have sufficient number of output contacts inherently, these shall be multiplied using auxiliary relays. These auxiliary relays shall be used for annunciation, indication, etc. only. For tripping, only the contact of main relay shall be used directly

c) Wiring And Accessories

Cubicles shall be completely wired upto equipment / terminal block. Interpanel and inter-cubicle looping of control and cubicle space heating supplies to be carried out by CONTRACTOR. Wiring to be carried out with 650V grade single core PVC insulated stranded copper conductor of following sizes :

- All circuits except CT circuit :1.5 sq.mm.
- CT circuit :2.5 sq.mm.

Longitudinal troughs extending throughout the full length of the panels to be provided for interpanel wiring, AC-DC supplies, PT circuits, annunciator circuits, etc. Ferrules for wire termination to be provided. Wire connected to trip circuit will have red coloured ferrule.

7.3.3.12 Terminal Blocks

- a) Terminals blocks for CT and PT secondary leads shall be provided with test links and isolating facilities.
- b) All spare contacts and terminals of the panel mounted equipment and devices shall be wired to terminal blocks. At least 10% spare terminals shall be provided.
- c) Terminal blocks to be suitable for connecting the following conductors of the EMPLOYER's cables on each side:

All circuits except CT circuit	Minimum of two 1.5 mm ² copper
CT Circuits	Minimum of four 2.5 mm ² copper

7.3.3.13 Cable Terminations

- a) Power and control cable glands and crimping type lugs shall be supplied to suit the cable sizes.
- b) Glands shall be heavy duty, double compression type made of brass and plated.

7.3.3.14 Control Supply

230/110V AC supply be provided for the switchgear. Suitable control transformer shall be provided to derive 110V AC control supply voltage. All inter panel wiring required shall be included in the scope.

7.3.3.15 Tests To Be Conducted

- a) Functional test, temperature rise test, high voltage test, limits of operation test, insulation test. EMPLOYER will have the option to witness the tests at the MANUFACTURER'S work before dispatch.
- b) TENDERER shall furnish the type test certificates along with the Tender. In the absence of the same, the CONTRACTOR shall arrange to carry out the type test without any cost implication to the EMPLOYER.

7.3.3.16 List Of Drawings

The CONTRACTOR shall furnish the following drawings for the switchgear:

- a) Overall outline dimensions and general arrangement including plan, front elevation, rear & side elevations, clearances recommended in front and back.
- b) Switchgear layout plan including floor openings, fixing arrangements and loading details.
- c) Schematic control diagrams to cover controls, protection, interlocks, instruments, space heaters, etc. for each type of module.
- d) Detailed internal wiring diagram of each type of module, including terminal block numbers, ferrule numbers and the external cable connection designations
- e) Item wise bill of material for each module, listing all devices mounted and also otherwise furnished like cable glands, indicating the MANUFACTURER's type, rating, quantity & special notes, if any.
- f) Inter panel interconnection wiring diagram including terminal numbers and ferrule numbers.
- g) Each type of protection relay and circuit breaker release characteristics

NOTES:

- The CONTRACTOR shall be entirely responsible for the correctness of the internal wiring diagrams
- The CONTRACTOR shall ensure that the characteristics of the CTs, fuses, protection relays, VTs and all other devices offered by him are such as to be suitable for the purpose for which they are intended.

7.3.3.17 Test Certificates

Type test certificates of all standard component parts, e.g. contactors, breakers, switches, fuses, relays, CTs, VTs, and for the standard factory built assembly shall be submitted by the CONTRACTOR.

7.3.3.18 Instruction Manuals

The CONTRACTOR shall furnish specified number of copies of the instruction manual which would contain detailed instructions for all operational & maintenance requirement. The manual shall be furnished at the time of dispatch of the equipment and shall include the following aspects:

- a) Outline dimension drawings showing relevant cross-sectional views, earthing details and constructional features.
- b) Rated voltages, current, duty-cycle and all other technical information which may be necessary for correct operation of the switchgear.
- c) Catalogue numbers of all components liable to be replaced during the life of the switchgear.
- d) Storage for prolonged duration.
- e) Unpacking.
- f) Handling at site.
- g) Erection.
- h) Precommissioning tests.
- i) Operating procedures.
- j) Maintenance procedures.
- k) Precautions to be taken during operation and maintenance work.

7.3.3.19 Installation

The installation work shall cover assembly of various sections of the panels lining up, grouting the units etc. In the case of multiple panel switch boards after connecting up the bus bars etc., all joints shall be insulated with necessary insulation tape or approved insulation compound. A common earth bar as per these specifications shall be run inside at the back of switch panel connecting all the sections for connection to frame earth system. All protection and other small wirings for indication etc. shall be completed before calibration and commissioning checks are commenced. All relays, meters etc. shall be mounted and connected with appropriate wiring.

7.3.3.20 Testing And Commissioning

Commissioning checks and tests shall include all wiring checks and checking up of connections. Relay adjustment/setting shall be done before commissioning in addition to routine Megger tests. Checks and tests shall include the following: -

- a) Operation checks and lubrication of all moving parts.
- b) Interlock function checks.
- c) Continuity checks of wiring, fuses etc. as required.
- d) Insulation test: When measured with 500V Megger the insulation resistance shall not be less than 100 mega ohms.
- e) Trip tests and protection gear test.

7.4 POWER FACTOR CORRECTION SYSTEM

7.4.1 Scope

Design, manufacture, supply, erection, testing and commissioning of Indoor type power correction capacitor banks for power factor improvement as per specification given below.

7.4.2 Rating

50 KVAR (or less) capacitor units as specified in the BOQ shall be used to form a bank of capacitors of designed capacity.

7.4.3 Enclosure

The panel shall be indoor type, free standing, and floor mounting with IP42 degree of protection. It shall be completely made of CRCA sheet steel. The enclosure shall have sturdy support structure with angle supports as necessary and shall be finished with powder coating in the approved colour shade/s to match the colour of the other panels. The thickness of powder coating should be minimum 80 microns.

Suitable provisions shall be made in the panel for proper heat dissipation. Air aspiration louvers for heat dissipation shall be provided as a necessary.

The front portion shall house the switchgear and the rear portion shall house capacitors. The enclosure is to be suitably sized to accommodate all the components, providing necessary air clearance between live and non-live parts, providing necessary working clearance.

7.4.4 APFC Relay / Controller

Microprocessor based APFC relay (Intelligent VAR controller) shall sense the PF in the system and automatically switch ON / OFF the capacitor unit or stage to achieve the preset target PF. The controller shall have the following features :

- a) Digital settings of parameters like PF, Switching time delay, Step limit etc.
- b) Indication of PF, preset parameters.
- c) Minimum threshold setting of 1% of CT current.
- d) No-volt release.
- e) Protective shut down in case of harmonic overload.
- f) Indication for Failure to achieve the target PF, Harmonic overloading, Step failure etc.
- g) All electricity supplies exceeding 100 A, 3 phase shall maintain their power factor between 0.95 lag and unity at the point of connection.

7.4.5 Capacitor Unit

Each basic unit of mixed dielectric extra low loss heavy duty capacitor shall be built with a number of elements. These elements shall be combination of capacitor tissue paper and biaxially oriented polypropylene film impregnated with non PCB bio-degradable impregnant or Film Foil capacitor manufactured using Poly propylene film placed between 2 layers of metal foil and winding. The elements shall be connected to the external bus bars through these leads in a series parallel connection to form a three phase unit.

The capacitor units shall be floor mounting type using minimum floor space. The container of capacitors shall be made out of 2 mm thick M S sheet steel of polyester paint coated finish. Each standard unit shall be provided with internal fuses (operation co-ordinated with case-rupture characteristics to avoid rusting).

Total Harmonic Distortion (THD) of upto 5% on voltage and current waveforms shall not affect the life of capacitors. $\pm 10\%$ variation in line voltage shall not affect the life of the capacitors.

7.4.6 Capacitors

General specifications : 3 phase, delta connected, 50 Hz.

Voltage : Shall be designed for minimum 520V and shall withstand system over voltage, increased voltage due to series reactor and harmonics.

Capacitor type : Super heavy duty with double side metallised capacitor tissue paper. Oil impregnated and self-healing type with bi-axially oriented polypropylene film shall be fitted with pressure sensitive disconnecter in each individual capacitor cell.

Overvoltage +10% (12h / 24h), + 15% (30m / 24h), + 20% (5m), +30% (1m) as per Clause 6.1 of IS 13340-1993.

Over current : $2.5 \times I_n$

Pak Inrush current withstand : $350 \times I_n$

Total watt-losses including discharge resistors : $< 0.45 \text{ W / k V Ar}$.

Temperature category : -25 deg.C to 70 deg.C.

Capacitor shall be self-heating type and oil impregnated for longer life. The impregnant shall be non-PCB, biodegradable type, must be properly treated and degasified, so as not to have any degeneration properties and shall be non-oxidizing.

The design shall be modular for simple mechanical assembly, no extra accessories / metal parts to be required. Unit must be free standing with an IP 41 protection level.

7.4.7 Discharge Resistance

Capacitors shall be provided with permanently connected discharge resistors so that residual voltage of capacitors is reduced to 50 volts or less within one minute after the capacitors are disconnected from the source of supply.

7.4.8 Terminals

Each capacitor bank shall be provided with a terminal chamber and cable glands suitable for PVC insulated aluminum conductor armoured cables as specified.

7.4.9 Earthing

Two separate earthing terminals shall be provided for earth connection of each bank.

7.4.10 Testing

The reactor shall be tested using a separate source voltage test of 3 KV (coil to core) for one minute as per IEC 76/3. The reactor shall be fitted with a temperature sensitive micro-switch in the centre coil (normally open) for connection to trip circuit in case of high operating temperature.

7.4.11 Switchgear & Protection

Incomer switchgear shall be TP&N breaker appropriate rating (minimum 1.8 times the normal current to take care of inrush switching current). Suitable contactor for each step shall be used and must be capable of capacitor switching duty at each step for short circuit protection.

Busbars shall be suitably colour coded and must be mounted on appropriate insulator supports.

Power cables used shall have superior mechanical, electrical and thermal properties, and shall have the capability to continuously operate at very high temperatures up to 125 deg.C.

Internal wiring between main bus-bars, breaker, contactor and capacitors shall be made with 1100 V grade, PVC insulated, copper conductor cable of appropriate size, by using suitable copper crimping terminal ends etc.

Suitable bus links for input supply cable termination shall be provided.

7.4.12 Control Circuit & General Protection

The control circuit shall be duly protected by using suitable rating MCB.

Wiring of the control circuit shall be done by using 1.5 sq.mm, 1100 V grade, PVC insulated, multi-stranded copper control wire.

Inspection terminal strip, number ferruling, labeling etc. shall be provided.

440 V caution board on the panel shall be provided.

7.4.13 Installation

Capacitors banks shall be installed as per installation manual of supplier and shall conform to relevant Indian Standards.

All interconnections in the control panel shall be checked before commissioning.

Cable end boxes shall be sealed after cable connections to prevent absorption of moisture.

7.4.14 Testing & Commissioning

The capacitor bank shall be subject to tests as specified in relevant Indian Standards at the factory and the test certificates shall be furnished in quadruplicate.

Insulation resistance shall be tested with a 1000 volts megger between phases and phase to earth.

Residual voltage shall be measured after switching of the capacitors and the same shall not be more than 50 volts after one minute.

Each discharge resistor shall be tested for its working.

7.5 **TRANSFORMER - OIL TYPE:**

7.5.1 Scope:

Design, manufacture, testing, supply, Installation, testing and commissioning of outdoor type 33 kV /0.415 kV transformers with ONAN cooling complete with all the accessories and fittings for efficient and trouble free operation. The details are given in the data sheet. All other specifications shall be followed as per CPWD. First filling of oil shall be at site by contractor.

7.5.2 Standards:

7.5.2.1 The equipment and accessories covered by this specification shall be designed, manufactured and tested in compliance with the latest relevant standards published by the Indian Standards institution wherever available in order that specific aspects under Indian conditions are taken care of.

7.5.2.2 The equipment and accessories for which Indian Standards are not available shall be designed, manufactured and tested in accordance with the latest standards published by any other recognized national standards institution.

- 7.5.2.3 The equipment shall also conform to the latest Indian Electricity Rules as regards safety, earthing and other essential provisions specified therein for installation and operation of electrical plants.
- 7.5.3 General Design And Constructional Features:
- 7.5.3.1 All materials used shall be of best quality and of the class most suitable for working under the site conditions and shall withstand the variations of temperature and atmospheric conditions, overloads, over-excitation, short circuits as per applicable standards, without distortion or deterioration or the setting up of undue stresses in any part, and also without affecting the strength and suitability of the various parts for the work which they have to perform.
- 7.5.3.2 The design shall be such that the risks of accidental short-circuit due to birds or vermin's are obviated. All apparatus, including bushing insulators and fittings shall be so designed that water cannot collect at any point. Marshaling kiosks, boxes etc. shall be adequately ventilated to prevent condensation of moisture and so treated internally as to prevent growth of fungi on any coils, wires and insulating materials used.
- 7.5.3.3 The transformers shall operate with minimum noise and vibration. The cores, tank and other structural parts shall be properly constructed so that the mechanical vibrations are kept to the minimum, thus reducing the noise.
- 7.5.3.4 The design of the transformer shall be such that changes in transformer connection can be made by a simple change of link connection inside the tank. The transformers shall be designed to suppress harmonic voltages, specially the third and fifth, so as to eliminate distortion in wave form, and the possibility of circulating currents between the neutrals at different transformer stations.
- 7.5.3.5 All transformers shall be of the latest design, oil filled as called for in the main specification. All transformers shall be suitable for outdoor installation. The type of cooling and the corresponding ratings for each transformer shall be as indicated in the BOQ.
- 7.5.3.6 The magnetic circuit of each transformer shall be so designed as to minimize eddy-current and hysteresis losses in the core.
- 7.5.3.7 All electrical connections and contacts shall be of ample section for carrying the rated current without excessive heating.
- 7.5.3.8 All mechanisms shall be of stainless steel, brass, gunmetal, or other suitable material to prevent sticking due to rust or corrosion.
- 7.5.4 Tank:
- 7.5.4.1 The transformer tank shall be made of steel plate, shaped in such a way that minimum of welding is required. The tank shall be electrically welded and all welding stresses shall be properly relieved. Tank walls shall be reinforced by adequate stiffeners to ensure mechanical rigidity permitting hoisting of complete transformers filled with oil and also to damp transformer noise. The tank shall be sufficiently strong to withstand shocks likely to be encountered during transport of the transformer without any deformation or weakening of joints. The joints shall be oil tight. Guides shall be welded on the inner side of the tank to facilitate tanking and untanking of the transformer core and coil assembly.
- 7.5.4.2 Tank cover shall be bolted on to the flanged rim of the tank with a suitable weather-proof, hot-oil-resistant gasket in between for oil tightness. The bolted tank cover shall be so arranged that it can be removed and the core inspected without removal of the radiators. All requisite access and inspection holes shall be provided with bolted oil tight, gasket seated cover plates. Bushing turrets, covers of access holes, covers of pockets to prevent leakage of water into the tank shall be provided.
- 7.5.4.3 The exterior of tank and other steel surface exposed to the weather shall be thoroughly cleaned and have a priming coat of zinc chromate applied. The second

coat shall be of an oil and weather resistant nature preferably of distinct colour from the prime and finish coats. The final coat shall be of a glossy, oil and weather resisting non-fading paint of specified shade. The interior of the tank shall be cleaned by shot blasting and painted with two coats of heat resistant and oil insoluble paint.

7.5.4.4 Steel bolts and nuts exposed to atmosphere shall be galvanized however; surfaces of the transformer or other parts of the transformer or auxiliary equipment which are in contact with oil shall not be galvanized.

7.5.4.5 The transformer tank, auxiliary equipment and fittings shall be provided with necessary devices for lifting and haulage facilities. The tank shall be mounted on a substantial under-carriage.

7.5.4.6 Unless otherwise stated the tank together with radiators, conservator, bushings and other fittings shall be designed to withstand without permanent distortion the following conditions.

- a) Full vacuum of 760mm of Hg for filling oil by vacuum.
- b) Internal gas pressure of 0.35 Kg/Sq.cm. with oil at operating level.
- c) Valves shall not leak nor any welded joints sweat under above conditions.

7.5.4.7 Adequate space shall be provided at the bottom of the tank for collection of sediments.

7.5.5 Core:

7.5.5.1 The magnetic circuit shall be built of transformer grade cold rolled grain oriented low loss steel stampings having high permeability and conforming to adopted standards. Stampings shall be insulated from each other with material having high inter-lamination insulation resistance and rust inhibiting property and also capable of withstanding pressure, mechanical vibration and action of heat and oil, thus reducing the possibility of sludge formation to a minimum.

7.5.5.2 The framework, clamping arrangement and general structure of the cores of each transformer shall be of robust construction and shall be capable of withstanding any shock to which they may be subjected during transport, installation and service. The assembled core shall be securely clamped, on the limbs and the yoke, to build up a rigid structure. The clamping pressure shall be uniform over the whole of the core and so adjusted as to minimize noise and vibration in the core when the transformer is in service. The framework and the core bolts shall be efficiently insulated from the core so as to reduce the circulating currents to a minimum.

7.5.5.3 The core clamping frame shall be provided with lifting eyes for the purpose of tanking and untanking the core with winding mounted thereon and shall have ample strength to take the full weight of the core and winding assembly.

7.5.5.4 An approved type of core grounding system shall be used; the grounding connections being located at the top of the core for easy access from the inspection hole.

7.5.6 Winding:

7.5.6.1 The coils used for transformer winding shall be flat in shape, made of paper insulated, continuous and smooth, tinned or enameled electrolytic copper conductors of high conductivity.

7.5.6.2 The transformer winding shall be designed for basic impulse insulation level not lower than that specified in the main specification.

7.5.6.3 Liberal ducts shall be provided to prevent any hot spot temperature in the winding that may adversely affect the life of the transformer. Adequate supports, wedges and spacers of hard insulating material shall be so fitted that they will neither move nor permit relative movement of any part of winding during transit of normal service or under terminal short circuit, nor damage the winding insulation in any way. All leads and connections shall be robust, adequately insulated, protected and clamped. The winding assembly shall be dried in vacuum with tested insulating oil of approved

standard. The windings shall be subjected to a thorough shrinking and seasoning process so that no further shrinkage of windings occur during service at site. However adjustable devices shall be provided for taking up any possible shrinkage of coils in service. The assembly shall be held in position under adequate axial compression to withstand the axial thrust likely to occur under terminal short circuit.

7.5.6.4 The end turns on the high voltage winding shall have reinforced insulation to take care of the voltage surges likely to occur during switching or any other abnormal system condition.

7.5.6.5 The transformers shall be suitable for operation at full rated power on all tapplings without exceeding the specified temperature rise as indicated in the applicable standards.

7.5.7 Insulating Materials:

The insulating oil shall conform to IS-335 and shall be suitable in all respects for operating the transformer at the rating and under conditions specified in the main equipment specification. Sufficient oil shall be supplied for the first filling of transformer, the oil circulating equipment and the tank containing tap-changing mechanism and an extra 10% shall be supplied in non-returnable drums. The tender shall contain information about the grades of oil recommended by the transformer manufacturer for use in the transformer. Test certificates for the oil shall be furnished before dispatch of transformer and acceptance by Employer.

7.5.8 Transformer Tappings:

33/4.415 kV, delta / star wound, Transformers shall be with on load tap changer.

Transformer shall be provided with 'ON' load tap changing on 33 KV side. The tapings to be provided for variation on HV side from +7.5% to – 7.5% in steps of 1.25% each. Provision of bushing shall be made for neutral and neutral CTs shall also be provided.

7.5.9 Cooling Equipment:

Natural cooling by means of banks of detachable type radiators made from pressed/round tubes around transformer tank shall be provided. The radiators shall be of seamless mild steel sheet with clean bright internal surface and shall be suitably braced to protect them from shock.

7.5.10 Terminal Arrangement

7.5.10.1 High Voltage Side (33 KV)

Cable box shall be provided suitable for terminating one no. 3C x 300 sq.mm XLPE insulated armoured 33 KV cable complete with disconnecting chamber, compression glands, tinned copper lugs, Armour earth clamp and body earth terminal.

Cable box shall be fitted with bushing insulators for H.T. cable termination side.

7.5.10.2 Low Voltage Side (415V)

2 MVA, 33 KV / 0.415 kV delta / star Transformers – 33 kV Cable, outdoor connections shall be made. 33/0.415 kVA Transformers shall be suitable for cable or bus ducts as mentioned in BOQ & drawings (SLDs).

7.5.10.3 Disconnecting Chamber

The disconnecting chamber shall be air insulated and complete with seal off bushing, removable flexible connectors / links and removable covers. It shall be possible to trail out the transformer without having disconnecting the bus duct / cables.

Phase to phase and phase to ground clearances within the chamber shall be such as to enable either the transformer or cable to be subjected separately to H.V. test.

7.5.10.4 Bushing:

Bushings shall conform to IS: 2099 and other relevant standards.

Bushings shall be supplied with terminal connector clamp suitable for connecting the bushing terminal to the Employer's conductor.

Creepage distance of bushing shall be (41mm/kv phase ground) adequately,

7.5.11 Marshalling Box

Whenever optional fittings, temperature indicators, with auxiliary contacts, Buchholtz Relay and Bushing CT's are specified then the bidder shall provide a Marshalling box and Marshall to it all the contact terminals of electrical devices mounted on the transformer. It shall be in the contractor's scope to provide:

- a) The interconnection cabling between the Marshalling box and the accessory devices either by PVC insulated copper wire in G.I. conduits or PVC insulated copper conductor armoured cables.
- b) Necessary compression type brass cable glands at the Marshalling box for above cables.

The Marshalling box shall be tank mounted, water/dust tight sheet steel (2mm thick) enclosed with hinged door having padlocking facility. All doors, covers and plates shall be fitted with neoprene gaskets. Top surface shall be sloped and bottom shall be atleast 600mm from floor and provided with gland plate and cable glands as required.

Terminals shall be clipon type rated for 10A. All contacts for alarm/trip indication shall be potential free, wired up to the terminal block. Wiring shall be done with stranded copper conductor wires of sizes not less than 1.5 sq.mm for control and 2.5 sq.mm for CT circuits. C.T. terminals shall be provided with shorting facility.

7.5.12 Electrical & Performance Requirement:

Transformer shall operate without injurious heating at the rated kVA at any voltage within +/- 10% of the rated voltage of that particular tap.

Transformer shall be designed for 110% continuous over fluxing withstand capability.

The neutral terminals of the winding with star connection shall be designed for the highest over current that can flow through the winding.

Overloads shall be allowed within the conditions defined in the loading guide of the applicable standard. Under these conditions, no limitations by terminal bushings, tap changers or other auxiliary equipment shall apply.

Temperature Rise shall be continuously rated for full load. The temperature rise shall not exceed 45 degree C by thermometer in oil or 55 degree centigrade by resistance over an ambient of 38 degree C.

7.5.13 Earthing:

7.5.13.1 Two separate earthing terminals to be provided at the bottom of the tank on opposite sides. The terminals shall be suitable for connection to grounding strip.

7.5.13.2 Internal Earthing:

The frame work and clamping arrangements of core and oil shall be securely earthed inside the tank by adequately sized copper strip connections to the tank.

7.5.14 Fittings And Accessories:

The transformer shall be provided with all standard fittings and accessories specified in the applicable standard for the size and type of transformer concerned. The accessories and fittings shall generally be as specified below:

a) Lifting Lugs:

The arrangement for lifting the active part out of the transformer tank along with the cover by means of lifting lugs without disturbing the connections.

b) Swivel Type Rollers:

The transformer to be provided with 4 No's Bi-Directional rollers fitted on cross channels to facilitate the movement of the transformer in both directions.

c) Oil Conservator:

The transformer to be provided with an oil conservator with welded end plates. It is to be bolted to the cover and can be dismantled for purpose of transport. It has to be provided with magnetic oil level gauge and an oil filling hole 1 1/4" BSF size with a cap, which can be used for filtering oil. For draining purpose a plug shall provided. A connection pipe between the conservator and the main tank is to be provided which projects inside the conservator and the main tank is to be provided which projects inside the conservator.

d) Air release Valve:

An air release valve is to be provided on the top of the tank cover facilitate the release of the entrapped air and filling of oil.

e) Breather:

The transformer to be provided with an indicating dehydrating silica gel breather of sufficient capacity.

f) Drain-cum-oil Filter Valves:

The transformer to be provided with a drain-cum-oil filter valve of 1 1/4" BSF size at the bottom of the tank.

g) Diagram and rating plate:

Diagram and rating plate shall be provided indicating the details of transformer, connection diagram, vector group, tap changing diagram etc.

h) Dial type Magnetic thermometer (150 mm dia) with maximum set pointer at 75 deg C and electrical contacts for electrical alarm at high temperature.

i) Winding temperature indication and electrical contacts for trip / alarm (except for below 800 kVA Transformer)

j) Buchholz relay of double float type with electrical contacts for low oil level alarm and high gas pressure trip suitable for 24 volts DC supply.

k) Filter valve of 1 1/4" BSF at top.

l) Explosion vent.

m) Repeater for Oil and Winding Alarm and Trip for BMS connection.

n) RTD for temperature signal to BMS.

o) Surge Relay

7.5.15 Drawings And O&M Manuals:

Four copies of manual of complete instructions for the installation, operation, maintenance and repairs circuit diagrams, foundation and trenching details shall be provided with the transformers. List of spare parts shall also be indicated.

Two copies of the drawings incorporating the following particulars shall be submitted with the offer for preliminary study.

GA drawing showing dimension, net weight and shipping weight, quantity of insulating oil etc.

Suitable capacity of crane requirements for assembly and dismantling of the transformer.

Drawing indicating GA of busduct/cable box and its dimension for cable entry cut out requirements etc.

The drawings in (four sets) to be furnished by the supplier for approval after acceptance of his order shall include the following.

GA showing front and side elevations and plan of transformer and all accessories and external features, detailed dimensions, crane lift for untanking, oil quantity, H.T./L.T. clearances etc.

Drawings of Bus duct/cables termination arrangement.

HV cable box arrangement & disconnecting chamber GA & details drawings.

Drawing of each type of bushing.

Name plate and terminal making and connection diagram.

Control wiring & schematic diagram showing polarity and vector group of windings, CTs and OTI, WTI, circuits, Alarm/trip circuits etc.

Reproducible copy of the above drawings for records

Maximum allowable Power losses shall be as per ECBC norms.

7.5.16 Testing:

The transformer shall be subjected to all routine tests in accordance with IS : 2026 at the factory before dispatching the same and test certificates shall be furnished.

Testing at site:

- a) Insulation test of HT and LT winding
- b) Oil dielectric strength test
- c) Ratio test of transformer

Four copies of the test reports in bound volume shall be submitted for approval.

SOAK PIT AND DRAIN PIT (Wherever required) shall be provided as per IS 10028- 2.

The transformers foundation shall be surrounded by a suitable soak pit enclosed by a 150 mm high non- combustible curb. This soak pit shall be filled with coarse crushed stones about 25mm in diameter to a minimum depth of 300 mm. The volume of the soak pit minus the volume of the stones should be sufficient to contain the entire oil content of the transformer if the oil content is less than or equal to 5 kl. In case the oil content is more than 5 kl, the volume of soak pit minus the volume of stones should be sufficient to contain at least one third of the total oil content. The excess should be led through two or more hume /concrete pipes (min. 150 dia.) from bottom of pit to a central remote burnt oil tank.

7.5.17 Remote Tap Changer Control Panel (RTCC) for 33/0.415kV, 2 MVA transformer

RTCC panel shall be of sheet steel cabinet for indoor installation, floor mounting type. The RTCC panel shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket and padlocking arrangement. RTCC panel shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of RTCC panel shall be 14 SWG

CRCA sheet steel and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall conform to IS-8623-1977 (part-I) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC. All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of RTCC panel. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panel.

The following components shall be provided in the RTCC panel:

- a) Digital Tap Position Indicating Meter
- b) Raise/Lower Push Buttons for Remote Control of OLTC
- c) Tap Change in Progress Signal Lamp.
- d) Supply on Signal Lamp
- e) Local / Remote Control Indicating Lamps
- f) Panel illuminating lamp with door switch.
- g) Space Heater with Switch and Thermostat.
- h) Automatic Voltage Relay with Time Delay Element.
- i) Selectors switch for Auto/Manual Operation.
- j) Undrilled Gland Plate for Cable entry.
- k) Earthing Terminal
- l) Lifting Eyes Bolts.

7.6 BUS DUCTS

7.6.1 Scope:

The specification covers design, manufacturing, supply, installation, testing and commissioning of Sandwich type busbar trunking for use as feeder busbars for interconnection between separate electrical equipment / load centers, and for use as plug in busbar risers.

7.6.2 System details:

The busbar shall be suitable for operation in a 600V system, with frequency of 50 Hz having 100% neutral and internal earth.

The bus duct shall conform to IEE/NEMA/BUI/JIS for seismic protection certification.

7.6.3 Design & Construction requirements – Sandwich bus bars

7.6.3.1 General:

The busbars shall be of sandwich construction, non-ventilated design. It shall be possible to mount the busbar system in any orientation, without affecting the current rating.

The bus duct shall consist of three phases and neutral bus bar permanently positioned dust and vermin proof and the degree of enclosure protection shall be IP 52 for

indoor installation and shall be IP-65 for outdoor installation as per schedule of quantities.

7.6.3.2 Busbars:

The busbars shall be of high conductivity Copper, or Aluminum, as specified in the tender.

Where an earth conductor is required, it shall be a separate, integral earth conductor, of the same high conductivity material as the phase conductors.

7.6.3.3 Insulation:

The busbars shall be insulated throughout their length by epoxy coating / Mylar. The insulation material used shall be of Class H (180 deg. C). The insulation must comply to UL 94 V-O. It shall be Halogen Free.

Housing: The housing shall be made of extruded Aluminum case duly enameled/ electro-galvanized sheet steel, with an epoxy powder coated paint finish. The housing shall be profiled, to provide higher strength and efficient heat dissipation. The width of the housing shall preferably be the same for all ratings of busbars, in order to provide interchangeability of tap off boxes.

7.6.3.4 Joints:

The joints between sections shall be made so as to provide flexibility during installation and expansion / contraction of busbar during operation. The joints shall be of the single bolt type

The joint construction must have the following features.

- a) Heat expansion of at least 3mm per joint.
- b) The joint insulation must be of one piece molded design and not have any cut edges which can absorb moisture.
- c) The joint construction must allow a +/- 14mm adjustment at the time of installation, for ease of adjusting to site measurement variations.
- d) The joint bolt must be insulated with a bolt insulator. The bolt insulator must be of molded one piece.
- e) The joint system must be designed in a way that the installer cannot insert the busduct length too far and damage the bolt insulator.
- f) The busbar ends shall not have holes or slots at the joints – the electrical continuity shall be through pressure plates, achieving a high area of joint cross section and expansion capability.
- g) It shall be possible to install and remove the joints without disturbing the busbar run.

7.6.3.5 End termination:

At the termination either on the transformer side or on the panel side, bus duct shall be provided with flange ends, adopter box and copper flexible (preferably multi sheet types) to connect bus bar of bus duct to bus bar of panels or transformer terminals.

7.6.3.6 Accessories:

A full range of accessories like bends, end flanges, end feed units, and support brackets etc. shall be available.

7.6.4 Installation

Bus ducts running along the wall shall be supported at intervals not exceeding 1.5 m. In case of branching, there shall be support on all branches at a distance of 300 mm

from the point of branching, Support shall not be less than 40 x 40 x 6 mm MS angle secured in an approved manner. Supports may also be provided in the form of brackets fixed to walls where the duct runs along the wall. In case of ceiling suspended bus ducts, supports made out of 40x40x6 mm MS angle iron shall be provided along with 12mm dia MS rod with threading and nut bolts. The horizontal distance between two such supports shall not be more than 1200 mm. The ducts supports shall be suspended from suitable approved suspension devices provided in the ceiling. Fire barrier shall be provided at each floor/wall crossing as per relevant IS code. Continuous earth bus of suitable size shall be provided along with throughout the length of Bus duct. Fire barrier of 2hrs rating shall be provided on each floor.

7.6.5 Testing

The busbars shall be type tested at a reputed international test laboratory (ASTA or CPRI) for short circuit withstand. The test shall be for a minimum duration of 1 second. Tests shall be performed over a range of current ratings, covering the different frame sizes of the manufacturer.

Degree of ingress protection (IP rating) shall also be tested at any reputed independent laboratory. This test shall be for IP54 for indoor application and IP65 for outdoor application for sandwiched busbars.

The following tests shall be carried out at site and test results to be recorded:

- a) Insulation resistance shall be tested with 1000 V megger and shall be not less than 100 mega ohms.
- b) Earth continuity test

7.7 **HT CABLE (UE)**

7.7.1 General

Cables shall be aluminium conductor, unearth type , FRLS, cross linked polyurethane construction and shall be supplied, inspected, laid, tested and commissioned in accordance with drawings, specifications, relevant Standard Specifications and cable manufacturer's instructions.

7.7.2 Material

Conductor

The Conductor shall be made from electrical grade aluminum, stranded wires compacted together.

Insulation

High quality TROPOTHEN - X (XLPE) unfilled insulating compound of natural colour shall be used for insulation. Insulation shall be provided by extrusion process and shall be chemically cross linked in continues vulcanization process.

Shielding

Cables shall be provided with conductor shielding as well as insulation shielding and shall consist of extruded semi-conducting compound, additionally insulation shield shall be provided with semi-conducting and metallic tape shield over the extruded

insulation shield. XLPE insulation and outer core shielding shall be extruded in one operation.

Armoring

Armoring shall be provided over the inner sheath and shall comprise of flat steel wires (strips).

Outer Sheath (with FRLS)

Tough outer sheath of heat resisting PVC compound shall be FRLS extruded over the armoring in case of armored cables, or over inner sheath in the case of unarmored cables.

7.7.3 Tests

Cables shall be type tested and routine tested in accordance with IS:7098 (Part II).

The following tests shall be carried out at site for insulation between phases and between phase and earth before and after the cable laying is complete.

- a) Insulation Resistance Test.
- b) Continuity resistance test.
- c) Sheathing continuity test.
- d) Earth test.
- e) High Voltage test.

Cables shall be laid with a clearance of at least 75 mm between two cables.

Before laying of cables megger values shall be taken and shall be recorded.

7.7.4 End Termination of HT Cable

Pre-moulded cable terminations for XLPE cable shall be used as per manufacturer's instructions. The heat shrinkable raychem shall consist of highly track resistant insulating section vulcanised to a semi-conducting section. The pad material shall have cold-flow properties and shall be flame retardant.

Each end terminal shall undergo Hi Pot Test at site. Necessary equipment shall be arranged at site by contractor.

7.7.5 Laying of HT Cables

Direct In Ground

The work shall involve digging of outdoor trench in ground and laying cable(s) as indicated in specifications and Schedule of Quantities.

The depth of the trenches shall not be less than 1200 mm for 33 KV, 900mm for 11kV plus radius of cable, from the upper surface of ground. Where more than one multicore cable is laid in the same trench, a horizontal inter spacing of 250 mm shall be left in order to reduce mutual heating and also to ensure that fault occurring on one cable will not damage the adjacent cable.

Cable shall be laid in cement pipes encased in concrete or hume pipes at all road crossing. Cables shall be laid in trenches over rollers placed inside the trenches. After the cable has been properly laid and straightened, it shall be covered with 80 mm thick layer of sand. Cable shall then be lifted and placed over the sand cushion. Again, the cable shall be covered with 80 mm layer of sand. Over this cable protection shall be provided by providing tiles which shall overlap cables 50 mm on either side. Trenches shall then be back-filled with earth and shall be consolidated. Suitable cable markers made of cast iron with aluminium paint indicating the voltage grade, direction of run and size of cables shall be provided at regular intervals.

7.7.6 RCC/MASONRY TRENCH

For laying of HT cable in RCC/Masonry trench refer detail on sub-station layout drawing and IS-1255-1983.

7.8 1.1 KV GRADE CABLES AND CABLE TRAYS

7.8.1 Standards Of Codes

This chapter covers the specifications for supply and laying of Medium Voltage XLPE insulated PVC sheathed FRLS cables for 1100 volts.

All equipments, components, materials and entire work shall be carried out in conformity with applicable and relevant Bureau of Indian Standards and Codes of Practice, as amended upto date. In addition, relevant clauses of the Indian Electricity Act 1910 and Indian Electricity Rules 1956 as amended upto date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and /or IEC Standards shall be applicable.

7.8.2 Cables

Medium voltage cables shall be aluminium/copper conductor XLPE insulated, FRLS PVC sheathed, armoured conforming to latest IS. Cables shall be rated for 1100 Volts.

All Conductor cables shall be as per BOQ.

Conductors shall be insulated with high quality XLPE base compound. A common covering (bedding) shall be applied over the laid up cores by extruded sheath of unvulcanised compound. Armouring shall be applied below outer sheath of PVC sheathing. The outer sheath shall bear the manufacturer's name and trade mark at every meter length. Cores shall be provided with following colour scheme of PVC insulation.

1 Core	:	Red/Black/Yellow/Blue
2 Core	:	Red and Black
3 Core	:	Red, Yellow and Blue
3 ½ /4 Core	:	Red, Yellow, Blue and Black

7.8.3 LAYING

Cables shall be laid as per the specifications given below :

7.8.3.1 Duct system

Wherever specified such as road crossing, entry to building or in paved area etc. cables shall be laid in underground ducts. The duct system shall consist of a required number of stone ware pipes, GI, CI or spun reinforced concrete pipe with simplex joints and all the jointing work shall be done according to the CPWD building specifications or as per the instructions of the Engineer-In-Charge as the case may be. The size of the pipe shall not be less than 100mm in diameter for a single cable and shall not be less than 150mm for more than one cable and so on. The pipe shall be laid directly in ground without making any special bed but wherever asbestos cement pipes are used, the pipes shall be encased in concrete of 75mm thick. The ducts shall be properly anchored to prevent any movement. The top surface of the cable ducts shall not be less than 60 cm. below the ground level. The ducts shall be laid a gradient of at least 1:300. The duct shall be provided manholes of adequate size at regular intervals for drawing the cables. The manhole cover and frame shall be of cast iron and machine finished to ensure a perfect joint. The manhole covers shall be installed flush with the ground or paved surfaces. The duct entry to the manholes shall be made leak proof with lead-wool joints. The ducts shall be properly plugged at the ends to prevent entry of water, rodents, etc. Suitable duct markers shall be placed along the run of the cable ducts. The duct markers shall at least be 15 cm. square embedded in concrete, indicating duct. Suitable cable supports made of angle iron shall be provided in the manholes for supporting the cables. Proper identification tags shall be provided for each cable in the manholes.

7.8.3.2 Cables in outdoor trenches

Cable shall be laid in outdoor trenches wherever called for. The depth of the trenches shall not be less than 75cm from the final ground level. The width of the trenches shall not be less than 45 cm. However, where more than one cable is laid, an axial distance of not less than 15 cm. shall be allowed between the cables. The trenches shall be excavated in reasonably straight line with vertical side walls and with uniform depth. Wherever there is a change in direction suitable curvature shall be provided complying with the requirements. Suitable shoring and propping may be done to avoid caving in of trench walls. The bottom of the trench shall be level and free from stone brick bats etc. The trench shall then be provided with a layer of clean, dry sand cushion of not less than 8 cm. in depth.

The cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains. The entire cable length shall as far as possible be paved of in one stretch. However where this is not possible the remainder of the cable may be removed by "Flaking" i.e. by making one long loop in the reverse direction. After the cable has been uncoiled and laid into the trench over the rollers, the cable shall be lifted slightly over the rollers beginning from one end by helpers standing about 10 mtrs. apart and drawn straight. The cable should then be taken off the rollers by additional helpers lifting the cable and then laid in a reasonably straight line.

For short cut runs and sizes upto 50 sq.mm of cables upto 1.1 KV grade any other suitable method of direct handling and laying can be adopted with the prior approval of the Engineer-in-charge.

When the cable has been properly straightened, the cores are tested for continuity and insulation resistance and the cable length then measured. The ends of all cables shall be sealed immediately. In case of PVC cables suitable moisture seal tape shall be used for this purpose.

Cable laid in trenches in a single tier formation shall have a covering of clean, dry sand of not less 17 cms above the base cushion of sand before the protective cover is laid. In the case of vertical multi tier formation after the first cable has been laid, a sand cushion of 30 cms shall be provided over the initial bed before the second tier is laid.

If additional tiers are formed, each of the subsequent tiers also shall have a sand cushion of 30 cms as stated above. The top most cable shall have final sand covering not less than 17 cms before the protective cover is laid.

Unless otherwise specified, the cables shall be protected by the second class bricks of not less 20 cms x 10 cms x 10 cms (nominal size) protection covers placed on top of the sand (bricks to be laid breadth wise) for the full length of the cable. Where more than one cable is to be laid in the same trench, this protective covering shall cover all the cables and project at 5 cm. over the sides of the end cables. The trenches shall be taken back filled with excavated earth free from stones or other sharp edge debris and shall be rammed and watered, if necessary, in successive layers not exceeding 30 cm, unless otherwise specified.

7.8.3.3 Route Marker

Cable route marker marked "Cable" shall be provided alongwith the route of the cable and location of loops. The route markers shall be of tapered concrete slab of 60 x 60cm at bottom and 50 x 50cm at top having a thickness of 10cm. Cable marker shall be mounted parallel to and 50cm away from the edge of the trench.

7.8.3.4 Cables in indoor trenches

Cables shall be laid in indoor trenches wherever specified. The trench shall be made of brick masonry with smooth cement mortar finish with suitable removable covers (i.e. precasted slabs or chequered plates). The dimensions of the trenches shall be determined depending upon the maximum number of cables that is expected to be accommodated and can be conveniently laid. Cables shall be arranged in tier formation in trenches and if necessary, cables may be fixed with clamps. Suitable clamps, hooks and saddles shall be used for securing the cables in position. Spacing between the cables shall not be less than 15 cm centre to centre. Wherever specified, trenches shall be filled with fine sand and covered with RCC or steel chequered trench covers.

7.8.3.5 Cable on Trays/Racks

Cable shall be laid on cable trays/racks wherever specified. Cable racks/trays shall be of ladder, trough or channel design suitable for the purpose. The nominal depth of the trays/racks shall be 150 mm. The width of the trays shall be made of steel or aluminium. The trays/racks shall be completed with end plates, tees, elbows, risers, and all necessary hardware, entire steel trays/ racks shall be hot dip galvanized including widths & accessories. Cable trays shall be erected properly to present a neat and clean appearance. Suitable cleats or saddles made of aluminium strips with PVC covering shall be used for securing the cables to the cable trays. The cable trays shall comply with the following requirements :

The tray shall have suitable strength and rigidity to provide adequate support for all contained cables.

- a) It shall not present sharp edges, burrs or projections injurious to the insulation of wiring/cables.
- b) If made of metal, it shall be adequately protected against corrosion or shall be made of corrosion-resistant material.
- c) It shall have side rails or equivalent structural members.

- d) It shall include fittings or other suitable means for changes in direction and elevation of runs.

7.8.4 Installation

Cable trays shall be installed as a complete system. Trays shall be supported properly from the building structure. The entire cable tray system shall be rigid.

Each run of the cable tray shall be completed before the installation of cables.

In portions where additional protection is required, non combustible covers/enclosures shall be used.

Cable trays shall be exposed and accessible.

Where cables of different system are installed on the same cable tray, non combustible, solid barriers shall be used for segregating the cables.

Cable trays shall be grounded by two nos, earth continuity wires. Cable trays shall not be used as equipment grounding conductors.

At no place the cable tray / rack / ladder running horizontally should rest on any building partition like Brick wall, RCC beams etc. but instead proper MS supports/hangers to be provided at minimum of 1500 mm intervals and at every Turning Angles.

7.8.5 Jointing and termination's

Cable jointing shall be done as per the recommendations of the cable manufacturer. All jointing work shall be done only by qualified/licensed cable jointer.

All jointing pits shall be of sufficient dimensions as to allow easy and comfortable working.

Jointing materials and accessories like conductor, ferrules, solder, flex, insulating and protective tapes, filling compound, jointing box etc. of right quality and correct sizes, confirming to relevant Indian Standards.

Each termination's shall be carried out using brass compression glands and cable sockets. Hydraulic crimping tool shall be used for making the end termination's. Cable gland shall be bonded to the earth by using suitable size copper wire/tape.

7.8.6 Specific Requirements - Power Cables

The cables shall be 1100V grade, single / multicore, stranded XLPE insulated aluminium/copper conductor and FRLS PVC sheathed. The cables for emergency

services shall be with additional FRLS properties. The cables shall conform to IS-1554 - Part - I (1988). For multicore cables, fillers used to fill in the space between the phases shall be non-hygroscopic, chemically inert and non-putrescent.

Cables laid outside the building, either buried or in trench shall be of armoured type.

7.8.7 Specific Requirements - Control Cables

1100V grade multicore, 1.5 / 2.5 sq.mm stranded copper conductor, PVC insulated and extruded PVC inner sheathed and extruded FRLS PVC outer sheathed of PVC. FRLS cables, which have outer sheath of specially formulated FRLS PVC cable, shall be used for cables connected to Emergency services. The cables shall conform to IS 1554 Part- I (1985) / IEC 502 (1983) in all other respects.

Cables laid outside the building, either buried or in trench shall be of armoured type.

7.8.8 Design Criteria For Cable Sizing

Power cables shall be selected on the following basis:

- a) Power cable shall carry the full load current of the circuit continuously under site conditions considering the various derating factors like ambient air temperature (50 deg C), grouping, laying methods etc.
- b) Power cables shall be sized to restrict the voltage drop to 5% and a voltage dip of 10% for motors.
- c) Power cable shall withstand the fault current of the circuit for the duration not less than the maximum time taken by the primary protective system to isolate the fault.

7.8.9 Testing of Cables

Cables shall be tested at works for all routine tests as per IS including the following tests before being dispatched to site by the project team.

Insulation Resistance Test.

Continuity resistance test.

Sheathing continuity test.

Earth test.(in armoured cables)

Hi Pot Test.

Test shall also be conducted at site for insulation between phases and between phase and earth for each length of cable, before and after jointing. On completion of cable laying work, the following tests shall be conducted in the presence of the Employer's site representative.

Insulation Resistance Test (Sectional and overall)

Continuity resistance test.

Sheathing continuity test.

Earth test.

All tests shall be carried out in accordance with relevant Standard Code of Practice and Electricity Rules. The Contractor shall provide necessary instruments, equipment and labour for conducting the above tests and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the Engineer In charge/ his representative, results will be noted and signed by all present and record be maintained. All the test certificate shall be submitted by contractor.

7.9 CABLE TRAYS

- 7.9.1 Cable Trays shall be Hot dip Galvanized and factory fabricated out of G.I. channels, angle iron, tee, bends, sections, flats and perforated sheet for different loads and number and size of cables as given below :

Cable trays shall be galvanized as per Specification given elsewhere.

1000 mm wide

Runners 25 x 100 x 25 x 3 mm

Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C

Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.

750 mm wide

Runners 20 x 75 x 20 x 2.5 mm

Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C

Suspenders 2 Nos. 32 x 32 x 5 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI angle.

600 mm wide

Runners 20 x 75 x 20 x 2.5 mm

Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C

Suspenders 2 Nos. 32 x 32 x 5 mm GI angle 1800 mm C/C with base Support of 40x 40 x 5mm GI angle.

450 mm wide

Runners 20 x 75 x 20 x 2.5 mm

Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C

Suspenders 2 Nos. 25 x 25 x 4 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI angle.

7.9.2 Supply and fixing of perforated type cable trays of the following sizes of pre-galvanized iron.

- a) 1000 mm width x 75 mm depth x 2 mm thick
- b) 900 mm width x 75 mm depth x 2 mm thick
- c) 750 mm width x 75 mm depth x 2 mm thick
- d) 600 mm width x 75 mm depth x 2 mm thick
- e) 450 mm width x 50 mm depth x 2 mm thick
- f) 350 mm width x 50 mm depth x 2 mm thick
- g) 300 mm width x 50 mm depth x 1.6 mm thick
- h) 250 mm width x 50 mm depth x 1.6 mm thick
- i) 150 mm width x 50 mm depth x 1.6 mm thick

Note: Suitable length of 10 mm dia GI rod suspenders at 1800 mm interval shall be included in the item for perforated type cable tray.

Specification for Hot Dip Galvanizing Process for Mild Steel Used For Earthing, Cable Trays Or Junction Boxes For Electrical Installation.

7.9.3 General Requirements

7.9.3.1 Quality of Zinc

Zinc to be used shall conform to minimum Zn 98 grade as per requirement of IS:209-1992.

7.9.3.2 Coating Requirement

Minimum weight of zinc coating for mild steel flats with thickness upto 6 mm in accordance with IS:6745-1972 shall be 400 g/sqm.

The weight of coating expressed in grams per square metre shall be calculated by dividing the total weight of Zinc by total area (both sides) of the coated surface.

The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash and dross inclusions, bare patches black spots, pimples, lumpiness, runs, rust stains bulky white deposits, blisters.

Mild steel flats / wires shall undergo a process of degreasing pickling in acid, cold rinsing and then galvanizing.

The thickness of galvanizing shall be 610 gm / Sq. mtr. (87 Microns) in line with IS: 4759

All finished cable trays and accessories shall be free from sharp tees, corners, burrs and unevenness.

7.9.3.3 Cable Trays - Installation Notes

Cable trays shall be installed generally at the elevations shown in respective cable tray layout drawings. If any major modifications in the drawings are envisaged in the field, these should be carried out after getting approval from design office.

Before laying the trays, contractor shall submit the shop drawing & take the approval from client/Project Manager.

It shall be the responsibility of the electrical contractor to mark up all the field modifications on the latest issues of the drawings and return two copies of all such “as constructed” drawings to client/Project Manager’s design office.

The type and size of tray to be used shall be as mentioned in the individual layout drawings.

Cable trays shall be welded to the mounting/carrier structures. Trays shall be supported with suitable angle/hitech rod supports.

Each continuous laid out length of cable tray shall be earthed at minimum two places by GI flats of minimum size 25x6 mm (unless otherwise noted) to the Employer’s earthing system. The distance between earthing points shall not exceed 10 meters.

The following shall be checked before laying the cables on trays.

- a) Check for proper identification nos. of the trays.
- b) Check for continuity of cable trays over the entire route.
- c) Check that all sharp corners, burrs and waste materials have been removed from the tray.
- d) Obtain clearances from piping contractor / engineer that no piping will be taken in the way of cable trays.
- e) Check for earth continuity & earth connection of cable trays.
- f) Cable tray installation work shall comply with all currently applicable statutes, regulations and safety codes in the locality/country where the installation is to be carried out.

7.10 **LIGHTING SYSTEM**

7.10.1 Scope

This specification covers the design, material specification, manufacture, testing, inspection and delivery to site installation, testing and commissioning of lighting system equipment such as lighting fixtures, light control switches, receptacle units, lighting wires, lighting poles, conduits and other similar items necessary for lighting system. Customer / Architect shall have final authority to select light fittings.

7.10.2 STANDARDS

The items of supply and installation shall comply with the latest applicable standards as specified in specification, Notes and Details and lighting layout drawings. Where no standards are available, the supply items shall be backed by test results shall be of

good quality and workmanship and any supply items which are bought out by the CONTRACTOR shall be procured from approved manufacturers acceptable to the EMPLOYER.

7.10.3 LIGHTING FIXTURES AND ACCESSORIES

7.13.3.1 Lighting Fixtures / Luminaries – General Requirements:

- a) Luminaries shall be designed for continuous trouble-free operation under atmospheric conditions without reduction in lamp life or without deterioration of materials and internal wiring. Outdoor fittings shall be weatherproof and waterproof.
- b) All Luminaries shall be supplied complete with lamps suitable for operation on a normal supply voltage and the variation in supply voltage and frequency indicated in data sheet.
- c) Fluorescent T5 type, sodium vapour and metal halide type Luminaries shall be complete with accessories like lamps, ballasts, power factor improvement capacitors, starters etc. These shall be mounted as far as possible in the Luminaries housing only. If these cannot be accommodated integral with the Luminaries then a separate metal enclosed control gear box shall be included to accommodate the control accessories together with a terminal block suitable for loop-in, loop-out connections. Outdoor type fixtures shall be provided with outdoor type weatherproof box with IP 55 or better.
- d) Fluorescent type Luminaries with more than one lamp shall be provided with capacitors connected in lead-lag circuit for correction of stroboscopic effect.
- e) Each Luminary shall have a terminal block suitable for loop-in, loop-out and T-off connection. Terminals shall be of stud or clamp type. Terminal blocks shall be mounted with minimum two fixing screws.
- f) Mounting facility and conduit knockouts for the Luminaries shall be provided.
- g) All hardware used in the Luminaries shall be suitably plated or anodised and passivated for use in chemical, industrial and power plants.
- h) Earthing
Each Luminaries and control gearbox shall be provided with an earthing terminal suitable for connection earthing conductor as indicated.
- i) Painting / Finish
All surfaces of the luminaries / control gearbox housing accessories shall be thoroughly cleaned and degreased. It shall be free from scale, rust, sharp edges and burrs.
The finish of the luminaries shall be such that no bright spots are produced either by direct light source or by reflection.
- j) External control gear box provided for housing accessories shall be galvanized.

7.13.3.2 LED (Light Emitting Diode) FITTED LUMINAIRE

- a) The LEDs shall be of reputed make such as OSRAM / Philips / Lumileds / Cree/ Nichia.

- b) LED fixtures to be utilized for Utility area and Street lighting.
- c) LED module/ array shall deliver at least 85 % of initial lumens, when installed for a minimum of 50,000 hours.
- d) To enhance the secondary optics of the fixture, suitable Acrylic Optical Lenses shall be used.
- e) The Correlated Color Temperature (CCT) of the LED fixture shall be in the range of 5500-6000°K.
- f) The luminaries shall ensure a CRI of minimum 70.
- g) The Uniformity Ratio (E_{min} / E_{avg}) shall be minimum of 60%.
- h) The LED luminaries shall produce constant lux level in the voltage range of 140V to 280V. Voltage variations/ fluctuations in the specified voltage range shall not impinge upon the lux level it produces.
- i) The life span of the LED source including its Driver shall be minimum or greater than 50000 hours.
- j) The P/N junction temperature of individual LED must not exceed 100°C. High Thermal conduction must be achieved by use of silicon heat conductive greases an adhesive.
- k) LED Light must be constructed to achieve the average illumination of 35 LUX and at the ground level/ working level for the all the Utility Plants roads with the Uniformity Ratio (E_{min} / E_{avg}) of minimum of 60% and tranverse ratio (E_{min}/E_{max}) of 0.4 as per relevant to the employers requirement.
- l) All fasteners must be of stainless steel and rustfree.
- m) LED must be mounted on heat sinking conductive bars if any with suitable large area surface by means of fins to dissipate the conducted heat. The fins must be exposed to ambient flowing air.
- n) Heat sink used should be aluminium extrusion / high pressure die cast aluminium having high conductivity. Heat sink should be integrated within luminaire and efforts shall be made to keep the overall outer dimensions optimum such that it permits sufficient heat dissipation through the body itself so as to prevent abnormal temperature inside the luminaire and consequential damage to cover, gasket material, LEDs, lenses and drivers.
- o) The electrical component of the LED and LED driver must be suitably enclosed in hermetically sealed unit.
- p) In addition, LEDs should be voltage control dimmable with provision for power line communication modem or other standard communication system which shall be able to communicate with electronic drivers or similar type of lighting controllers and operate without generating excessive heat. All the LEDs should be “on” while dimming
- q) The luminary should be provided with in-built power unit & electronic driver. The luminary should be so constructed to ensure that the drivers are replaceable, if required.
- r) The luminaries shall conform to IEC 60598 or equivalent standard. The driver should comply with IEC 61347-2-13, IEC 61547, CISPR-15; and 61000-3-2. The supplier should submit luminary test report conforming to the specified standards.
- s) Light Distribution shall be of Cut Off/ Semi Cut Off type.
- t) Each lighting fixture shall be provided with an earthing terminal suitable for connecting 2.5 sq. mm (1 core of the 3Cx2.5 sq. mm copper-PVC cable to be used) copper stranded conductor.
- u) Applicable standards
- v) The standards and code of practices referred to below shall be the latest editions Including all official amendments and revisions.

- w) General safety requirements: IS 1913 - for luminaries
- x) Luminaries for street lighting: IS 10322 - electric cables
- y) Current waveform for the LED drivers should meet relevant national and international standard.
- z) Electronic components IC (Integrated circuit) shall be of industrial grade or above.
- aa) Metallic film/ Paper/ Polyester Capacitor shall be rated for a sustained operating temperature of 105° C.
- bb) The construction of PCBs and the assembly for components for PCBs should be as per IS standards.

7.10.4 Construction

- a) The casing of the lighting luminaries shall be made of pressure die cast aluminum coated with epoxy polyester powder coat single. The driver unit must be accessible and if need be replaceable easily and with minimum use of tools.
- b) The casing made of non-corrosive aluminum having high conductivity shall have external surface designed in a manner so as to act as an efficient heat sink to extract heat generated at PN-junction of a LED. Efforts shall be made to install the fittings on the required street light pole without compromising on the performance of the LEDs or luminary.
- c) The assembly and manufacturing process for the LED source assembly in modules/arrays shall be designed to assure all internal components are adequately supported to withstand sudden impacts and mechanical shock and vibration from high winds and other sources.
- d) No part shall be constructed of polycarbonate unless it is UV stabilized.
- e) Material used for the lens of LED source shall be of toughened glass, heat resistant and shall not undergo discoloration during lifetime of the LED source. It shall conform to ASTM specifications for the materials. Any discoloration observed in the lens shall be considered a failure under warranty clause.
- f) All luminaries shall be provided with acrylic / polycarbonate / glass diffusers and/or aluminized reflectors and/or lenses to provide proper road lighting distribution.
- g) Toughened and/or tempered glass of sufficient strength may be provided under the LED chamber to protect the LEDs and luminaries.
- h) The LED lens shall be UV stabilized and shall be capable of withstanding ultraviolet (direct sunlight) exposure for a minimum period of 60 months without exhibiting evidence of deterioration.
- i) The finish of the fixture shall be powder coated and of grey colour.
- j) The luminaries shall be capable of operating normally in ambient temperatures from -20°C to 50°C maintaining junction temperature below 100°C and heat sink temperature below 60°C, ensuring efficient thermal management of the luminaire.
- k) The fixture shall be designed in such a manner that it is easy to handle and install, is not too large and unwieldy, is of robust construction, light weight and conforms to minimum IP66 class of protection for outdoor use.

Luminary's manufacturer should submit IP test report from Govt. Accredited Test Lab / R&D Labs.

- l) The luminary shall be provided with a built-in external heat sink as well as an aluminum MCPCB printed circuit board, designed in such a way that the heat generated within the LED source is efficiently dissipated to the surrounding atmosphere without abnormal rise in temperature. Any debris build up shall not degrade heat dissipation performance of the luminaries. A lighting luminaire fitted with an assisted cooling system is not acceptable.
- m) The Entire LED lamps should be driven by minimum 2 or more numbers of the driver circuits. The entire power supply to the LED Lamps should be divided among the drivers, thus each driver controlling a group of LED lamps.

7.10.5 Thermal Management

- a) The manufacturers shall ensure that the fixture is designed in such a manner that it conducts the heat away from the LEDs as efficiently as possible. The design shall ensure that the junction temperature is kept as low as possible during operation. Thermal management shall be in such a way that Luminaire shall have trouble free operations from -20 °C to +50°C. The following tests shall be done to determine efficient thermal Management.
- b) The Fixture manufacturer shall perform solder point temperature (Tsp) measurement and compute junction temperature (Tj). The manufacturer shall show the proof that the junction temperature shall not go beyond the LED manufacturer's maximum junction temperature for long term lumen maintenance (i.e., 85% of the original value of lumen output after 50000 hours of operation).
- c) The fixture manufacturer shall furnish proof that the LEDs that have been offered and used in the fixture have White Point stability data (6000 Hours) as per IESNA's LM80-08, done at high ambient temperature 85°C and solder point temperature of 85°C.
- d) The fixture manufacturer shall furnish proof that the LEDs that have been offered and used in the fixture have been tested to IEC 62471 for safety requirements.

7.10.6 Electrical

- a) The LED fitted lighting fittings shall operate at 50 Hz +/- 3 % Hz AC over a voltage Ranging from 140V to 280V with a power factor > 0.95 in a 3-wire distribution system. The total power consumption in the LED lighting fixture shall not exceed the total guaranteed power consumption including power consumption in the electronic circuit of the driver for that particular application over the entire voltage range given in clause.
- b) The fluctuations in line voltage shall have no visible effect on luminous intensity of the LED luminaries. The operating voltage of the luminaries shall be 230V. All parameters measured at this voltage shall stand valid for the entire operating voltage range of 140- 280V.
- c) Total harmonic distortion (THD) of current and voltage induced into the AC power supply by an LED lighting source shall not exceed 15% for current and 5% for voltage. Harmonic Generation shall be as per EN61000-3-2 and EN61000-3-3 / IEEE 519.

- d) The driver module on board circuitry shall include voltage surge protection to withstand High-repetition noise transients as stated in Section 2.1.6 of NEMA Standard TS-2/ 1992.
- e) The LED circuitry shall function at an operating frequency that must be greater than 120Hz to prevent perceptible flicker to the unaided eye over the entire voltage range Specified above.
- f) The lighting luminaries shall withstand the following tests.
 - a. HV test of 4.5 KV
 - b. IR test of 500V
- g) The output circuit shall have short circuit and open circuit protection inbuilt to the driver unit.
- h) The material used in the construction of driver printed boards; driver enclosure etc. shall be non-flammable and heat resistant. Also, all the PCBs in the system shall be coated to prevent any corrosion.

7.10.7 Testing

- a) Design Qualification Testing shall be performed by the manufacturer or an independent testing lab hired by the manufacturer on new LED module/ array designs and when a major change has been implemented on an existing design.
- b) The bidder shall submit manufacturer's test certificates complete with verification of Design Qualification Testing details by an independent testing authority.
- c) The Luminaire manufacturer must show proof that the LEDs they use have been tested and approved to IESNA's LM80-09. The manufacturer must be able to provide the test data set to establish the authenticity and genuineness of the LEDs.
- d) Tests conducted on LED luminaries are classified as: 1) Type test, 2) Acceptance test, 3) Routine test and 4) Mock-up test.
 - i. Type Test shall be carried out to prove confirmation with the requirements of specification and general quality/ design features of the unit. In case of any change in Bill of Material or design of unit, complete type test shall be repeated. If any sample fails in any of the type tests, fresh samples shall be taken and tested. If any sample again fails in that test, the whole lot shall be rejected.
 - ii. Acceptance Tests are carried out by an inspecting authority at the supplier's premises on sample taken from a lot for the purpose of acceptance of a lot. Acceptance tests shall not be carried out from particular size or lot on which type tests have already been conducted,
 - iii. Routine Tests shall be performed by the manufacturer on each complete unit of the same type and the results shall be submitted to the inspecting agency, prior to offering the lot for acceptance test. The firm shall maintain the records with traceability.
 - iv. Mock up Test.

The successful bidder shall provide proposed LED lamp and luminaries on three consecutive poles as demonstration to prove the suitability of the fittings matching with the requirement in regards to lux level,

quality of illumination for professional, objective & impartial review jointly by the bidders team along with team of MSME Engineers. This shall be carried out within two weeks from the date of issue of work order and prior to submission of detail design package for approval.

Sample size and criteria for conformity

The luminaries shall be selected from the lot at random. In order to ensure randomness of selection, procedures given in IS 4905-1968 (Reaffirmed 2001) may be followed.

Test Scheme:

Sr. No	Description of Test	Type Test	Acceptance Tests	Routine Tests
1	Visual and Dimensional check	Y	Y	Y
2	Checking of documents of purchase of LED	Y	Y	Y
3	Resistance to humidity	Y	-	-
4	Insulation resistance test	Y	Y	Y
5	HV test	Y	Y	Y
6	Over voltage protection	Y	-	-
7	Surge protection	Y	-	-
8	Reverse polarity	Y	Y	Y
9	Temperature rise	Y	Y	-
10	Lux measurement	Y	Y	-
11	Fire retardant	Y	-	-
12	Test for IP66 protection	Y	-	-

7.10.8 Marking

- i. The following information shall be distinctly and indelibly engraved on the housing:
 - Year of manufacture
 - Batch Number
 - Serial Number

- Name of Manufacturer
- Rated Wattage and Voltage (Input)
- Markings like CE, CB
- ii. ISO Certification: The agency shall preferably possess the ISO certification for design, Manufacturing and supply of the complete Lighting Unit.

7.10.9 Guarantee Terms and Condition

- a) Warranty
- b) In addition to meeting the performance requirements for the minimum period of 60 months, the manufacturer shall provide a written warranty against defects in materials and workmanship for the modules/ arrays for a period of 60 months after acceptance of the modules/ arrays. Replacement modules shall be provided promptly after receipt of modules that have failed at no cost to the Employer.
- c) The bidder shall stand guarantee for full replacement of the luminary due to any failure in 5 years, from the date of purchase. Failures shall include failure/ deterioration of LEDs in terms of performance like guaranteed luminous efficiency, high junction temperature, and abnormal lamp lumen depreciation, deterioration in LED including its lens, driver unit and quality of light. The vendor shall replace the entire LED module/ array of the defective luminaire with new module /array free of cost immediately.
- d) In the event of single LED source getting defective, the entire array/ module shall be replaced by the bidder by the new fittings.
- e) The bidder shall stand guarantee against lumen depreciation beyond 15%. Vendor shall ensure that LED module/ array shall deliver at least 85% of initial lumens, when installed for a minimum of 50,000 hours, failing which bidder shall carry out necessary rectification free of cost to the entire satisfaction of MSME.
- f) The bidder shall maintain appropriate level of inventory in India for immediate replacement of a defective/ malfunctioning luminary/ LED module/ array/ driver etc.

7.10.10 Compliance to Standards

- a) The luminaries shall comply with IS 10322 for functional, photometric and safety requirements. The fixture shall conform to safety standard EN60598.
- b) The luminaries shall conform to norms on transient voltages, voltage dips and fluctuations as per EN 61547.
- c) The luminaries fitted with LED source shall be CE and ISO certified to ensure quality of the LED source.
- d) The other relevant standards applicable to LED based lighting solutions to which lighting luminary must conform are as under:

ANSI C78.377.2008	Specifications for the Chromaticity of Solid State Lighting Products
IESNA LM- 79-08	IESNA Approved Method for the Electrical and Photometric Measurements of Solid State Lighting Products.
IESNA LM-80-08 (Recommended)	IESNA Approved Method for Measuring Lumen Maintenance of LED Lighting Sources.

UL Standards (Latest Approved)	<ul style="list-style-type: none"> • 8750 Light Emitting Diode (LED) Light Sources for use in Lighting Products. • 1598 Luminaries • 1012 Power Units other than Class-2 • 1310 Class-2 Power Units • 2108 Low Voltage Lighting Systems.
IEC 62471	Photo-biological safety of lamps and lamp systems.

7.10.11 Street lighting Design

Details and considerations as follows:

- a. Configuration of the Road : 6.0 Mtrs
- b. Mounting height : 6/8 Mtrs
- c. Span : 20 Mtrs
- d. Required Lux Level (Eavg) : 15
- e. Emin/Eavg : 0.5
- f. Emin/Emax : 0.3
- g. Maintenance Factor : 0.7

7.10.12 Decorative Luminaries

a) Fluorescent Luminaries

- These luminaries shall be generally indoor type provided with cold rolled cold annealed (CRCA) sheet steel channel / rail cum reflector housing complete with all electrical control accessories mounted on it. The finish shall be stove enameled.
- Decorative fluorescent type luminaries shall be either open type, provided with translucent white opal acrylic diffusers, polystyrene lens prismatic or square polystyrene louvres.
- Luminaries shall be suitable for the number of lamps of specified wattage, direct mounting on ceiling / wall/ column pendant mounting or for recess mounting in false ceiling.
- Decorative luminaries with mirror optic reflectors shall be made with reflectors with a high specular reflectivity (of more than 90%) and wide-angle dispersion type. Where these luminaries are mounted in control rooms and computer rooms, special type of anti-glare mirror (CAT-2) system shall be provided to direct the light output in the desired direction. This is mainly to reduce reflection of the light source from computer screens.
- Luminaries mounted recessed in false ceiling shall be with reflector housing and spring loaded fixing arrangement for the diffuser / louvre frame. It shall be possible to have access to the lamp and other accessories from below.

- Low loss electronic ballasts shall be provided for all fluorescent & CFL lamp luminaries.
- b) Incandescent / Mercury Vapour / Sodium Vapour / Metal Halide Luminaries
- Decorative luminaries with sodium vapour lamp / metal halide shall be generally outdoor weather proof type with degree of protection IP 55 suitable for conduit mounting.
 - The luminaries may be provided with integral mounted control accessories or with external mounted control gear box.
 - Decorative lantern luminaries shall be outdoor weather proof type with degree of protection IP 55, cast aluminums, stove enameled housing, prismatic heat resistant, toughened glass cover complete with neoprene gaskets, top or side conduit entry and integral mounted control gear box.
- c) Bulk Head Luminaries
- The luminaries shall be robust construction, cast aluminum / vitreous enameled housing, heat and shock resistant prismatic or clear glass cover fixed with neoprene gaskets for sealing. For mechanical protection to the glass cover, round steel wire guard with vitreous enameled finish shall be provided. The luminaries shall be suitable for incandescent lamp upto 150 watts, for direct mounting to ceiling / wall /column and is used for general purpose indoor lighting.

7.10.13 OUTDOORS LUMINAIRES

- a) Street Lighting Luminaries
- Street lighting luminaries shall be outdoor weather proof LED and it will be fed from Solar panel.
 - The luminaries shall be constructed of die-cast aluminium clear printed single panel, tempered safety glass cover adjust to tilt angles of 0°/5° Light distribution : Asymmetrical, ME-Optic (Characteristic : For street illumination) Elec. equip LED approx. 120W (5600k) with electronic ballast, IP-66, Protection rating-I, can be mounted on standard poles with fitter diameters - 60mm side mounted and 76.1 mm (Pole top mounted).
- b) Post Top Lantern
- Post top lantern luminaries shall be generally outdoor weather proof type for illumination of walkways, gate posts, gardens etc.
 - The luminary shall have cast aluminium spigot finished with corrosion proof paint for mounting, opal acrylic or high density polyethylene (HDP) diffuser bowl, complete with integral mounted control gear, neoprene gaskets, earthing terminal etc.
 - The luminaries shall be suitable upto 100 W incandescent lamp, 40 W LED
- c) Aviation warning system luminaries
- Medium Intensity type luminaries
 - Medium intensity luminaries shall be outdoor, weather-proof type, suitable for mounting on structures / buildings up to 200 metres height

- This luminaries shall be with cast aluminum base with LED lamp, red prismatic glass/acrylic cover, neoprene gaskets and bottom conduit / pipe entry.
- The means for attaching the luminaries shall be designed to suit the weight of the luminaries and strength to withstand wind speeds as applicable to particular area as per relevant IS specification.
- Environmental Lighting Luminaries

d) Bollard Luminaries

- Bollard Luminaries shall be outdoor, weatherproof type for illumination of lawns, gardens, pathways etc.
- The Luminaries shall be of FRP housing, clear acrylic cover, louvres for directing light downward and bottom cable entry.
- The Luminaries shall be suitable for 40 LED or 9 / 11 W CFL.

7.10.14 Accessories For Luminaries

a) Reflectors

- The reflectors shall be made of CRCA sheet steel / aluminium / silvered glass/ chromium plated sheet copper as indicated for above mentioned Luminaries.
- Thickness of steel / aluminium shall comply with relevant standards specified in Data Sheet. Reflectors made of steel shall have stove enamelled / vitreous enamelled / epoxy coating finish. Aluminium used for reflectors shall be anodized / epoxy stove enamelled / mirror polished. The finish for the reflector shall be as indicated for above-mentioned fittings and or in Data Sheet.
- Reflectors shall be readily removable from the housing for cleaning and maintenance without disturbing the lamps and without the use of tools. They shall be securely fixed to the housing by means of positive fastening device of captive type.

b) Lamp / Starter Holders

Lamp holders shall comply with relevant standards specified in Data Sheet. They shall have low contact resistance, shall be resistant to wear and shall be suitable for operation at the specified temperature without deterioration in insulation value. They shall hold the lamps in position under normal condition of shock and vibration met with under normal installation and use.

c) Ballasts

- Ballasts shall be designed manufactured and supplied in accordance with the relevant standards specified in Data Sheet. The ballasts shall be designed to have a long service life and low power loss.
- Ballasts shall be of the inductive, heavy-duty type copper wire wound, filled with thermosetting, insulating, moisture repellent polyester compound filled under pressure or vacuum. Ballasts shall be provided with taps to set the voltage within the range specified in enclosed Data Sheet. End connections and taps shall be brought out to a suitable terminal block rigidly fixed to the ballast enclosure. Ballasts shall be free from hum and

such of those which produce hum shall be replaced by VENDOR with free of cost.

- Separate ballast for each lamp shall be provided in case of multi lamp Luminaries, except in the case of 2 x 20 watts Luminaries.

d) Electronic Ballast

Electronic ballast shall be suitable for 1x18W, 1x24W, 1x28W and 2x18W fluorescent lamp and shall be energy saving, warm start type having a power factor better than 0.96, having an optimum wattage delivery to the lamp. The choke shall be suitable for 180 – 270 V AC for operation at ambient temperature range of -15°C to +50°C. The choke shall have low radiated and conducted EMI / RFI. Refer BOQ

e) Digital Ballast

Digital ballasts shall be designed and manufactured with latest techniques using specially designed high-grade electronic components housed in pre coated galvanized sheet. Shall be suitable for operation with luminaries incorporating fluorescent and compact fluorescent lamps with dimming. The ballast shall be suitable for 200 – 320 V AC for operation at ambient temperature range of -15°C to +50°C. The ballast shall have low radiated and conducted EMI / RFI. Refer BOQ

f) HIGH FREQUENCY ELECTRONIC BALLAST

High frequency electronic ballast shall be used with fluorescent / Compact Fluorescent Lamps wherever specified in the schedule of quantities. High frequency electronic ballast shall comply to the following:

- IEC 927, IEC 928 for $\leq 10\%$ total harmonic distortion.
- EMI / RFI – Confirming to FCC / VDE Class A/B.
- Line Transient as per IEEE C62.41.
- Ballast Crest Factor $C1.7\%$.
- No Stroboscopic Effect
- Constant Wattage / Light output between $240\text{ V} \pm 10\%$.
- Circuit protection for surge current and inrush current.
- Short circuits, open lamp protection
- $\text{PF} > 0.99$ for fluorescent / T5 lamp and 0.95 for CFL.
- Deactivated lamp protection
- Suitable for use with single and twin lamps
- $\text{RFI} < 30\text{ MHz}$ EN 55015
- Total Harmonic Distortion (THD) $\leq 10\%$
- Immunity to interference EN 61547
- Safety EN 60928 / IS 13021 (Part I)
- Performance EN 60929 / IS 13021 (Part II)
- Vibrations & Bump tests IEC 68-2-6 FC
- IEC 9001

- Quality Standard ISO 9001
- Environmental Standard ISO 14001
- DC Operation EN 60924
- Emergency Lighting Operation VDE 0108

g) Starters

Starters, if required shall have bimetal electrodes and high mechanical strength. Starters shall be replaceable without disturbing the reflector or lamps and without the use of any tool. Starters shall have brass contacts and radio interference capacitors.

The starters shall generally conform to the relevant standards specified in Data Sheet.

h) Capacitors

Capacitors shall have a constant value of capacitance and shall be connected across the supply of individual lamp circuits.

Capacitors shall be suitable for operation at supply voltage and shall have a value of capacitance so as to correct the power factor of its corresponding lamp circuit to the extent of 0.95 lag or better.

Capacitors shall be hermetically sealed preferably in a metal enclosure to prevent seepage of impregnant and ingress of moisture.

i) Lamps 5 Star Rating

Lamps shall be capable of withstanding small vibrations and the connections at lead in wires and filaments / electrodes shall not break under such circumstances.

Lamps / tubes shall conform to relevant standards specified in Data Sheet.

j) Incandescent lamps

General lighting service (GLS) lamps shall be tungsten filament incandescent type. The filament shall be coiled coil type rated for 230 / 250 volts, single phase AC.

k) Halogen Lamps

Halogen lamps shall be tungsten halogen type suitable for fitment in flood light Luminaries.

Lamps shall be rated 250 volts single-phase AC upto 1000 watts.

l) Fluorescent Lamps T5

Fluorescent T5 lamp luminaries shall be with TRULITE lamps, low wattage consumption, high efficiency and longer burning life (about 10000 hours).

T5 Lamps shall be of warm white or cool day light type with triband phosphor coated type, suitable for operation on 240V, single phase AC, in standard lengths of 2 and 4 feet.

T5 Lamp colour shall be colour-82 for lift lobby and colour 86 for all other areas.

m) Compact Fluorescent Lamps

These compact fluorescent lamps shall be of low pressure, low wattage type with integral glow switch starter with separate/inbuilt ballast. Suitable for operation on 240 V, single phase AC with burning life (about 10000 hours).

Lamps shall be rated 9 W, 11 W, 18W, for compact fluorescent (PL) type.

Lamp colour shall be colour-82 for lift lobby and colour 86 for all other areas.

n) High Intensity Discharge Lamps

These lamps include the high-pressure sodium vapour lamp, metal halide lamps.

High pressure sodium vapour lamps shall be with polycrystalline translucent, coated discharge tube, coated shell, quick restrike time (of within 5 minutes) and with burning life (about 10,000 hours) in standard ratings upto 400 watts.

Metal halide lamps shall be single ended or double ended as required. The lamps shall be with quartz discharge tube and transparent / internal coated shell, quick restrike time (of within 5 minutes) with burning life (upto 5000 hours) in standard ratings upto 2000 W. The colour rendering index of these lamps shall be very high. These lamps shall be used only in enclosed Luminariess (lamps without protective coating) and can be used only in open Luminariess in lamps with Teflon or other coating to hold the shell in case of non-passive end of lamp life.

7.10.15 Lighting System Equipment

Light Control Switches

- a) Light control switches of ratings and types, i.e. decorative/industrial, shall be supplied as indicated in project layout drawings/price schedule. The switches shall be suitable for use on 240 V, 1 phase, 50 Hz supply.
- b) Switches shall be of flush type for mounting behind an insulated plate or incorporated with a switch or switch box/suitable enclosure. The switch box/ enclosure may be recessed into or mounted on wall as per the requirements of project layouts.
- c) Size of enclosure boxes shall be chosen to accommodate the number of switches to be installed at the particular location. The enclosures shall be made of 1.2 mm thick CRCA sheet steel, stove enameled/galvanized. The enclosure box shall be covered with perspex/insulating cover. An enclosure intended for surface mounting shall not have holes or gaps in its sides other than those expressly provided for cable entry.
- d) Switches shall conform to the relevant standards.

7.10.16 Receptacle Units

- a) Receptacle units shall consist of socket outlet with associated switch, neon indicating lamp and plug. The socket outlet and switch shall be flush mounted within a stove enameled/ galvanized 1.2 mm thick CRCA sheet steel enclosure with perspex/insulating cover. The box may be recessed into or mounted on a wall as per requirements of project layouts.
- b) Outdoor type receptacles shall be housed in a 2 mm thick CRCA sheet steel epoxy painted enclosure with gasket, hinged door having locking

arrangement. The enclosure shall be with rain canopy and removable gland plate entry from bottom. Composite receptacle with switch modules housed in a box shall be with degree of protection IP 66.

- c) The receptacle units shall be suitable for 240 V, phase, 50Hz/415V, 3 phase, 50 Hz supply as indicated in project layout drawings/price schedule.
- d) Single-phase receptacles shall be associated with a switch/MCB of same current rating and the receptacle shall become live only when the associated switch/MCB is in "ON" position.
- e) Three phase receptacles shall be associated with a TPN switch housed in the same enclosure. The receptacle shall become live only when the associated switch is in "ON" position and it shall not be possible to withdraw the plug with the switch in "ON" position.
- f) Plugs shall be provided with cord grips to prevent strain and damage to conductors/wires at connection and entry points.
- g) Types and current ratings of receptacle units shall be as indicated in the layout drawing/price schedule and they shall conform to the applicable standards.
- h) Whenever stated in layout drawing/price schedule, receptacle units may be provided with MCBs instead of switch.

7.10.17 Lighting Wires

- a) The wires for wiring in lighting system shall be 1100 V, 2Runs x 2.5 Sqmm multi stranded PVC insulated copper wires with 1Runs x 1.5 Sqmm multi stranded PVC insulated copper wire. The wires shall conform to the applicable standards.
- b) The minimum area of conductor for lighting fixtures shall be 2.5 sq.mm for phase, neutral and earth, for 13A and 16A receptacles conductor size shall be 1100 V, 2Runs x 2.5 Sqmm multi stranded PVC insulated copper wires with 1Runs x 1.5 Sqmm multi stranded PVC insulated copper wire.

7.10.18 Lighting System Installation Work

Lighting Fixtures

- a) The installation of lighting fixtures shall be based on the mounting arrangement shown in the drawings enclosed with this specification. The unit rates quoted for installation shall include all materials required to mount the fixtures in the manner as shown in the drawings. Unit rate for installation of lighting fixtures shall include cost of installation of control gearbox wherever applicable.
- b) Installation of receptacles and switches shall be carried out suitably as per the lighting layout drawings. Switch shall be mounted in flush with the front cover plate. Cost of supply and installation of necessary hardware shall be included in the unit rates quoted for installation of receptacles/switches.
- c) Lighting distribution boards shall be installed in the location indicated in the layout drawings. Installation rates quoted for installation of lighting distribution boards shall include supply and installation of wall brackets, etc.

7.10.19 External / Street Lighting Poles

- a) Swaged Type Welded M.S. Tubular Poles

4.5/6 Meter High Pole:

4.5 meter high (3.5 meter above and 1 meter below ground) shall be 60 mm dia, 3.25 mm wall thickness MS tubular straight pole with a cast aluminium adaptor for post top mounting. Pole shall be provided with 300 mm x 300 mm x 6 mm thick MS base plate. Foundation for the pole shall be of cement concrete in 1:2:4 rates (1 part cement, 2 parts coarse sand and 4 parts stone aggregate) IP-65 weather proof junction box shall also be provided to accommodate 1 No. 3 phase and neutral terminal block and 1 No. 6 amps SP MCB including 2.5 sq.mm PVC insulated copper conductor wires from the terminal block to the fixture and 2 Nos. 32 mm dia GI sleeves of suitable length shall be provided to the junction box.

b) Description of top bracket / arms

Single double decorative arm shall be provided on the pole (as asked for in B.O.Q.), secured with the help of two nos. bolts outreach not less than 400 mm.

c) Service window

A service window of the size 150 mm x 100 mm shall be provided in the base of the pole to allow access to electrical connections and terminations. It shall be covered with MS plate and proper rubber gaskets shall be provided to prevent any ingress of water etc.

d) Electrical connections

Four way connectors shall be provided along with Slide lock and 1 no. 6 amps Sp MCB including 2.5 sq mm PVC insulated copper conductor wires from the terminal block to the fixture and 2 nos. 32 mm dia GI sleeves of suitable length shall be provided up to the service window. An earth boss is provided on the control plate along with connectors and interrupters.

7.11 **EARTHING SYSTEM**

7.11.1 A complete earthing system comprising earthing conductors, earth electrodes and earth connections necessary for effective and permanent bonding to earth, all non-current carrying metal work and for termination of the earthing conductors of all electrical 415V switchboards, sub boards, distribution boards, etc., installed for the Electricity Distribution System for this project shall be supplied, erected and connected under this section of the specification and the associated drawings.

Earthing conductor shall be as follows

Conductors above ground level : Galvanised

and in cable trenches

Conductor buried in earth : GI

Electrodes : Galvanised Steel Pipe/GI plate /Cu plate

The earthing conductor sizes shall be as follows

Main earthing conductor: Refer Earthing layout

Equipment earthing lead

(a)	415 V Switchgear, Motor control centre and DG set	:	Refer Earthing layout
(b)	Sub board, distribution boards, control panels, cable trays, 3/1 phase receptacles	:	Refer Earthing layout
(c)	Lighting fixtures, single phase receptacles, power and lighting conduits, junction boxes, hand rails and exhaust fans	:	Refer BOQ
(d)	Metallic non-current carrying structures	:	Refer Earthing layout

Earthing main conductor shall be provided around the buildings and interconnected as shown in the drawings. The Main Conductor and tap off Conductors length buried in soil shall be wrapped with bitumen tape for protection against corrosion.

Layout of earthing conductor inside the building shall be planned to provide earthing connection to all equipment and structures by short and direct earth leads. Grid riser in electrical shafts with tap-offs at each floor shall be provided.

The joints in the run of the earthing conductors shall be welded type. Connections with equipment/ structure shall be of bolted type.

Cable trays, steel pipes / conduits, steel columns, etc., shall not be used as earth continuity conductors.

Earth connections for all sections of installation shall be electrically and mechanically sound.

All electrical equipment rated 240 Volts and above shall be earthed at two points except the 3-phase / 1 phase receptacles, cable trays, lighting fixtures, conduits, hand rails, metallic non-current carrying structures, which shall be earthed at one point.

All works performed under this section shall also comply with the requirements of the local authority, IS 3043, 1987 and Earthing and Lightning Protection System-Notes and Details.

All three phase equipment shall be double earthed.

7.11.2 Earthing Systems – Installation Notes

General

- These notes shall be read and considered in conjunction with earthing drawings and specification. In case of any conflict between these notes and drawings/ specification, the later shall prevail.
- Earthing system layouts are diagrammatic only. Exact location of earthing conductors, earth electrodes and test pits and connection may be changed to suit the site conditions. Major modification should be referred to EMPLOYER for clearance.

- c) Neutral point of the system of the different voltages, metallic enclosures and frameworks associated with all current carrying equipment and extraneous metal works associated with electric system shall be connected to a single earthing system unless stipulated otherwise.
- d) Earthing system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, Relevant Indian Standards and codes of practice and Regulations existing in the locality where the system is installed.

7.11.3 Earthing Conductor Layout

- a) Earthing conductor in outdoor area shall be buried at least 600mm below finished floor level unless stated otherwise.
- b) The spacing between adjacent rod / pipe electrode shall be twice the length of the electrode, unless otherwise stated elsewhere. The spacing between adjacent plate electrodes shall be 5000 mm minimum, unless otherwise stipulated otherwise.
- c) Earthing conductor around the building shall be buried in earth minimum distance of 1500mm from the outer boundary of the building.
- d) Earthing conductors embedded in the concrete floor of the building shall have at least 50mm concrete cover.
- e) Earthing conductor along their run on the columns, walls, etc., shall be fixed by suitable welding or cleating at intervals of 1000mm and 750mm respectively.
- f) Tap connections from the floor earthing grid to the equipment / structure to be earthed shall be terminated on the earthing terminals of the equipment, if the equipment is available at the time of laying the grid. Otherwise “earth raiser “ or “earthing pads” shall be provided near the equipment foundation / pedestal for future connection to the equipment earthing terminals.
- g) In outdoor areas, buried conductors shall be brought 500mm above the ground level for making tap connections to the equipment (above ground level)
- h) Earthing conductors crossing the road shall be either installed in Hume pipes are laid at greater depths to suit the site conditions.
- i) Wherever earthing conductor cross underground service ducts, pipes, trenches, tunnels, railway tracks etc., it shall be laid in Hume pipes and minimum 300mm below them. The earthing conductor shall be re-routed in case it fouls with equipment foundation.
- j) Wherever earthing conductor passes through walls, floors etc., galvanized conduit / HDPE pipe sleeves shall be provided for the passage of the conductor. Both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves. The seals in addition shall be fire proof if the specification / project drawings call for the same.
- k) Water stops shall be provided wherever earthing conductors enters the building from outside, below the ground level.
- l) Separate / isolated earthing system, if required, shall be provided for instrumentation and control and control systems in the plant, including dedicated earth pits.

7.11.4 Equipment And Structure Earthing

- a) Earthing pads / terminals will be provided by the manufacturer of the apparatus/ equipment at accessible positions. The connection between the earthing pads/ terminals and earthing grids shall be made by short and direct earthing leads free from kinks and splices.
- b) Whether specifically shown in drawing or not, Steel / RCC columns, metallic stairs, Hand rails etc., of the building housing electrical equipment shall be connected to the nearest earthing grid conductor by at least one earthing lead. Electrical continuity shall be assured by bonding the different sections of the handrails and metallic stairs.
- c) Electrical conduits, pipes and cable tray sections shall be bonded to ensure electrical continuity and connected to earthing conductors at regular intervals. Apart from intermediate connections end and beginning points shall also be connected to earthing system. These details are covered separately under cabling installation notes and details which shall apply.
- d) Steel / RCC columns, metallic stairs, Hand rails, Cable trays, metallic conduits, and pipes etc. shall not be used as earth continuity conductor.
- e) A separate earthing conductor shall be provided for earthing lighting fixtures, receptacles, switches, junction boxes, lighting conduits, poles etc. This conductor in turn shall be connected to the main earth. These details are covered separately under lighting installation notes and details, which shall apply.
- f) Whenever earthing conductor crosses or runs at less than 300mm distance along metallic structures such as gas, water, steam pipes, conduits etc., and steel reinforcement in concrete, it shall be bonded to the same. In case earthing connection to pipe and conduit etc. at a distance higher than 300mm is required, the same shall be marked on the drawing.
- g) Miscellaneous items such as junction boxes, field switches, cable end boxes/ glands, fitting and fixture shall be earthed whether specifically show or not.
- h) In general minimum two earth leads shall be used for earthing each equipment / structure enclosing the power conductor operating at more than 250V and one earth lead if the voltage level is 250V or less.

7.11.5 Jointing

- a) Earthing connections to equipment earthing pads / terminals shall be bolted type with GI bolts and nuts. Contact surfaces shall be free from scale, paint, enamel, grease, rust or dirt. Two bolts (min.) shall be provided for making each connection. Equipment bolted connections, after being checked and tested, shall be painted with anti corrosive paint/ compound.
- b) Connection between equipment earthing lead and main earthing conductors and between main earthing conductors shall be welded / brazed type. For rust protection the welds shall be treated with red lead and afterwards thickly coated with bitumen compound to prevent corrosion.
- c) Steel to copper, copper to copper connections should be brazed type. Welding shall be adopted in case of steel. Welding to be done as per IS: 816.
- d) The jointing whether welded, brazed or bolted shall be such that the resistance of the joint is not more than the resistance of the equivalent length of the conductor.

- e) Welding / brazing surfaces shall be cleaned and made free of all oxide films, grease, oil or any foreign material. However, the joining surfaces should not be made too smooth / highly polished, to prevent the joining material from flowing away.
- f) All brazing should be done by oxy- acetylene torch flame.
- g) All welded connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.
- h) Bending of large diameter rod / thick conductors shall be done preferably by gas heating.
- i) All arc welding with large diameter conductor shall be done with low hydrogen content electrodes.
- j) For brazing alloys of silicon bronze/ phosphor or copper/ phosphor-silver-copper shall be used.

7.11.6 Cable Earthing

Metallic sheaths, screens and armour of all multicore power/ control cables shall be earthed at both equipment and source / switchgear end. Sheath and armour of single core power cables shall be earthed at source /switchgear end only, unless otherwise stated elsewhere.

7.11.7 Testing & Commissioning

After completion of erection works before equipment is charged, the following minimum test shall be carried out. All test shall be recorded in the format as approved by Architect/Project Manager besides the test mentioned below any other tests specified by the local authority shall also be carried out. All tools and celebrated instruments for testing, labour, materials and incidentals necessary, to conduct the tests mentioned below shall be provided by the contractor at his own cost.

- Insulation resistance test of all the feeders by 500 V megger.
- Insulation resistance test of all LT cables with 500 V megger.
- Continuity test of all the cores and the armour cables.
- Sheathing continuity test.
- Testing of Wiring:
 - All wiring systems shall be tested for continuity of circuits, short circuits, and earthing after wiring is completed and before installation is energized.
- Testing of Earth Continuity Path:
 - Insulation resistance Test
 - Polarity test of switches

The above test reports shall be submitted by contractor to Engineer incharge.

7.12 LIGHTNING PROTECTION SYSTEM

- 7.12.1 The lightning protection air termination rods and/or horizontal air termination conductors shall be fixed in such a way that they remain in their installed position even during severe weather conditions. The necessary accessories such as cleats, clamps, welding materials, bolts, nuts, shall be supplied by CONTRACTOR.
- 7.12.2 Air termination system shall be connected to earthing system below ground by down conductors as shown in various project drawings. For this purpose separate treated earth pit to be constructed. The down conductors shall follow a direct path to earth. There shall not be any sharp bends, turns and kinks in the down conductors.
- 7.12.3 All joints in the down conductors shall be of welded/brazed type. All metallic structures within 2 meters from down conductors shall be bonded to lightning protection system.
- 7.12.4 The lightning protection system shall not be in direct contact with underground metallic service ducts, cables, cable conduits and metal enclosures of electrical equipment. However all metal projections, railings, vents, tanks etc. above the roof shall be bonded together to form a part of roof grid.

7.13 DIESEL GENERATORS

7.13.1 Scope

The scope of this section consists of but not necessarily limited to the following in accordance to Technical specification prescribed in tender:

- a) The contractor shall supply, deliver to site, hoisting into position, install, test and commission the Prime rated power generating set together with the necessary controls and switchboards as specified and indicated in the Drawings. Protection circuits, control wiring and interlock circuits not specified or indicated in the Drawings, but deemed necessary for the safe operation of the generating system shall be provided without any additional cost to complete the system.
- b) Provide manufacturer's factory representative's services, including coordination, and start-up and testing supervision.
- c) Testing (factory and field), start-up supervision, training and providing necessary documentation and tools for operation.
- d) Carry out performance test run at site with Load bank & Lube oil etc. arranged by contractor.

7.13.2 Engine

Engine shall be multiple cylinder vertical, 4 stroke cycle, Prime rated, multi-cylinder direct injection, compression ignition type operating at a speed of 1500 rpm and shall be silent, vibration free while in operation and comply Center / State Pollution Control Board , turbo charged after cooled as BS 5514/ISO 3046, 1500 RPM. Engine shall deliver not less than 400kW at site at 0.8 lagging power factor and shall be suitable for sustaining of 10% overload for 1 hour in every 12 hours of continuous operation at full load without damage. Engine shall be with the following accessories:

- a) Flywheel to suit flexible coupling.

- b) Dry type air cleaner. Replaceable air cleaner elements with mechanical air restriction gauge mounted on air cleaner. The filter shall be suitable for operation under dusty conditions.
- c) Exhaust Residential Type silencer with flexible connections and thermal lagging.
- d) Electronic Instrument panel comprising of:
 - Power Command Control Module or equivalent (for AMF System)
 - Sensors
 - Fuel control actuators
 - Fuel shut-off valves
 - Starting switch with key.
 - Lube Pressure Gauge.
 - Water temperature gauge.
 - Battery charging ammeter & voltmeter.
- e) Hour meter with RPM indicator.
- f) Safety control for low lube, oil pressure, high water temperature and over speed.
- g) Lube oil cooler with all standard accessories.
- h) Lube oil filter with replaceable type filter element as required.
- i) Fuel oil system comprising.
 - 5 mm thick epoxy coated from inside MS Steel sheet daily service fuel tank of 990 liters capacity including with glass type level indicator and level controllers with potential free contacts.
 - Fuel transfer pump including piping, fitting valves, strainers, filters between day tank and engine.
 - All instrumentation and control for day tank.
- j) 2 No. 12 volt 25 plate lead acid batteries in series and parallel connection to make 24 volts, 4 x 180 Ah batteries duly charged along with connecting leads mounted on acid resistant frame work.
- k) Anti vibration mounts as per manufacturer recommendation.
- l) Electronic Governor with governing class 'A' direct.
- m) All moving parts to be mechanically guarded to minimize hazard to people around.

Air intake and exhaust systems with filters, residential type silencers, ducts, pipes, dampers, fittings, supports and other necessary accessories.

The exhaust gas expulsion system shall be in accordance with the drawings. The exhaust piping shall be fitted with hospital type silencer in order to limit the sound level. Expansion joints shall take care of thermal deformations. The pressure drop in exhaust piping including silencer, bends, expansion joints etc., shall be compatible with exhaust gas leaving the engine. The exhaust piping shall be duly covered throughout the length from engine outlet upto the outlet point with mineral wool insulation and aluminium sheet cladding. The exhaust piping shall be independent for each engine and shall be with minimum bends. The bending radius of bends shall be not less than 3-internal diameters of

chosen piping. A drain plug shall be fitted at the lowest point of piping for condensate extraction. The exhaust pipe shall meet the following regulations of pollution board as mentioned. Suitable supports shall be provided for proper installation of exhaust pipes.

7.13.3 Limits Of Noise For Power Generating Sets Manufactured On Or After The 1st January, 2005

7.13.3.3 Applicability

These rules apply to Generator sets of rated output, installed on or after 1st January, 2005.

7.13.3.4 Requirement of Certification

Every manufacturer or importer of Power Generating set must have valid certificates of Type Approval and also valid certificates of conformity of production for each year, for all the product models being manufactured or imported after 1st January, 2005 with the specified noise limit.

All Power Generator shall have a valid Type Approval certificate and conformity of production certificate.

All Power Generator shall have conformance label meeting the requirements.

The conformance label shall contain the following information:

- a) Name and address of the supplier (if the address is described in the Client's manual, it may not be included in the label).
- b) Statement "This product conforms to the Environment (Protection) Rules, 1986"
- c) Noise limit viz. 75 dB(A) at 1 m.
- d) Type approval certificate number.
- e) Date of manufacturer of the product.

7.13.3.5 Authorized agencies for certification

The following agencies are authorized to carry out such tests as they deem necessary for giving certificates for Type Approval and Conformity of production testing of Generator and to give such certificates :

- a) Automotive Research Association of India, Pune.
- b) National Physical Laboratory, New Delhi.
- c) Naval Science & Technology Laboratory, Palghat
- d) National Aerospace Laboratory, Bangalore

7.13.3.6 Alternator

The alternator shall be brushless synchronous and suitable for 3 phase, 415 volts, 50 Hz., 0.8 p.f. and 1500 RPM.

The alternator shall be suitable for coupling directly to the engine described in clause no. 1.3 It shall be drip proof screen protected as per IP23.

The alternator shall be continuously rated and shall have class “H” insulation designed and built to withstand tropical conditions. It shall be conforming to IS:4722-1992. The output of the alternator shall be 400 KW rated output at site conditions at 0.8 lagging power factor and shall be suitable for sustaining of 10% overload for 1 hour in any 12 hours period without damage.

Six nos. embedded Resistant Temperature Detector (RTDs) of platinum, 100 ohms resistance at 0 degree to measure the winding temperature and 2 Nos. BTDS to measure bearing temperature shall be provided.

The leads of embedded RTDs shall be wired upto the terminal block in a separate terminal box. Manufacturer shall indicate the setting values for each RTD/ BTD for alarm and trip.

Greasing facility with grease nipples and grease relief device shall be provided.

All external nuts and bolts shall be of high tensile steel only.

Alternator shall be provided with anti-condensation space heater of adequate rating suitable for 240 V, 50 Hz, 1 Phase AC supply and shall be wired upto a separate terminal box.

The independent earth terminals on the frame complete with nuts, spring washer and plain washer shall be provided.

Alternator shall be provided with suitable adaptor box for termination of cables. Suitable arrangement shall be provided in the terminal box for formation of star point for Alternator neutral earthing.

QDCT for synchronizing relay i.e. DG Set shall be capable of working in synchronizing with other DG sets. The supply of any relays, contactors, CT's etc required for this purpose shall be included.

Alternator shall be suitable for bearing the starting current of Transformer after changeover.

7.13.3.7 Excitation System

The alternator shall be provided with a complete rotating diode type brushless excitation system, capable of supplying the excitation current of the generator under all conditions of output from no load to full load and capable of maintaining voltage of the generator constant at one particular value.

The exciter shall have class ‘H’ insulation.

The excitation system shall comprise a shaft driven AC exciter with rotating rectifiers. The rectifiers shall have in-built protection for over voltage.

The exciter shall be fast response type and shall be designed to have a low time constant to minimize voltage transients under severe load changes. The excitation voltage response ratio shall be at least 0.8.

The rated current of the main exciter shall be at least 10% more than the alternator rated exciter current and it shall have 40% overload capability for 10 seconds.

No external supply shall be required during starting and normal running of the alternator.

7.13.3.8 Automatic Voltage Regulator

An automatic high speed, dead band type voltage regulator shall be provided, complete with all accessories. The regulation system shall be provided with equipment for automatic and manual control.

The regulator shall regulate the output voltage from generator current and potential signals. Series compounding transformer shall be provided to enable maintaining adequate terminal voltage in the event of terminal faults. Alternatively excitation system shall be provided with arrangement for field forcing. Contractor shall coordinate suitability of protection relays for generator with the operational characteristics of automatic voltage regulator, specially under short circuit conditions.

Voltage regulation and steady state modulation shall be within $\pm 0.5\%$ of the line voltage.

Necessary equipment for field suppression and surge protection shall be provided as integral part of alternator.

The response time of exciter and the generator shall be properly matched to avoid hunting.

AVR system shall be provided with equipment for automatic and remote operation / control.

AVR shall be suitable for 24 V supply.

Necessary equipment shall be furnished for the following.

- To prevent automatic rise of field voltage in case of failure of potential supply.

7.13.3.9 Acoustic Enclosure For Diesel Generator

Acoustic Enclosure for DG Set shall be as given below:

- | | | | |
|----|------------------------|---|--|
| a) | DG Set Capacity | : | 500kVA |
| b) | Structure | : | |
| c) | Panels | : | |
| d) | Thickness of panels | : | |
| a. | Outer sheet | : | |
| b. | Inner Sheet | : | |
| c. | Frame & Strainer | : | |
| e) | Insulation | : | Mineral wool as per IS 8183 – 1993 |
| f) | Thickness | : | 100 mm thick (50 mm x 2 slabs) |
| g) | Density | : | 64 Kg / m ³ |
| h) | Air Circulation System | : | |
| • | Air Intake System | : | Axial flow fans of suitable capacity for 500 KVA DG Set offered. |

- Air Exhaust System :
DG set offered
- i) Finishing : Weather proof polyurethane paint
(Shade approved by Project Manager / EMPLOYER.
Paint coating to be done after each
component goes through 7 tank process.)
- j) Noise Level : 75 dBA at a distance of one
meter (as per CPCB)
- k) Insertion Loss : 25 dBA
- l) ΔT inside enclosure : should not exceed from 7 degree
C above
- i. ambient temperature. 1 No. dial gauge temperature monitor shall also be
provided.
- m) Location : Outdoor type
- n) Lighting / Switch / : Proper arrangement shall be
provided inside
- i. Wiring / Fans the acoustic enclosure

7.13.3.10 Microprocessor Based Auto Starting & Auto Mains Failure.

General

The auto synchronizing shall be provided as mentioned below and as per Schedule of Quantity.

Protection Through Relays (For DG Set)

Following protection shall be provided through Numerical relay both for the stator side and the rotor side if not provided in the controller:

a) Voltage restrained over current protection (50/51)

Relay shall not work when a over current fault occurs, due to higher current levels. There shall be drop in terminal voltage for the same fault impedance, the fault current shall reduce (with respect to terminal voltage) to a level below the pick-up setting. Consequently, relay shall not pick-up. It shall be necessary to have a relay whose pick-up setting shall be automatically reduce in proportion to terminal voltage. Hence, the over current protection shall be voltage restrained. Two levels over current protection shall be provided i.e. low set and high set (for short circuit protection)

b) Thermal overload (49)

It monitors the thermal status of machine for current between 105% to the low set O/C level (normally 150%).

c) Under / Over Voltage (27 / 59)

This will protect the machine from abnormal voltage levels, particularly during synchronization and load throw off conditions.

d) Under / Over Frequency (81)

This will protect the machine from abnormal frequency levels, particularly during synchronization and load throw of conditions. This will also help in load shedding scheme for the generator.

e) Breaker Failure Protection (52 BF)

This protection detects the failure of breaker to open after receipt of trip signal. Another trip contact is generated under breaker fail conditions, with which more drastic measures (like engine stoppage, etc.) can be taken.

7.13.3.11 Metering For Each DG

As mentioned in the Schedule of Quantities.

7.13.3.12 Annunciation

Annunciators with Hooter, Test, Accept and Reset P.B. and Annunciator.

16 Window Solid State Annunciator for each DG sets.

Channel No.	Inscription
01	Set fails to start (only alarm)
02	Over current (breaker trip)
03	Earth Fault (Breaker trip)
04	Excitation Failure (Engine should be stop with breaker trip)
05	Reverse Power (Breaker trip)
06	Over speed (Breaker will trip with engine stop command)
07	Low Lube Oil pressure (Breaker will trip with engine stop command)
08	High Water Temperature (Breaker will trip with engine stop command)
09	Over / Under Voltage (Breaker trip)

7.13.3.13 PRE-COMMISSIONING CHECKS

All standards checks including the ones elaborated in the specifications to ensure that the installation of the DG sets and associated systems has been carried out satisfactorily shall be done on completion of installation. These shall include.

DG sets

- Checking of piping interconnections
- Checking electrical interconnections
- Checking of insulation resistance
- Checking of earthing
- Checking of instruments and controls.
- Checking of alignment
- Checking of vibration transmission to building a structure.

- h) Checking of expansion joints.

Exhaust system

- a) Checking of silencer operation
b) Checking of surface temperature of exhaust piping

Fuel system

- a) Checking of automatic operation of fuel transfer pumps.

Upon completion of work the performance test shall demonstrate the following among other things:

- a) Equipment installed complies with specification in all respects and is of the correct rating for the duty and site conditions.
b) All items operate efficiently and quietly to meet the specified requirements.
c) All circuits are correctly protected and protective devices are properly coordinated.
d) All non current carrying metal parts are properly and safely grounded in accordance with the specifications and appropriate codes of practice.

7.13.3.14 DG Sets – Test Procedure

The Tenderer shall enclose copies of type test certificates, wherever applicable, for all the equipments and materials, quoted by him, along with the bid for Employer's reference as per the relevant standards specified.

All the type tests, if not conducted earlier on similar type of equipments, covered under the relevant standards, shall be conducted, wherever required, by the suppliers for all the equipment and materials at manufacturer's works in the presence of the Employer's representative. The test certificates of all the equipments / materials shall be approved by the Employer's representative before dispatch / acceptance of the equipment and materials. Routine tests for all equipment will be witnessed by Engineer's Representative.

The following tests shall be done at works before dispatch,

Tests on alternator:

1	DC Resistance Measurement
1.1	Stator
1.2	Rotor
2	Insulation Resistance Measurement, before and after High Voltage Test
2.1	Stator
2.2	Rotor
3	High Voltage Test
3.1	Stator
3.2	Rotor

	Functioning Tests on RTDs
	DC Resistance Measurement
	Characteristics
	No Load Saturation Tests
	Open Circuit Magnetization Characteristics
	Voltage Measurement
	Symmetry of generated voltage
	Phase Sequence (Phase Rotation) check
	Direction of Shaft Rotation check
	Vibration Measurement
	During No Load Mechanical Run
	During No Load Open Circuit Magnetization Test
	During Sustained 3Phase Short Circuit Magnetization Test
	Over speed test (120% of rated speed for 2 minutes).
	Regulation Tests
	Voltage & current
	Temperature Rise Test
	No Load losses
	Determination of efficiency

The following tests shall be carried out on Generator and Excitation system:

- a) Insulation Resistance Tests
- b) Winding Resistance Test
- c) Phase sequence Test
- d) Open and Short Circuit Characteristic Test
- e) AVR response / Regulation Test.
- f) Load test on Generator at both unity and 0.8 PF.
- g) Excitation at full load and under specified variation of voltage and speed

- h) Measurement of voltage dips at the generator terminals while feeding the base load 75% and on simultaneous starting of the largest motor.
- i) EMPLOYER reserves the right to reject the equipment if the guaranteed performance is not met with.
- j) All instruments required for performance testing of the equipment covered in this specification shall be provided by the TENDERER at no extra cost to the Employer for entire duration of the performance test.
- k) The TENDERER shall ensure that instruments and gauges to be used for testing and inspection of critical parameters as identified in the specification shall have valid calibration and the accuracy can be traceable to National Standards.
- l) In addition to the above guarantees, TENDERER shall also guarantee the period for completing supply, erection, testing and commissioning as six (6) months for DG set and accessories from the date of Letter of Award.

Load / Run Test at Site :

DG sets shall be tested at different loads at site after dispatch and installation at site.

In case at any point of the test a trip should occur the test shall be conducted again.

The necessary fuel oil, lube oil & consumables required for the test shall be provided by contractor. No extra payment shall be made in this regard.

Copies of manufacturer's type test for the engine and the alternator of all ratings shall be enclosed along with the dispatch of the DG sets as per relevant standard/codes.

The contractor shall provide all necessary instruments and labour for testing. He shall make adequate records of test procedures and readings and shall repeat any tests requested by the Engineer Incharge. Test certificate duly signed by an authorized person shall be submitted for scrutiny.

If it is proved that the installation or part thereof is not satisfactorily carried out then the contractor shall be liable for the rectification and retesting of the same as called for by the Engineer Incharge. All tests shall be carried out in the presence of Client inspection team.

These tests shall form part of this contract. Above tests shall be conducted for all DG sets. The test results shall match with the technical requirements specified in the technical data sheet.

The Engineer Incharge shall have the right to accept or reject the modules if it does not meet the technical requirements.

The load test shall be conducted through resistive load bank at unity power factor.

Before conducting test, following shall be recorded on test report :

- a) Engine serial No.
- b) Engine model & make No.
- c) Alternator serial No.
- d) Engine & alternator rating
- e) Date of testing
- f) Rated speed, voltage & kW

Loads & duration: Engine shall be given a test run for atleast six hours with alternator supplying full rated load at site and overload test to the extent of 10% over the rated load shall be conducted immediately after the full load run test

No load : 5 mins

25% load – 30 mins

50% load – 30mins

75% Load – 30 mins

100% Load- 4.5 hrs

110% Load – 1 hr

The following parameters shall be noted on the test report

Description	Time (After start of Load test)						
	1 hr	2hrs	3hrs	4hrs	5hrs	6hrs	7hrs
a) Load in kW							
b) Power factor							
c) Voltage							

- d)** Current
- e)** Frequency
- f)** Alternator winding temperature
- g)** Alternator bearing temperature
- h)** Lube oil pressure
- i)** Lube oil temperature
- j)** Fuel consumption through flow meter
- k)** Cylinder head temperature

Impact test:

A block load of at least 50% shall be put on the DG from no load condition & similarly when DG is 100% loaded, the load is removed & the parameters like voltage, frequency & RPM is noted. The readings should be within acceptable limits.

Performance Tests

- a)** The following items of performance shall be guaranteed during site performance tests in respect of the DG and the auxiliaries for the specified site conditions:
- b)** Net electrical output (continuous)
- c)** Freedom from vibration and noise
- d)** Governor response, over-speed trip and speeder gear capability
- e)** Voltage regulator response
- f)** Excitation at full load and under specified variation of voltage and speed.

Start-up & testing at site

A equipment manufacturer's representative approved by the Project Manager / Client shall be engaged to perform start-up and load test upon completion of installation with the Project Manager / Client in attendance. A certified test record shall be provided.

Tests shall include, but are not be limited to, the following:

- a) Check fuel, lubricating oil, and antifreeze in liquid cooled models for conformity to the manufacturer's recommendations under environmental conditions present.
- b) Test, prior to cranking of engine, for proper operation of accessories that normally function while the set is in a standby mode.
- c) Check, during start-up test mode, for exhaust gas leaks outside the building, cooling air flow, movement during starting and stopping, vibration during running, line-to-line voltage and phase rotation.
- d) Test by means of simulated power outage, automatic start-up by remote-automatic starting, transfer of load, and automatic shutdown. Engine generator sets are to be synchronized and paralleled during tests. Monitor throughout the test, engine temperature, oil pressure, battery charge level, generator voltage, amperes, and frequency.
- e) Tests shall demonstrate capability and compliance of system with operating requirements. Where possible, correct malfunctioning units at site then retest to demonstrate compliance; otherwise remove and replace with new units, and proceed with retesting. Retesting to be at no cost to the Project Manager / Client.
- f) This section includes a very basic outline of the start-up sequence. The actual sequence will be determined after the final design is completed. The commissioning of the new generators will occur on weekends and after-hours depending upon the scheduling requirements of the business.

7.13.3.15 Rejection

The Employer may reject any DG Sets during tests or service any of the following conditions arise and the provision under the relevant clause of the general conditions of contract shall immediately become applicable:

If it is not adhere to:-

- a) GUARANTEED TECHNICAL PARTICULARS- Diesel Engine.
- b) GUARANTEED TECHNICAL PARTICULARS- Generator
- c) DG Sets fails on performance guarantee test at works.
- d) DG Sets fails on performance guarantee test at site.

- e) Proven performance in number of running hours for the type / Model of the DG set
- f) DG Sets is proved to have been manufactured not in accordance with the agreed specification.
- g) The Employer reserves the right to retain the rejected DG Sets and take it into service until the tenderer replaces the defective DG Sets by a new acceptable DG Sets at no extra cost. The tenderer shall repair or replace the DG Sets within a reasonable period mutually agreed time to the satisfaction of the Employer at no extra cost.

7.14 UPS SYSTEM

7.14.1 General Requirements

- a) This specification covers the design, manufacture, testing, inspection at Manufacturer's works, packing, forwarding and transport to site, unloading, storing, installation, testing and commissioning of the UPS System as described herein and shown on the drawings.
- b) The UPS system shall consist of rectifier / battery charger, batteries, inverter, static bypass transfer switch, synchronizing devices, protective devices, bypass switch, filter circuits, and accessories as specified herein that will automatically maintain the continuity of electrical power within specified tolerance, without interruption, upon failure of the normal power supply.
- c) The UPS system shall be manufactured in a modular way so as to enable the power of the UPS system installed to be easily increased on the site by paralleling more than one module to meet the new operating requirements and the desired reliability. In this connection, transformation of unitary module into a multi-module configuration shall be able to be carried out directly on site without returning the equipment to the factory for modification and with a minimum installation down time.

7.14.2 Quality Assurance

- a) UPS ratings shall be the final effective values after the application of all appropriate derating factors. These ratings shall be adjusted to suit local conditions, viz. maximum ambient temperature, etc.. Derating factor due to the non-linearity of the load to be connected to the UPS shall be taken into account.
- b) The UPS shall be manufactured for continuous reliable operating such that the "Mean-Time-Between-Failures" (MTBF) for individual modules of the UPS viz. Rectifier / charger unit, inverter unit and static switch, etc.. shall be more than 8760 hours.
- c) To ensure minimum down time, the "Mean-Time-To-Repair (MTTR) of the UPS shall not exceed one (1) hour. The MTTR shall be the time required to diagnose the fault and restore the UPS to normal working condition, say by means of module replacement at site, but excluding the traveling time.
- d) All battery use shall be heavy duty type of life span of minimum 5 years.
- e) The factory acceptance test shall include the following as a minimum:

Full load and half load efficiency test.
 Frequency and voltage limits over the whole range of load;
 Overload voltage and short circuit protection;
 Voltage and frequency regulation during sudden load application.
 Overload performance
 Instrument calibration
 Output tests while being supplied for batteries only; and
 Battery charging and discharging test.

7.14.3 **Submission**

7.14.4 All technical submissions shall be approved by the Engineer in charge / Architect.

7.14.5 As a minimum requirement, the submission shall include the following:

Shop drawings showing the co-ordinated installation detail diagram

Client's works requirement;

Battery arrangement and manufacturer confirmation on 'zero' gas emission by battery to meet

Civil Defence requirement without separate room ventilation requirement.

7.14.6 **System Operation**

7.14.7 The UPS system shall generally include its basic and supporting equipment for the monitoring, control and protection of the system, including input the output AC filters, electronic AC line conditioner, AC and DC input and output circuit breakers, converter, inverter, shielded isolation transformer, static by-pass switch and mechanical bypass switch. The battery bank may be in a separate matching battery enclosure (s).

7.14.8 Under normal conditions, power from the mains shall be supplied to the rectifier / charger unit. The rectifier / charger unit shall convert the incoming AC power to DC power which is fed into the inverter unit and battery unit. The inverter unit shall convert the DC power to AC power, which is then supplied to the load through the static transfer switch. As long as the operable inverter unit is supplied with DC, it shall supply AC to the load.

7.14.9 Upon failure of the mains, the battery shall maintain the flow of DC to the inverter unit and the inverter unit shall continue to supply the load without interruption. Upon restoration of mains supply or when the generator supply is available, input power for the inverter unit and for the recharging of the batteries shall automatically be supplied from the rectifier / charger output without interruption. If the battery is exhausted before the availability of the mains or generator supply, the UPS system shall shut down automatically.

7.14.10 The static transfer switch shall normally connect the inverter output power to the load. Should the inverter malfunction, the static switch shall automatically transfer the load to the bypass source without interruption of the power supply to the load.

7.14.11 During periods when the UPS system is being serviced, the transfer switch shall be operated to transfer the load to the bypass source.

7.14.12 In the case of the parallel redundant system, the total system load shall be automatically distributed equally between the two UPS modules under normal conditions. Malfunction in one of the UPS modules shall cause instantaneous isolation of the faulty module from the system and the remaining healthy UPS module shall take over the full critical load without interruption. If both UPS modules fail, the critical load shall be transferred to the bypass source.

7.14.13 Functional Requirements

- a) Contractor shall furnish On-Line Uninterruptible Power Supply (UPS) system of continuous duty of the ratings mentioned in Bill of Quantities. Each UPS shall give regulated filtered & uninterruptible power supply as described in the specifications.
- b) Contractor shall note that the KVA ratings of the UPS systems shall be guaranteed at 50 deg.C ambient temperature. In case contractor's standard UPS KVA rating are based at a lower temperature, the contractor must consider a derating factor of atleast 1.5% per deg.C for arriving at the specified UPS capacity at 40 deg.C ambient temperature.
- c) In case the calculated /specified UPS capacity is not the same as one of the standard KVA ratings of the UPS manufacturer, the next higher standard KVA rating shall be selected. UPS of non standard rating shall not be acceptable.
- d) UPS system supplied by the contractor shall be the latest state of the art technology system fully digitalized using microprocessor controlled full wave rectification and IGBT inverter.
- e) Batteries shall be valve regulated lead acid specially meant for UPS application.
- f) Monitoring and control system shall also be state of the art technology LCD touch panel type providing all relevant data described in this document.
- g) The monitoring and control system shall be capable of RS232 input software for connecting to customer's computer system for data display and monitoring.
- h) All necessary components required for protecting UPS equipment and connected inputs and outputs shall be furnished by the Contractor as an integral part of the UPS system.
- i) The control logic power supply shall have redundant power supply AC input and the system battery as power sources.
- j) The UPS systems shall include but not be limited to the following equipment :
 - UPS system including 100% capacity float-cum-boost charger with 100% sealed valve regulated lead acid batteries with guaranteed battery life of 5 years.
 - Suitable factory built battery cabinet for housing the batteries, including terminal isolator / breaker and power disconnect device. The enclosure shall conform to IP 20 as minimum.
 - All cables, connectors, accessories like turning, cable trays, conduits etc. required for connection between battery and the UPS unit.

7.14.14 Static Converter

General

The static converter (rectifier) shall be a multi-functional converter providing functions of power conversion, battery charging and shall have the additional functions of input power factor improvement and current harmonics reduction by PWM / IGBT filter. The converter equipment shall include all necessary control circuitry and device to conform requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc. as given below.

The converter shall be a solid state static PWM converter utilizing Intelligent Power Module (IPM) and shall include intelligent features like the drive circuitry, over

current protection, over temperature protection, control power failure protection and short circuit protection.

The IPM transistors shall enable high speed switching at 6 KHz thus reducing the heat dissipation in the UPS and thereby providing high efficiency.

The PWM converter shall utilize the above and achieve unity power factor and reduce input current harmonics as given earlier and thus improve the overall power factor of the converter achieving input KVA savings.

During any step inverter load change (0-100%) the converter shall only supply 100% current to the inverter. The battery shall not be cycled at any time during this step load changes.

a) Input Current Limit

The converter logic shall provide input current limiting by limiting the DC output current. Two (2) line-side current transformers shall be employed as a means of sensing the current amplitude. The converter logic shall also be capable of providing auxiliary current limited when the logic is signaled to do so via an external dry contact closure (e.g. UPS fed from generator). The converter shall be capable of supplying overload current in excess to the full load rating. It shall also have sufficient capacity to provide power to a fully loaded inverter while simultaneously recharging the system battery to 95% of full capacity within 10 times the discharge time. The DC output current limit values shall be as follows:

Rectifier output current (maximum) 100% Note : 100% current shall be under the battery recharging mode.

Battery Charge Current Limited

The converter logic shall provide current limiting function of battery charging to prevent the battery from damage. The following battery current limit and protection shall be provided.

- Battery charge current limit 10% of battery Ah rate.
- Over-current protection at 120% of above item.

b) Voltage Regulation

The rectifier / charger output voltage does not deviate by more than +/- 1% of the nominal output voltage, due to the following conditions:

- From 0 to 100% loading.
- Rectifier input variations of voltage and frequency within the limitations set.
- Environmental condition variations within the limitations set.

7.14.15 Automatic Input Current Walk-in

The converter logic shall employ circuitry to allow a delayed and timed ramping of input current. Subsequent to energizing the converter input, the ramping of current shall be delayed by a maximum of 3 seconds. Upon starting the walk-in process, the ramping of current is timed to assume the load gradually within 1 through 60 seconds (every 1 second selectable).

7.14.16 Input Overload Protection

The A/C input fuses shall be provided at the converter input as a means of overload protection. The AC maximum current shall be controlled by the Converter.

7.14.17 Equalizing Charge Timer

The UPS logic shall provide an electronic automatic equalize charge timer which shall be selectable 24 hours for Lead Acid type or 8 hour for Alkaline type batteries. The timer circuit, once activated shall provide a high rate equalizing charge voltage to the system battery for the selected time. The circuit shall also be capable of manual activation via the LCD touch panel mounted on the front door. The level of equalizing voltage shall be equal to that stated by the battery manufacturer. Upon completion of the timer count, the converter output voltage shall automatically return to the specified float voltage.

7.14.18 Step Load Change

During any step inverter load change (0-100%), only the converter shall supply 100% current to the inverter. The batteries SHALL NOT be cycled at any time during these step load changes.

7.14.19 Input Voltage

The converter shall be fed from the Normal Power Supply source.

7.14.20 The converter shall meet the above specifications in addition to other requirements stated in Data Sheet.

Static Inverter

General

The static inverter shall be of solid state type using proven Pulse Width Modulation (PWM) technique. The inverter equipment shall include all necessary control circuitry and devices to conform requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc. as given below.

The inverter shall utilize Insulated Gate Bipolar Transistors (IGBT) or Intelligent Power Module (IPM) Transistors which shall provide intelligent features like the drive circuitry, over-current protection, over temperature protection, control power failure protection and short circuit protection.

The IGBT / IPM transistors shall enable high speed switching of 6 KHz thus reducing the heat dissipation in the UPS and thereby providing high efficiency.

The UPS shall utilize both Voltage and Current feedback control circuits so that the inverter shall act not only as a constant voltage source but also as a load required current source. This shall enable the inverter to quickly adapt to the changing load current value and wave shape.

7.14.21 Voltage Regulation

The inverter output voltage shall not deviate by more than +/- 1% RMS due to the following steady state conditions:

- a) From 0 to 100% loading
- b) Inverter DC input voltage varies from maximum to minimum.
- c) Environmental conditions variations within the limitations.

7.14.22 Frequency Control

The inverter output frequency shall be controlled by an oscillator internal to the UPS module logic. It shall be capable of synchronizing to an external reference (e.g. the bypass source or another UPS module) or operating asynchronously. The oscillator shall maintain synchronization with the external reference within the limitations set hereunder. The inverter shall operate on self run mode without synchronism if the bypass frequency exceeds the set value. The oscillator, while running

asynchronously, shall maintain the frequency as 50 Hz + 0.01% (or + 0.005 Hz). Automatic adjustment of phase relationship between inverter output and standby bypass source shall be gradual at a controlled slew rate which shall be adjustable at the rate of 0.5, 1.0, 2.0, 3.0 Hz / second. (default 2.0 Hz / second).

The inverter output frequency shall not vary during steady state or transient operation due to the following conditions:

- a) From 0 to 100% loading.
- b) Inverter DC input varies from maximum to minimum.
- c) Environmental condition variations within the limitations.

7.14.23 Output Voltage Harmonic Distortion

The inverter output shall limit the amount of harmonic content to the values as indicated in data sheets. The use of excessive or additional filtering shall not be required to limit the harmonic content thus maintaining a high level of efficiency, reliability and original equipment footprint.

7.14.24 Output Overload Capability

The inverter output shall be capable of providing an overload current while maintaining rated output voltage to the values as indicated in data sheets. An LED indicator shall be located on the control panel to identify this condition. If the time limit associated with the overload condition expires or the overload is in excess of the set current amplitude, the load shall be transferred to the bypass source without interruption.

7.14.25 Inverter Current Limit

The inverter output shall be limited to 150% of rated load current. The two sensing locations shall operate separately and independently thus providing redundancy and, in the event of a failure, preventing unnecessary damage to power transistor components / fuses. Load current above 150% shall cause an immediate transfer of the load to the bypass source for fault clearing.

7.14.26 Inverter Overload Protection

The AC output from the inverter shall utilize fuses for overload protection. The inverter shall utilize a contactor to isolate the inverter output from the critical bus.

The inverter fuses shall be the fast acting semiconductor type.

The inverter output isolation contactor shall be located in the UPS module and shall be controlled by the internal UPS module system logic.

The inverter shall meet the following specifications in addition to other requirements stated in Data Sheet.

7.14.27 Built-in Isolation Transformer

This shall provide neutral separation which shall mean that output neutral will be independent of incoming neutral, hence critical load shall be isolated from the problems like incoming neutral open or, short or, variations in neutral to earth voltage due to sudden loading in neighboring installation.

7.14.28 Reverse Phase Sequence Protection

In the event of Phase sequence reversal at the input, UPS system shall continue to work on the main power supply, or UPS systems shall go into battery mode, and shall not trip the UPS system.

7.14.29 The overall efficiency of complete UPS system shall not be less than or equal to 94%

7.14.30 Bypass And Static Transfer Switch

A bypass circuit shall be provided as an alternate source of power other than the inverter. A high speed switch and wrap-around contactor shall be used for the critical load during automatic transfers to the bypass circuit. The static switch and wrap-around contactor shall drive power from an upstream bypass feed circuit breaker internal to the UPS module provided for overload protection. The wrap-around contactor shall be electrically connected in parallel to the static switch and shall at the same time as the static switch, energize and upon closure, maintain the bypass source.

The static switch shall only be utilized for the time needed to energize the wrap-around contactor thus increasing reliability. The bypass circuit shall be capable of supplying the UPS rated load current and also provide fault clearing current. The UPS system logic shall employ sensing which shall cause the static switch to energize within 150 microseconds thus providing an uninterrupted transfer to the bypass source when any of the following limitations shall exceed:

- a) Inverter output under voltage or over voltage.
- b) Overload beyond the capability of the inverter
- c) DC circuit under voltage or over voltage
- d) Final end voltage of system battery is reached.
- e) Bypass source present and available
- f) System failure (eg. Logic fail, fuse blown, etc.)

7.14.31 Keeping the above requirements in view, the static switch shall have the following minimum rating. Capacity continuous equal to 100% of continuous rating of the inverter. Capacity overload equivalent to overload characteristics specified for UPS.

Technical parameter are given in Technical Data sheet shall be followed.

7.14.32 Automatic Re-Transfer

In the event that the critical load must be transferred to the bypass source due to an overload, the UPS system logic monitors the overload condition and, upon the overload being cleared, perform an automatic re-transfer back to the inverter output. The UPS system logic shall only allow a re-transfer to occur three times within a ten minute period. Re-transfer shall be inhibited on the fourth transfer due to the likelihood of a recurring problem at the UPS load distribution. The re-transfer a load to the inverter shall also be inhibited due to the limitations set.

7.14.33 Manual Transfer

The UPS shall be capable of transferring the critical load to / from the bypass source via LCD touch panel. When performing manual transfer to inverter or automatic re-transfers, the UPS system logic shall force the inverter output voltage to match the bypass input voltage and then parallel the inverter and bypass source providing a make-before-break transition allowing a controlled walk-in of load current to the inverter.

7.14.34 Maintenance Bypass Switch (MBS)

The UPS shall include as standard equipment, a zero energy maintenance bypass switch. Full UPS wrap-around enables personnel to do work inside the UPS module or maintenance bypass switchboard without danger from high voltage conditions.

7.14.35 UPS Battery System

- a) The UPS system shall, as an integral part, provide battery system for 15 minutes (Full Load) standby capacity.
- b) The latest state of the art Valve Regulated Sealed Maintenance Free Lead Acid Batteries shall be used with a 20 hours discharge rating.
- c) The battery system shall be sized to provide 15 minutes back up time when the UPS is supplying 100% rated load at 0.8 load power factor.
- d) An ageing factor of 15% shall be applied to the capacity arrived at, to allow for compensation against capacity loss during float operation.
- e) The battery system design shall be provided with necessary devices to prevent deep discharge beyond recommended limits to prevent the batteries discharging beyond end cell voltage specified by the battery maker. The connections from battery to battery shall be by using copper bus bar strips and the entire battery system shall be used in IP20 steel cabinet enclosure and shall be similar to the UPS enclosure.
- f) All batteries shall be clearly identified and identification numbers marked on the batteries and a schematic diagram along with the complete calculations, including manufacturers supporting curves, shall be submitted with the tender.

7.14.36 Operation

- a) Under normal operation, the UPS load will be fed from the Inverter with the bypass switch inhibited. The Converter, apart from providing DC power to the Inverter, also charges the battery under the float charge mode. The battery charge system shall have float charge, equalizing charge and recovery charge modes, to replenish the batteries self-discharging part while the battery is fully charged, equalizing the battery cell voltage to a constant value forcibly and recharging the battery system to the required values when the batteries have been used, respectively.
- b) The Inverter shall constantly monitor the AC source frequency and shall be in synchronization with the AC input source till the frequency of the AC input source is within synchronizing limit and if the frequency of the standby source exceeds the synchronizing limit the Inverter will work on its own internal oscillator maintaining an output frequency of 50 Hz +/- 0.01% under all conditions of load. When the Inverter operates on its internal oscillator, it shall continuously monitor the frequency of the input source and when the input source frequency returns to within synchronization limit, the Inverter shall automatically synchronize itself with the input A/C source frequency and use it as a signal for Inverter output frequency control.
- c) Battery Operation:
 - When the A/C input voltage drops below specified limits or in case of a power failure the Inverter continues to supply AC power of constant voltage and constant frequency utilizing the battery system as a power source until the input voltage returns to normal requirement. When the power supply is resumed or the input voltage returns to limits, the Converter shall automatically start and the load fed for normal operation status.
 - If the power failure continues beyond battery back up time or the battery voltage drops to the final discharge voltage, the Inverter should automatically stop and at the same time transferring the load to the bypass circuit. On resumption of power supply, the Converter shall automatically re-start the operations and charge the batteries whereas the Inverter should inhibit automatic start and should be started manually.

7.14.37 Bypass Operation:

When power is supplied from the Inverter in synchronization with the bypass, it shall accomplish the following:

- a) When the UPS output current reaches overload status it shall automatically transfer the load to bypass circuit with no interruption and when the overload status is cleared it automatically re-transfers the load to Inverter.
- b) When the battery final discharge condition is reached, the load shall automatically be transferred to the bypass circuit without interruption.
- c) In case of failure of the UPS, the load shall be automatically transferred to the bypass circuit with no interruption and when the failure is cleared, re-transfer the load to the Inverter shall be done manually.
- d) There should be provision made in the system to prevent, when necessary, asynchronous transfer.
- e) When the UPS goes on bypass mode in any of the conditions described above and if at that time there is no bypass power supply available due to power failure, the UPS shall remain in standby mode and as soon as the bypass power supply is available will transfer the load to bypass.
- f) A maintenance bypass transfer switch shall be provided with lock and key arrangement and should be manually done by authorized personnel only.

7.14.38 Cabinet And Enclosures

- a) The entire UPS system, including all components like inverter, static switch, maintenance bypass, shall be housed in free-standing steel type factory-finished enclosures complying with the protection standards of IP20. The enclosure shall be open able using a special tool for internal access. The colour shall be light grey.

b) Ventilation

Forced air-cooling shall be provided to allow components to operate within their rated temperature specified. The cooling fans shall have thermal relays protection using a latched cut fire re-setting, as a protection for the cooling fans.

Similarly, the backup battery system shall also be housed as described earlier in an IP20 cabinet.

7.14.39 Control And Monitoring

- a) The UPS shall utilize state of the art full DDC control software driven Control and Monitoring System. For UPS less than 40kVA software of lower version may be given.
- b) It shall be provided with LED displays. The display system shall have, as a minimum individual LEDs with different colours for the following:
 - Load on Inverter
 - Battery operation
 - Load on Bypass
 - UPS failure
 - LCD failure
 - Overload

- c) The UPS logic should provide one set of normally open dry contact / relay output to allow interfacing of UPS operating status to an external system and should be capable of providing, as a minimum, 10 numbers status and, should the UPS manufacturer's standard product does not provide such software, the bidder must add additional equipment and cost for the same.
- d) The UPS shall also have an RS232 port for interfacing to BAS system or client's centralized computer network.

7.14.40 LCD touch panel

- a) The UPS shall be provided with a operator friendly large scale LCD touch panel.
- b) The LCD touch panel shall also include graphic measurement display, operational procedures of each activity, fault status display and also have capability to record at least 50 faults.
- c) The touch screen panel shall clearly define specified areas for operational function, execution and message display.
- d) It should be possible to operate the entire UPS system and its components and obtain all measurements and data through the touch screen operation. The measurement software should provide capability to measure phase voltage, current in each phase, frequency, power factor, available battery time etc.
- e) Under all operating conditions, the system software should have capability for displaying fault alarm automatically. The tenderer should describe in detail the faults that would be displayed under this mode.

7.14.41 UPS Testing

- a) The Contractor shall perform the following tests, as a minimum, at site prior to handing over, to confirm the functional and the performance specification of the UPS as specified. All required test equipment like Digital Oscilloscope, Voltage Regulator, Measurement Meters, required artificial load etc. shall be the responsibility of the Contractor without any additional cost.
- b) The Contractor shall demonstrate as a minimum the following features on site by providing all required test equipment, such as power factor improvement, input current THD, output voltage THD, output frequency and all other performance monitoring requirements detailed before as required by the Employer. Warrantee/ guarantee certification shall be submitted by Contractor.
- c) Testing procedure is to be given by vendor and approved by Engineer incharge.

7.15 LIST OF ACT / BYE LAWS

The installations shall also be governed by the following Acts/Bye-laws/Codes as amended upto date in addition to the codes specified in the tender:

- a) ANSI/ASME/CENEN 81 CODE
- b) National Building Code of India - 2005
- c) Energy Conservation Builsding Codes 2007
- d) Relevant Codes of Bureau of Indian Standards
- e) NEC - NFPA 70, National Electric Code.
- f) Relevant Codes of National Fire Codes 2008

NOTE:

- Equipment, accessories, component parts, raw materials and tests shall in general conform to IS AND IEC.
- Latest edition of above mentioned codes / Bye Laws / Act shall be referred

7.16 SPARES AND MAINTENANCE TOOLS AND TACKLES

7.16.1 GENERAL

- a) All spares and maintenance tools and tackles shall be designed to enable maintenance to be carried out in the least time and at the least cost and support resources without affecting the performance and safety aspects.
- b) For all major equipment including pumps, fans, drives, heat exchangers and large valves etc., appropriate structural steel members shall be provided for mounting various handling devices which are necessary for the dismantling and re-assembly of the equipment components during maintenance.
- c) All the spares and maintenance tools and tackles supplied shall be new and unused.
- d) The VENDOR/CONTRACTOR shall guarantee that before going out of production of spares and maintenance tools and tackles for the equipment furnished, he shall give at least 12 months advance notice to the EMPLOYER, so that the latter may order his requirement in one lot, if so desired.

7.16.2 SPARES

The BIDDER shall include the following three (3) categories of spares in his scope of supply.

a) START-UP AND COMMISSIONING SPARES

Spares required for start-up and commissioning of the equipment, plant or system shall be indicated by the BIDDER in 'Schedule of Start-up and Commissioning Spares'. Total value of such spares shall be included in the quoted price for supply or erection of the equipment, plant or system. No additional amount is payable to the CONTRACTOR for equipment, plant and system for which erection and commissioning is in the CONTRACTOR's scope..

- b) All spares supplied shall be strictly inter-changeable with the parts for which these are intended to be replacements. The spares shall be treated and packed for long term storage under the climatic conditions prevailing at the site e.g., small items shall be packed in sealed transparent plastic bags with desiccator packs as necessary.
- c) Each spare shall be clearly marked or labelled on the outside of its packing with its description and purpose. When more than one spare is packed in a single case, a general description of the contents shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages shall be suitably marked and numbered for the purposes of identification.

7.17 Approved Make of Electrical Component/Equipment :

NOTE:

- All materials and products shall conform to the relevant standards and shall be of approved make and design. A list of manufacturers/ vendors is given separately herein below for guidance. The Engineer shall give the approval of a manufacturer/ vendor/ only after review of the sample/ specimen. In case the same is not available in the market or in case of change in trade name, equivalent makes/ re-designated manufacturer then an equivalent approved make shall be used with the approval of Employer/ Engineer. The complete system and installation shall also be in conformity with applicable Codes & Standards and Tender specifications.
- Only “First” class quality materials shall be used.
- Employer reserves the right to choose any of the approved make / vendors as per this list.
- In case of products not indicated in this list, bis marked products shall be preferred.
- Specification of manufacturer’s item shall be checked against tender item / specifications before selecting any product or brand name. In case of any discrepancy, tender item/ specifications shall prevail, and any such brand of item shall not be used which is not conforming to tender specifications even if it is listed in this list.
- For use of material from a bis listed/ certified manufacturer, the contractor shall furnish a copy of the BIS certificate to Employer before procuring the material.
- In case non-availability of any item/ material among approved manufacturers/ brands at a particular site/ region, alternate manufacturers/ brands conforming to BIS/ BS etc. shall be used subject to approval by Employer.
- In case of non-availability of any manufacturer among approved manufacturers at a particular site/ region, alternate manufacturer’s name shall be proposed along-with required credentials for Employer’s approval.
- In case of any item/ product neither covered in this list nor having A BIS specifications, the contractor shall submit the proposed item/ product along-with technical details/ specifications (as per bid), test certificates etc. And other credentials of the manufacturer for Employers approval.

LIST OF APPROVED MAKES FOR PRODUCTS AND MATERIALS FOR ELECTRICAL WORKS ARE INDICATED IN THE TABLE BELOW. HOWEVER, ANY OTHER MAKE WHICH IS EQUIVALENT AND MEETING THE TENDER SPECIFICATIONS ARE ALSO ACCEPTABLE WITH PRIOR APPROVAL OF THE ENGINEER

Sl. No.	Item	Sub-Vendor’s Name
1	DG Sets	M/s Kirloskar Electric Co.Ltd. M/s Crompton Greaves Ltd M/s Sudhir M/s Bharat Bijlee M/s Jyoti Limited
2	Control & Relay Panels	M/s Areva

Sl. No.	Item	Sub-Vendor's Name
		M/s Siemens, M/s ABB, M/s Easun Reyrolle
3	HT switchgear	M/s Schneider, M/s Siemens, M/s ABB, M/s Areva
4	33/0.415kV Transformer	M/s ABB M/s Schneider M/s Siemens M/s Areva
5	LT Sandwich Bus Duct	M/s L&T M/s Godrej M/s Schneider
6	Protective Relays	M/s ABB M/s Schneider Electric M/s L&T M/s GE M/s Siemens M/s Areva T&D M/s Easun Reyrolle
7	Current Transformers	M/s Pragati M/s Jyoti M/s Kappa M/s Ind Coil
8	Voltage Transformers	M/s Pragati M/s Jyoti M/s Kappa M/s Ind Coil
9	LT panels / LV Switchgears & Control gears	M/s Schneider Electric M/s ABB M/s. Siemens M/s GE M/s L&T
10	Lighting Fixtures and Accessories	M/s Philips M/s Havells M/s Crompton Greaves Limited M/s Wipro

Sl. No.	Item	Sub-Vendor's Name
		M/s Bajaj Electricals
11	Emergency Lighting Fixtures	Prolite or equivalent.
12	LDB's, UPSDB's, MCB's, RCCB's	M/s Indo Kopp M/s Legrand M/s L&T M/s Siemens M/s Schneider
13	Switches , Plugs, Sockets	M/s Legrand M/s Havells M/s Anchor M/s Schneider M/s ABB
14	33kV Cables	M/s RPG M/s KEI M/s Gloster M/s Universal M/s Nicco M/s Polycab M/s Finolex M/s Havells
15	33 / 11kV Cable termination	M/s Raychem M/s Mahindra M/s REPL Engineering Ltd. M/s 3M
16	Selector switches	M/s Kaycee M/s Siemens
17	LED Indicating Lamps	M/s Teknic M/s Vaishno M/s Siemens M/s Mathura Switchgears Pvt.Ltd
18	Terminal Block	M/s Elmex M/s Connectwell
19	Control fuses	M/s Siemens M/s GE
20	Push Button	M/s Siemens M/s L&T M/s Teknic, M/s Mathura Switchgears Pvt.Ltd M/s Schneider

Sl. No.	Item	Sub-Vendor's Name
21	Meters (Ammeter, Voltmeter)	M/s AE M/s Rishabh M/s Meco M/s Enercon M/s IMP
22	Cable Trays	M/s Indiana M/s Patni M/s Reliance M/s Sadhana
23	Digital Multifunction Meters / Load Manager	M/s Secure M/s AE M/s Conzerv M/s Enercon
24	LT Power Cables and Wires	M/s Universal Cables M/s Polycab M/s Havell's M/s Finolex
25	LT Cable Lugs	M/s Dowells M/s Jainson M/s Comet
26	LT Cable Glands	M/s Braco M/s Dowells M/s Hex M/s Comet
27	Lightning Arrestors	M/s Jayshree M/s Elpro M/s Oblum
28	Batteries	M/s Amara Raja Batteries Ltd M/s Exide Ltd M/s Standard Batteries Ltd M/s Sherene Electro Controls M/s Amco Power Systems Ltd.
29	Battery Charger	M/s HBL Nife M/s Exide M/s Automatic Electric Ltd. M/s Mass.Tech Controls (P) Ltd. M/s Chabbi Electricals Pvt Ltd
30	UPS	M/s Emerson M/s DB Power Electronics M/s Hi Rel Electronics Pvt.Ltd

Sl. No.	Item	Sub-Vendor's Name
		M/s Enercon Systems Pvt Ltd.
31	Sandwich Busduct	M/s C&S Protection & Control Ltd M/s M.K. Engineers M/s Godrej M/s Schneider M/s Legrand M/s Power Gear Pvt. Ltd
32	Receptacles, switches & switch boxes	M/s Legrand M/s MK M/s Crabtree M/s Anchor Roma
33	Lighting poles & High-Mast	M/s Bajaj M/s India Electric Poles Manufacturing co.
34	Contactors	M/s L& T M/s Siemens M/s Schneider-Telemecanique
35	Ceiling fans	M/s Bajaj M/s Crompton M/s Usha M/s Havells M/s Orient
36	PVC Conduits	M/s Precision M/s VIP M/s Avon
37	Geysers	M/s Bajaj M/s Ketco M/s Recold
38	Exhaust fan	M/s Jainson M/s Crompton M/s Havells
39	LED	M/s OSRAM M/s Philips M/s Lumileds M/s Cree M/s Nichia M/s High Beam

TECHNICAL SPECIFICATION

IBMS AND IT WORKS

IBMS & IT WORKS

8.1. BUILDING MANAGEMENT SYSTEM

8.1.1 Scope of work

- 8.1.1.1. This specification covers the requirement for design, engineering, manufacturing, testing at Vendor's/Sub-Vendor's works, supply, packaging, forwarding, delivery at site, unloading from carriers, storage at site, transport to site, loading, unloading, installation, commissioning, carrying out performance guarantee / acceptance tests at site of field instruments and Integrated Building Management System (IBMS).
- 8.1.1.2. The BIDDER shall be a recognised leader in integration of IBMS system and capable of supplying all necessary support services including hardware & software support, configuration services, system installation, commissioning & maintenance support. At least One- (1) no. of similar installations of the IBMS offered by the BIDDER should be in continuous operation for a minimum period of one year.
- 8.1.1.3. Microprocessor based Integrated Building Management System (IBMS) with functions distributed both geographically and functionally over the field controllers shall be provided. IBMS shall comprise of Direct Digital Controllers (DDC), IBMS server and IBMS operator station. The field instruments for HVAC system shall be supplied, installed, monitored and controlled by the vendor.
- 8.1.1.4. HVAC system, the Fire Detection & Alarm System (FDAS), Access Control System (ACS), Public Address System (PAS), CCTV system, DG sets, UPS, Energy meters and all other utilities and systems as Fire Fighting System, Waste Water Treatment plant shall be integrated with the IBMS system, monitored and controlled from Fire Command Centre room located at Ground floor in the Administration block.
- 8.1.1.5. It is not the intent to specify completely herein all details of design and construction of equipment or materials to be supplied or of services to be rendered. However, the equipment, materials and services shall conform in all respects to high standards of engineering design, workmanship and be capable of performing in continuous commercial operation in a manner acceptable to EMPLOYER who shall interpret the meaning of drawings and specifications and shall have the power to reject any work or material which in his judgement are not in full accordance therewith.

8.1.2 Codes and Standards

- 8.1.2.1. All equipment, systems and works covered under this specification shall comply with all currently applicable statutes, regulations, standards and safety codes in the locality where the equipment shall be installed.
- 8.1.2.2. In particular, the following standards are applicable

BIS : Bureau of Indian Standards

IEC : International Electrotechnical Commission

NEC : National Electric Code

NEMA : National Electrical Manufacturer's Association

NBC: National Building Code

GRIHA : Green Rating for Integrated Habitat Assessment

- 8.1.2.3. Other national standards established to be equivalent or superior to the codes and standards specified are also acceptable. The BIDDER shall furnish English translation of all standards specified in this specification.
- 8.1.2.4. In the event of any conflict between the codes and standards referred to in the specification and the requirements of this specification, the more stringent of these requirements shall govern.
- 8.1.2.5. Unless indicated otherwise, all codes and standards referred to in this enquiry specification shall be understood to be the latest version on the date of offer made by the Bidder.

8.1.3 System Description

8.1.3.1. Integrated Building Management System (IBMS) shall be a microprocessor based system with functions distributed both geographically and functionally over the field controllers. IBMS shall be PC based system allowing full seamless integration of following:

- a) Energy Management.
- b) Utility Services such as Water Treatment Plant, fire fighting system etc,
- c) DDC/Converters for Software Integration
- d) DDC's for Ventilation system
- e) Fire Detection & Alarm System
- f) Public Address System (PAS)
- g) Access Control System (ACS)
- h) DG set
- i) CCTV system
- j) Uninterruptible Power Supplies (UPSs)

All the above systems shall be integrated and monitored from the IBMS supervisory workstations.

8.1.3.2. IBMS server will be placed in the server room located at Second floor in the Administration block whereas workstations will be placed in the server room located at Fire command centre, Ground floor in the Administration block.

8.1.3.3. Building Management System DDCs shall have facility to connect any standard analog and digital Input / Outputs. Such as 4 to 20 mA, 0 to 10V, RTD and potential free contacts. 20% of used channels installed / wired spares shall be provided while sizing / selecting the DDCs. Energy Management functions such as duty cycling and optimisation for controlling AC&V equipment shall be done in optimum manner.

8.1.3.4. The supply & installation of the DDCs is in the BIDDER's scope.

8.1.3.5. These DDCs shall be interfaced with the IBMS system over MODBUS/LON/BACNET protocol and necessary hardware & software required in IBMS for interface shall be provided by the bidder.

8.1.3.6. Also the communication cables for interfacing the DDCs to IBMS system shall be provided by the bidder.

8.1.3.7. DDC shall have the following software features as minimum:

8.1.3.8. Energy management and Control Programs and Associated Data files shall be in non-volatile EEPROM or power-backed RAM memory.

8.1.3.9. Each DDC shall contain up to 10 unique User modifiable time programs (TP). Each TP shall consist of daily, weekly and annual programs plus a “TODAY” temporary function.

DAILY Programs shall be definable for day types such as working day, half day, holiday, weekend etc. Each daily program shall allow a list of time based Analog and Digital commands to be used to user selected plant elements and points.

WEEKLY programs shall allow a user selected set of daily programs to be defined for each day of the week (MONDAY through SUNDAY).

The ANNUAL program shall initially be an Automatic Compilation of 52 weekly programs. Selecting a date of the ANNUAL Program shall allow modification of the daily selection entered into the weekly program (such as changing JAN 26 from working day to a Holiday).

8.1.3.10. Control Application Software for DDC shall be customised strictly to meet the detailed requirements of the ‘Sequence of Operation’ specified.

8.1.3.11. Initial Software shall be fully modifiable, and not restricted by Vendor’s Specific Configuration guidelines.

8.1.3.12. All DDC control software shall be designed via a graphic programming facility.

8.1.3.13. IBMS Software shall include the following as minimum features:

- a) Microsoft Windows-based operating system.
- b) User Friendly Graphical interface providing a complete overview of all the systems connected to the IBMS system. The graphics should be universally understood.
- c) Seamless Integration of the various systems provided in the plant
- d) Measured values, operating status of drives displayed in real time
- e) Facility to be provided to the operator to adjust Set point from screen.
- f) Alarms displayed in real time, can be acknowledged & reset by operator from screen
- g) Time Scheduling – Time programmes shall ensure that HVAC & lighting are switched off automatically at the end of the day & during holidays. Apart from a 7-day programme, exception programmes shall also be made as required
- h) Historical Trending
- i) Report Generation – Provides a snapshot of the systems at any specific time or when specific events occurred.
- j) Access of viewing to only authorised users by provision of password at various levels.
- k) Separate screens shall be developed for operation and monitoring of each system. IBMS shall have capability to develop minimum 250 nos. of screens.
- l) Facility shall be provided to monitor and control all the systems from any IBMS operator station.
- m) Facility shall be provided to configure the software for any addition / deletion of data from any IBMS operator station.
- n) General arrangement drawings and architectural drawings for each building will be made available to the CONTRACTOR by client. CONTRACTOR shall

develop complete 3D view of the buildings displaying location of each equipment such as VRF's, cameras, access controlled doors, DG sets, stores, receptions etc.

8.1.4 System Specification

8.1.4.1. Air Conditioning

a) Variable Refrigerant Flow System (VRF)

Variable Refrigerant Flow System is monitored and controlled through soft integration using RS 485/MODBUS communication. There shall be total five nos. of VRF controllers for Training & Production Block, Admin Block and Dining Block.

- Time scheduled based operation
- Remote start/stop of each VRF unit through BMS.
- Monitor the status of each VRF unit through BMS and keep a log of the number of hours run.
- Monitor the space temperature through BMS & give an alarm for a high/low space temperature.
- Monitor relative humidity in seven no. of specialized labs. 3 Step Electric Heater shall be start/stop to maintain room humidity level within 35%RH - 65% RH.

b) Air Handling Unit (AHU) – Clean Room

There shall be total two nos. of AHU for Clean room in Production Block.

- Time scheduled based operation
- Remote start/stop of each AHU through BMS.
- Monitor the status of each AHU through BMS and keep a log of the number of hours run.
- Monitor the space temperature through BMS & give an alarm for a high/low space temperature.
- Monitor filter status

c) Scrubbers

There shall be total two nos. of scrubbers for Dining Block.

- Time scheduled based operation
- Start/stop of each fan through BMS.
- Monitor the status of each fan through BMS and keep a log of the number of hours run.

d) Air washers

There shall be two nos. of Air washers for Admin Block and four nos. of Air washers for Training & Production Block.

- Time scheduled based operation
- Start/stop of each fan and pump through BMS.

- Monitor the status of each fan and pump through BMS and keep a log of the number of hours run.
- Monitor relative humidity of serving area. If relative humidity is greater than 60% then stop pump whereas if humidity is less than 45% then start pump.
- Monitor sump level. If sump level is high, then pump shall stop.

8.1.4.2. Electrical System

- a) Monitor one no. of Incoming medium voltage breaker (HT) status
- b) Monitor two no. of outgoing low voltage breakers (LT) status. Keep provision for monitoring of one no. of outgoing low voltage breakers (LT) status for future.
- c) Tentatively 14 nos. of energy meters will be provided. However exact quantity and location will be finalised during detail engineering.

The Supply and installation of above system is not in the bidder's scope.

These energy meters shall be interfaced with the IBMS system over MODBUS/LON/BACNET protocol and necessary hardware & software required in IBMS for interface shall be provided by the bidder.

Also the communication cables for interfacing the energy meters to IBMS system shall be provided by the bidder.

This shall mainly focus on the integrated system as a whole for energy conservation at gross level whereas network operation monitors each utility. Electrical management shall be taken care i.e. the following parameters shall be monitored that contributes to the cost of electrical energy.

- Power (KW)
 - Power factor
 - Energy (KW H)
 - Demand
 - Voltage
 - Current
 - Frequency
- d) UPS will be provided at various locations depending upon the load requirement for reliable backup supply. Two nos. of UPS shall be provided in Utility building and two nos. of UPS shall be provided in Admin Building. The supply & installation of UPSs is not in the BIDDER's scope. However these UPSs shall be interfaced with the IBMS system over MODBUS/LON/BACNET protocol and necessary hardware & software required in IBMS for interface shall be provided by the bidder. Also the communication cables for interfacing the UPSs to IBMS system shall be provided by the bidder.

8.1.4.3. Plumbing System

- a) Monitor Hi/Lo level at One no. of Underground Domestic water tank
- b) Monitor Hi/Lo level at One no. of Underground Flushing water tank
- c) Monitor Hi/Lo level at 9 nos. of Overhead Domestic water tank
- d) Monitor Hi/Lo level at 9 nos. of Overhead Flushing water tank
- e) Monitor and control 9 nos. of solenoid valve based on Overhead Domestic water tank level. If water is at high level setpoint, then valve shall closed, whereas if water is at low level setpoint, then valve shall open.

f) Monitor and control 9 nos. of solenoid valve based on Overhead Flushing water tank level. If water is at high level setpoint, then valve shall closed, whereas if water is at low level setpoint, then valve shall open.

g) Monitor and control 2 Duty +1 Standby Domestic water pump based on Overhead Domestic water tank level and solenoid valve command.

If all Domestic water tank level is at High setpoint and all solenoid valves are command to close, then duty pumps shall command to stop.

If any of Domestic water tank level is at Low setpoint and any of solenoid valve is command to open position, then duty pumps shall command to start.

h) Monitor and control 2 Duty +1 Standby Domestic water pump based on Overhead Flushing water tank level and solenoid valve command.

If all Domestic water tank level is at High setpoint and all solenoid valves are command to close, then duty pumps shall command to stop.

If any of Domestic water tank level is at Low setpoint and any of solenoid valve is command to open position, then duty pumps shall command to start.

8.1.4.4. Fire Fighting System

a) Monitor one no. of Jockey pump status

b) Monitor one no. of Fire pump status

c) Monitor one no. of Diesel pump status

8.1.5 Direct Digital Control (DDC) Specification

Sr. No.	Description	Requirement
A.	GENERAL	
1.	Make	Bidder to Specify
2.	Model No	Bidder to Specify
B.	FEATURES	
1.	Type	Microprocessor based fully programmable with onboard real time clock
2.	Local display with DDC	Required <input type="checkbox"/> Not Required <input checked="" type="checkbox"/>
3.	Communication port	Required <input checked="" type="checkbox"/> Not Required <input type="checkbox"/>
4.	Memory	Non volatile memory
5.	Network capability	Required <input checked="" type="checkbox"/>

Sr. No.	Description	Requirement
		Not Required <input type="checkbox"/>
6.	Management function as alarm management, trending functions, remote management, access protection levels, time scheduling, data processing etc	Required <input checked="" type="checkbox"/> Not Required <input type="checkbox"/>
7.	Communication between DDC to DDC	Peer to Peer communication
8.	Network interface	TCP/ IP
9.	Inputs to DDC	Digital inputs, Analog inputs
10.	Outputs to DDC	Digital outputs, Analog outputs and PFC to drive auxiliary contactor
11.	Numbers of I/O module	Refer I/O table sheet
12.	Facility to expand I/O channels in each DDC	Required <input checked="" type="checkbox"/> Not Required <input type="checkbox"/>
13.	LED status for each I/O channel	Required <input checked="" type="checkbox"/> Not Required <input type="checkbox"/>
14.	Power supply	230VAC from UPS
15.	Data back-up in case of power failure	Required <input checked="" type="checkbox"/> Not Required <input type="checkbox"/>
16.	Location of the DDC	Please refer floor layout
17.	Final paint colour (Exterior)	RAL-7032
18.	Final paint colour (Interior)	Glossy white
19.	Heat dissipation	Bidder to Specify
20.	Rating of relay contact	Bidder to Specify
21.	Analog input/ output	Refer I/O table sheet
22.	Digital input/ output	Refer I/O table sheet
C.	CONSTRUCTIONAL FEATURES	
1.	Sheet material	CRCA-cold rolled prefabricated

Sr. No.	Description	Requirement
2.	Sheet material thickness	2mm
3.	Gland plate thickness	3mm
4.	Neoprene gaskets for doors / covers	Required <input checked="" type="checkbox"/> Not Required <input type="checkbox"/>
5.	Cable entry	Bottom <input checked="" type="checkbox"/> Top <input type="checkbox"/> Side <input type="checkbox"/>
6.	Lighting	Fluorescent (Fluorescent lamp of 40w shall be provided from one end of the panel to the other end at continuous length and shall be operated by the door switches as well as by manual switches.)
7.	Name plates	Required <input checked="" type="checkbox"/> Not Required <input type="checkbox"/>
8.	SS metal tags for all instruments (to be tagged at all hardware inside panel)	Required <input checked="" type="checkbox"/> Not Required <input type="checkbox"/>
9.	Receptacle with fuse switch	Bidder to Specify (Note: Each section of the panels shall be provided with one each 3 pin receptacles for 230V,1P,50C/S)
10.	Adequate maintenance space	Required <input checked="" type="checkbox"/> Not Required <input type="checkbox"/>
11.	Weight of the panel (total)	Bidder to Specify
12.	Panel shall be powder coated with thickness of coating of min. 60 microns	Required <input checked="" type="checkbox"/> Not Required <input type="checkbox"/>
D.	ENVIRONMENTAL CHARACTERISTICS	
1.	Ambient temperature range	0-50°C
2.	Humidity range	95%
3.	Weather protection class	Min. IP52 for indoor panels

Sr. No.	Description	Requirement
E.	SPARE	
1.	Quantity	Required

Input /Output table

EQUIPMENT	QTY	AI	AO	DI	DO	
AIR WASHER (DINING BLOCK)						
FAN ON/OFF STATUS	2	0	0	2	0	AT FAN MCC PANEL
FAN START-STOP COMMAND	2	0	0	0	2	AT FAN MCC PANEL
FAN TRIP ALARM	2	0	0	2	0	AT FAN MCC PANEL
FAN MANUAL/OFF/AUTO SWITCH	2	0	0	2	0	MANUAL/OFF/AUTO SWITCH
PUMP ON/OFF STATUS	2	0	0	2	0	AT PUMP MCC PANEL
PUMP START-STOP COMMAND	2	0	0	0	2	AT PUMP MCC PANEL
PUMP TRIP ALARM	2	0	0	2	0	AT PUMP MCC PANEL
PUMP MANUAL/OFF/AUTO SWITCH	2	0	0	2	0	MANUAL/OFF/AUTO SWITCH
HUMIDITY SENSOR	2	2	0	0	0	HUMIDITY SENSOR
SUMP HIGH LEVEL	2	0	0	2	0	LEVEL SWITCH
AIR WASHER (TRAINING BLOCK)						
FAN ON/OFF STATUS	4	0	0	4	0	AT FAN MCC PANEL
FAN START-STOP COMMAND	4	0	0	0	4	AT FAN MCC PANEL
FAN TRIP ALARM	4	0	0	4	0	AT FAN MCC PANEL
FAN MANUAL/OFF/AUTO SWITCH	4	0	0	4	0	MANUAL/OFF/AUTO SWITCH
PUMP ON/OFF STATUS	4	0	0	4	0	AT PUMP MCC PANEL
PUMP START-STOP COMMAND	4	0	0	0	4	AT PUMP MCC PANEL
PUMP TRIP ALARM	4	0	0	4	0	AT PUMP MCC PANEL
PUMP MANUAL/OFF/AUTO SWITCH	4	0	0	4	0	MANUAL/OFF/AUTO SWITCH

HUMIDITY SENSOR	4	4	0	0	0	HUMIDITY SENSOR
SUMP HIGH LEVEL	4	0	0	4	0	LEVEL SWITCH
SCRUBBER (DINING BLOCK)						
FAN ON/OFF STATUS	2	0	0	2	0	AT FAN MCC PANEL
FAN START-STOP COMMAND	2	0	0	0	2	AT FAN MCC PANEL
FAN TRIP ALARM	2	0	0	2	0	AT FAN MCC PANEL
MANUAL/OFF/AUTO SWITCH	2	0	0	2	0	MANUAL/OFF/A UTO SWITCH
PLUMBING SYSTEM						
DOMESTIC WATER						
WATER TANK HIGH LEVEL (OVERHEAD TANK)	9	0	0	9	0	LEVEL SWITCH
WATER TANK LOW LEVEL (OVERHEAD TANK)	9	0	0	9	0	LEVEL SWITCH
WATER TANK HIGH LEVEL (UNDERGROUND TANK)	1	0	0	1	0	LEVEL SWITCH
WATER TANK LOW LEVEL (UNDERGROUND TANK)	1	0	0	1	0	LEVEL SWITCH
VALVE ON/OFF COMMAND	9	0	0	0	9	SOLENOID VALVE
VALVE ON/OFF STATUS	9	0	0	9	0	SOLENOID VALVE
PUMP ON/OFF STATUS	3	0	0	3	0	AT PUMP MCC PANEL
PUMP START-STOP COMMAND	3	0	0	0	3	AT PUMP MCC PANEL
PUMP TRIP ALARM	3	0	0	3	0	AT PUMP MCC PANEL
MANUAL/OFF/AUTO SWITCH	3	0	0	3	0	MANUAL/OFF/A UTO SWITCH
FLUSHING WATER						
WATER TANK HIGH LEVEL (OVERHEAD TANK)	9	0	0	9	0	LEVEL SWITCH
WATER TANK LOW LEVEL (OVERHEAD TANK)	9	0	0	9	0	LEVEL SWITCH
WATER TANK HIGH LEVEL (UNDERGROUND TANK)	1	0	0	1	0	LEVEL SWITCH
WATER TANK LOW LEVEL (UNDERGROUND TANK)	1	0	0	1	0	LEVEL SWITCH
VALVE ON/OFF COMMAND	9	0	0	0	9	SOLENOID VALVE
VALVE ON/OFF STATUS	9	0	0	9	0	SOLENOID VALVE

PUMP ON/OFF STATUS	3	0	0	3	0	AT PUMP MCC PANEL
PUMP START-STOP COMMAND	3	0	0	0	3	AT PUMP MCC PANEL
PUMP TRIP ALARM	3	0	0	3	0	AT PUMP MCC PANEL
MANUAL/OFF/AUTO SWITCH	3	0	0	3	0	MANUAL/OFF/AUTO SWITCH
SEWAGE TREATMENT PLANT (PLC)	1					SOFT INTEGRATION
FIRE FIGHTING SYSTEM						
JOCKEY PUMP STATUS	1	0	0	1	0	AT PUMP MCC PANEL
MAIN FIRE PUMP STATUS	1	0	0	1	0	AT PUMP MCC PANEL
DIESEL PUMP STATUS	1	0	0	1	0	AT PUMP MCC PANEL
ELECTRICAL SYSTEM						
INCOMING BREAKERS STATUS (HT)	1	0	0	2	0	
OUTGOING BREAKERS STATUS (LT)	3	0	0	6	0	2 + 1 (FUTURE)
SMART METERS	14	0	0	0	0	SOFT INTEGRATION
UPS	4	0	0	0	0	SOFT INTEGRATION
VARIABLE REFRIGERANT FLOW (VRF) CONTROLLER	5	0	0	0	0	SOFT INTEGRATION
AIR HANDLING UNIT						
FAN ON/OFF STATUS	2	0	0	2	0	AT FAN MCC PANEL
FAN START-STOP COMMAND	2	0	0	0	2	AT FAN MCC PANEL
FAN TRIP ALARM	2	0	0	2	0	AT FAN MCC PANEL
FAN MANUAL/OFF/AUTO SWITCH	2	0	0	2	0	MANUAL/OFF/AUTO SWITCH
SPACE TEMPERATURE	2	2	0	0	0	HUMIDITY SENSOR
FILTER STATUS	2	0	0	2	0	DIFFERENTIAL PRESSURE SWITCH
TOTAL		8	0	143	40	

8.1.6 EQUIPMENT & SERVICES PROVIDED BY OTHERS

8.1.6.1. The following are the equipment and services that shall be provided to the CONTRACTOR by others:

- a) 240V AC, Feeder (UPS supply), for IBMS system at one location will be provided by Employer. CONTRACTOR shall lay the Power cables from the power supply distribution board to all the equipment supplied by CONTRACTOR.
- b) Uninterruptible Power supply (UPS).
- c) Energy meters
- d) DG set system
- e) Utility Systems as Fire fighting systems, Waste water Plant
- f) The cabling between utility systems & DDCs.
- g) HVAC system (excluding field instruments and controls). Tapping for mounting of instruments on HVAC equipment and ducts.
- h) Electrical & Instrument earth Pits

8.1.7 Cables and Conduits:-

8.1.7.1. Cabling

- a) Contractor shall supply & lay the following cables along with cable trays, conduits and all other installation hardware and accessories
- b) Field instruments / modulating valves to IBMS Server/operator station through DDC
- c) VRF controllers to IBMS Server/operator station through DDC
- d) AHU panels to IBMS Server/operator station through DDC
- e) Ventilation panels to the IBMS Server/operator station through DDC
- f) Power supply cabling from UPS system to the IBMS server/ operator station
- g) Power supply cabling from UPS to DDCs.

8.1.7.2. Cabling (standard communication link) from IBMS to other control systems viz., Fire detection and Alarm system, UPS(s), DG set panel, energy meters for communication.

8.1.7.3. Cable specification for Instrument signals

- a) For Digital signals 2 core x 1.5 sq.mm stranded annealed tinned copper conductor, PVC insulated, overall shielding with aluminium tape, FRLS sheathed, unarmoured cable. For Analog Signals 1P X 1.0 sq.mm, stranded annealed tinned copper conductor, twisted pair, PVC insulated, overall shielding with aluminium tape, FRLS sheathed, unarmoured cable.
- b) All these cables shall be from field instruments to DDC Controllers and should be laid in conduits.
- c) The cables standards shall be conforming to IS 1554, BS:5308.

8.1.7.4. Conduits shall be UPVC as per IS: 9537 Part III and accessories i.e. junction boxes, tees etc. as per IS: 3419. Flexible conduits shall be used at relevant places. The size of the conduits shall be discussed during detailed engineering.

8.1.7.5. CONTRACTOR shall use UPVC conduits upto 2 runs of cables, above two runs Galvanised Iron covered cable trays shall be used for laying of cables.

8.1.8 Installation Works

8.1.8.1. Bidder has to supply and lay the conduits with the structural steel supports and required accessories. Supply and laying of all the cables of IBMS in the conduits shall be done by the bidder.

8.1.8.2. Bidder shall be responsible for the following:

- a) Exposed conduiting is planned overall, above false ceiling and laying of the exposed conduits along with accessories for the systems shall be by the CONTRACTOR.
- b) Cabling and conduiting for the modules located on walls shall be concealed and laying of concealed conduits shall be by the bidder. CONTRACTOR should carry out necessary chasing in the brick/block walls, laying, fixing, re-doing the plastering and making the surface neat.
- c) CONTRACTOR to estimate the quantity of cables and conduits as per the system layout enclosed.
- d) CONTRACTOR to confirm the BOM based on the system being supplied. Any changes suggested by the CONTRACTOR in the system layouts enclosed with this tender should be supported by valid explanation. On mutual agreement the BOM shall then be revised.
- e) UPS power shall be provided and further distribution at all elevations wherever required shall be by the CONTRACTOR.
- f) CONTRACTOR to indicate the feeder requirements at all elevations.
- g) CONTRACTOR shall use UPVC conduits upto 2 runs of cables, above two cable runs Galvanised Iron covered cable trays shall be used for laying of cables

8.1.9 POWER SUPPLY

8.1.9.1. IBMS shall be operated on 230V AC, single Phase, 50 Hz Supply. The entire IBMS shall be on UPS with battery backup for 30 minutes. The feeder or socket points shall be provided by others at the required points and the further cabling shall be by the bidder. Bidder to indicate total UPS power/feeder requirement at each location.

8.1.10 Instrument Grounding

8.1.10.1. Separate instrument earth pits as required will be provided for grounding the instrument cable shield. Instrument casing will be connected to electrical safety earth. The ground resistance shall be less than / equal to 10 ohms.

8.1.10.2. Earthing:

- a) Earthing for the entire system to be provided, shall be in CONTRACTOR's scope. Separate electrical & instrumentation earth pits shall be provided by others.

Both electrical and instrument earth pit will be interconnected. Contractor shall connect the safety ground bus & instrument ground bus for the systems supplied by him to the respective earth pits.

- b) Single point earthing configuration shall be followed for the cable shields i.e. all signal and control cables shields shall be grounded at one end only to avoid ground loop.

8.1.11 SUMMARY OF DATA TO BE FURNISHED ALONG WITH BID AND AFTER ACCEPTANCE OF PURCHASE ORDER

- 8.1.11.1. The CONTRACTOR shall ensure the following documentation are prepared and submitted to EMPLOYER for his review / record.

Sr.no.	Drawings/Docs.	To be furnished along with bid	To be furnished after award of contract
1	Data sheet & write-up shall be signed/filled and stamped by the CONTRACTOR indicating compliance to the specifications.	*	
2	Technical Catalogues of each module/card/instrument of each type required for the complete IBMS system with software features	*	
3	Overall system Configuration diagram with add on interfacing	*	
4	Dimensional drawings of Panels along with estimated BOQ for each of the systems.		*
5	Testing & evaluation plan for the systems offered		*
6	Operation & maintainance manuals		*
7	Quality assurance documentation specific for the project.		*
8	Final built documentation folder with all items for future reference.		*
9	Unpriced purchase order copy for various bought out / sub contracted equipment / services.		*

Sr.no.	Drawings/Docs.	To be furnished along with bid	To be furnished after award of contract
10	Internal wiring diagrams indicating termination details of each component.		*
11	Bill of material indicating tag no, quantity, make / model no. of various cards / modules for IBMS system with software, DDCs, field instruments, any other item required for completion of system.	*	
12	Datasheets & catalogues for power & Communication, I & C cable.		*
13	Cable schedules & interconnection cable schedules		*
14	Copies of the graphics / screens to be developed for operation and monitoring of entire system.		*
15	List of signals connected to each DDCs.		*
16	Power supply distribution scheme		*
17	Estimated Power consumption location wise		*

* CONTRACTOR shall furnish the data.

8.1.12 TRAINING

8.1.12.1. 1 No. Contractor's engineer shall be made available for 1 month for assistance in operation, maintenance, tuning & training of Employer's personnel at Site after commissioning of IBMS & PA system with all necessary integration with other systems.

8.1.12.2. Training shall be required on both hardware & application software development.

8.1.13 SITE ACCEPTANCE TEST

Full integrated site acceptance test shall be performed before hand over of total system to the EMPLOYER. The test shall demonstrate the entire system

functionality to the complete satisfaction of client / Project Manager. The supplier shall provide all personnel, test facilities, equipment and tools etc. for the same.

8.1.14 MAINTENANCE REQUIREMENTS

In order to carry out preventive maintenance, it should be possible to readily disassemble, repair, and reassemble the equipment in the shortest period and to attend to any defect by a minimum disassembly.

All system must have convenient maintenance characteristics including easy access to replacement part which can be installed by personnel with minimum skill.

8.1.15 ANNUAL MAINTAINANCE CONTRACT

All components, system software, parts and assemblies supplied by the BIDDER shall be guaranteed against defects in materials and workmanship for one year from acceptance date.

Bidder to quote for Annual maintenance & operations Contract of IBMS system after defects liability period, for a period of three years.

8.1.16 TESTING, INSTALLATION, COMMISSIONING AND ACCEPTANCE

8.1.16.1. Testing Requirements

8.1.16.2. Tests on cables

- Check details are in accordance with the specification.
- Check for physical damage.
- Megger test between each core and armour/sheath
- Continuity check including screen continuity
- Terminations of the cables at both ends.

8.1.16.3. Tests on electrical installation

- Checking of closing, tripping, supervision and interlocking of control devices.
- Checking operation of all system circuits.

8.1.16.4. Test on complete IBMS system.

- On completion, the functioning of IBMS systems with all other utilities systems interfaced with it shall be tested to demonstrate its correct operation in accordance with the Specification.
- For testing, the Contractor may provide temporary means to simulate operating conditions, but the system shall not be finally accepted until correct operation has been demonstrated to the satisfaction of the Employer.

8.1.17 Commissioning

8.1.17.1. Commissioning Procedure shall be carried out in a methodical sequence as follows

- Start-up,
- Initial running,
- Operability adjustment,
- Stable operation
- Final adjustment

- 8.1.17.2. The Contractor shall check the operating conditions by constantly monitoring operating data.
- 8.1.17.3. The CONTRACTOR shall specify for each discrete part of the system for which the operational data has to be recorded and the manner in which the data is to be taken. All the operating data shall be recorded, evaluated and submitted to the EMPLOYER.

8.1.18 SPECIFIC REQUIREMENTS / INSTRUCTION TO BIDDERS

- 8.1.18.1. This is a Unit rate contract. The price/ contract value shall be arrived at based on quantities indicated in Bill of Quantity and unit rates for supply & erection quoted by the Bidder. The break-up of unit prices for various items in Bill of Quantity shall be used for future addition/deletion of the items, if any.
- 8.1.18.2. Contractor shall estimate Cable quantities based on enclosed GA drawings & layouts for bidding purpose only. However the Contractor is advised to visit Site & take actual measurements for arriving at the cable quantities actually required at Site before placement of Order.
- 8.1.18.3. The construction of this facility requires that, all CONTRACTOR'S adhere to good daily housekeeping practices. During construction the CONTRACTOR shall every day, keep all work and storage areas used by them free from accumulation of waste materials. Scrap / rubbish shall be removed from the site to the satisfaction of the EMPLOYER. The CONTRACTOR shall maintain a crew to carry out this function without any additional payment.
- 8.1.18.4. The equipment to be supplied and erected under this specification shall be in accordance with specification & data sheets.
- 8.1.18.5. Any item which may not have been specifically mentioned herein but are needed to complete the equipment / system shall also be treated as included and the same shall also be supplied and erected at no extra cost, unless otherwise specifically excluded as indicated.
- 8.1.18.6. The BIDDER shall comply with all systems / parameters wherever they are specified in data sheets. No credit will be given during tender evaluation, if parameters better than those specified are offered by the BIDDER.
- 8.1.18.7. Deviation from the specifications, if acceptable to the EMPLOYER in so far as practicable shall be converted to rupee value and added to the bid price to compensate for the deviation from the specification. In determining the rupee value of the deviations, the EMPLOYER shall use the parameters consistent with that specific in the documents and specifications and other information as necessary and available to the EMPLOYER.
- 8.1.18.8. Bidder's Offer
- a) To enable thorough and fast scrutiny of the BIDDER's offer, BIDDERS are advised to respond all their technical data in the enquiry by clearly marking out their response, wherever they want to provide additional data and / or they deviate from the specified requirements. In case of full compliance, the enquiry specification and data sheets shall remain unaltered. Each data sheet & write up in specification shall be signed and stamped by the BIDDER. This requirement is very important. Non compliance of this by the BIDDER may result in their bid being rejected.

- b) BIDDER is advised to quote for the complete scope and partial response shall not be entertained. In case of few items which do not directly fall under BIDDER's manufacturing range and / or not available from indigenous source, BIDDER should take the responsibility upon themselves to arrange to procure them and supply to ensure that their offer is complete in all respects.

8.1.19 SPARES AND MAINTENANCE TOOLS AND TACKLES

8.1.19.1. GENERAL

- a) All spares and maintenance tools and tackles shall be designed to enable maintenance to be carried out in the least time and at the least cost and support resources without affecting the performance and safety aspects.
- b) All the spares and maintenance tools and tackles supplied shall be new and unused.
- c) The VENDOR/CONTRACTOR shall guarantee that before going out of production of spares and maintenance tools and tackles for the equipment furnished, he shall give at least 12 months advance notice to the EMPLOYER, so that the latter may order his requirement in one lot, if so desired.

8.1.19.2. SPARES

The BIDDER shall include the following three (3) categories of spares in his scope of supply.

- a) All spares supplied shall be strictly inter-changeable with the parts for which these are intended to be replacements. The spares shall be treated and packed for long term storage under the climatic conditions prevailing at the site e.g., small items shall be packed in sealed transparent plastic bags with desiccator packs as necessary.
- b) Each spare shall be clearly marked or labelled on the outside of its packing with its description and purpose. When more than one spare is packed in a single case, a general description of the contents shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages shall be suitably marked and numbered for the purposes of identification.

8.2. FIRE DETECTION AND ALARM SYSTEM

8.2.1 Scope of work

- 8.2.1.1. This specification covers specific requirements of design, preparation of detailed drawings, manufacture, testing at manufacturer's works, supply, inspection at Bidder's/Sub-Bidder's works, packing, forwarding, transportation, transit insurance, delivery at site, installation, testing at site and commissioning of the Fire Detection and Alarm System (FDAS).
- 8.2.1.2. FDAS shall be proposed for Training and Production block, Administration block, Dining Block and Utility block.
- 8.2.1.3. Main Fire Alarm Control Panel (FACP) shall be placed in the Fire command centre room at Ground Floor in the Administration block. One no. of FACP is placed at Reception area of Training and Production Block and one no. of FACP is placed at Ground Floor of Dining Block. Additionally a repeater fire alarm panel shall be provided at the Main security gate of entire complex.

8.2.1.4. The FDAS system shall form a network to monitor the status of entire system in the Fire command centre room at Ground Floor in the Administration block. Graphical presentation of FDAS system shall be viewed at IBMS monitor.

8.2.1.5. It is not the intent to specify completely herein all details of design and construction of equipment or materials to be supplied or of services to be rendered. However, the equipment, materials and services shall conform in all respects to high standards of engineering design, workmanship and be capable of performing in continuous commercial operation in a manner acceptable to EMPLOYER who will interpret the meaning of drawings and specifications and shall have the power to reject any work or material which in his judgement are not in full accordance therewith.

8.2.2 Codes and Standards

The equipment and installation shall comply with the current and latest edition of the following codes and listing:

8.2.2.1. Codes

a. National Fire Protection Association (NFPA):

- NFPA 72 National Fire Alarm Code
- NFPA 76 Telecommunication Facilities
- NFPA 101 Life Safety Code
- NFPA 90A Air conditioning & ventilation system

8.2.2.2. Listings

a. Underwriters Laboratories Inc. (UL) - USA:

- UL 268 Smoke Detectors for Fire Protective Signalling Systems
- UL 864 Control Units for Fire Protective Signalling Systems 9th Edition
- UL 268 A Smoke Detectors for Duct Applications
- UL 521 Heat Detectors for Fire Protective Signalling Systems
- UL 464 Audible Signalling Appliances
- UL 38 Manually Actuated Signalling Boxes
- UL 346 Water flow Indicators for Fire Protective Signalling Systems
- UL 1971 Visual Notification Appliances
- UL 228 Door Holders
- UL 1481 Power Supply for fire protective signalling system.
- UL 1711 Amplifiers for Fire Protective Signalling Systems.
- UL 1635 Digital Alarm Communicator System Units

ADDENDUMS thereafter in UL Code for Fire Detection (2007).

- UL 9th Schedule Certification
- International Standards Organization (ISO)
- ISO-9000
- ISO-9001
- European Union (EU)
- EMC Directive 89/336/ EEC
- Electromagnetic Compatibility Requirements
- Factory Mutual (FM) Approval

b. Local Codes

- NATIONAL BUILDING CODES
 - IS-2189
- c. European Standards
- EN54

8.2.3 System Description

8.2.3.1. The Fire Detection and Alarm system comprises of the following.

- a. Multi-Criteria Detector
- b. Smoke Detector
- c. Heat detectors
- d. Sounders cum Strobe
- e. Manual call points
- f. Response Indicator
- g. Fault Isolator Module
- h. Control Module
- i. Monitor Module
- j. 3 Nos. FDAS panel
- k. 1 No. Repeater panel to be located in Security gate.
- l. Cabling for FDAS

8.2.3.2. Please refer FDAS layout drawings for location of fire detectors, manual call points and sounders. However it is the contractor's responsibility to evaluate the quantity & type of fire detectors, manual call points and sounders as per the specified Codes & standard.

8.2.4 Specifications

8.2.4.1. Fire Alarm Control Panel Specification

Sr. No.	Description	Requirement
A.	GENERAL	
1.	Type	Microprocessor Based
2.	Panel Location	<ol style="list-style-type: none"> 1. Fire Command Centre, Ground Floor, Administration Building 2. Reception Area, Ground Floor, Training & Production Building 3. Ground Floor, Canteen Building
B.	DISPLAY ON PANEL	
1.	Type	Backlit LCD
2.	Lines X Characters	LCD, Alphanumeric, display of addresses, Minimum 80/160 characters
3.	Parameters to be displayed	<ol style="list-style-type: none"> 1. Addresses 2. Fire situation

Sr. No.	Description	Requirement
		3. Fire progression 4. Evacuation details 5. Fault Conditions
4.	LED indication for:	1. Power ON 2. Fire alarm 3. Maintenance 4. Fault conditions
5.	Programming facility	1. Keypad 2. Touch screen
6.	Password and selectable access level	Required
7.	Switches / Push buttons	Acknowledge, Silence and System reset
C.	PANEL CHARACTERISTICS	
1.	Audio indication on alarm	Required
2.	Fault isolation capability	Required
3.	Alarm verification capability	Required
4.	Sensitivity adjustment	Required
5.	Sensor self test capability	Required
6.	Zone wise grouping	Required
7.	Response time	10 Seconds (Max) for full loaded panel. Note: The maximum allowable response delay from activation of an initiating device to receipt and display by the receiver/ fire alarm control unit shall be 10 seconds.

Sr. No.	Description	Requirement
8.	Fault tolerant wiring capability	Required
9.	No. of loops / Panel	2 Nos. Loops (Working + Spares for future) Spare cards shall be mounted inside the panel along with working cards
10.	Expansion capability	Required
11.	Minimum addressable points per loop	Each loop shall be loaded upto 80% of its capacity. However 20% spare shall be considered in each loop for future additional detectors / devices.
12.	SLC loop cabling type	Style 6, class 'A' as per NFPA 72
13.	Loop length supported	Upto 1.5 Km
14.	Memory	NON-Volatile, NON-Erasable and NON-Rewritable
15.	Networking	<ol style="list-style-type: none"> 1. Panel to Panel 2. Panel to Repeater Panel 3. Panel to Graphical User Interface (GUI) 4. PC to printer
16.	Networking protocol	RS-485 or Ethernet
17.	Degraded mode operation	Required
18.	Redundancy for controller	Not Required
19.	Event recorder	Required
D.	POWER	
1.	Supply voltage to panel	230V - 10%, 50Hz, UPS mains supply
2.	Operating current	Bidder to specify
3.	Output voltage	Bidder to specify

Sr. No.	Description	Requirement
4.	Wattage consumption	Bidder to specify
5.	Types of batteries	Sealed Maintenance Free (SMF) Note:- Battery shall be supplied having manufacturing date nearer to the supply date of battery.
6.	Battery capacity	As per NFPA 72 Note:- Battery shall have sufficient capacity to power the fire alarm system under non alarm condition for a minimum of 24 hours and shall be capable of operating the system during emergency condition for a period of 15 minutes at maximum connected load, upon normal AC power failure. The full load shall consist of simultaneous operation of all sounders, operation of detectors at least 25% of zones (with minimum of two zones) and the operation of fault indicators.
7.	Terminal blocks for mains supply	Required
8.	Isolated earth bar for shield grounding	Required
E.	MECHANICAL CHARACTERISTICS	
1.	Dimensions	Bidder to specify
2.	Weight	Bidder to specify
3.	Mounting	<div>Wall <input checked="" type="checkbox"/></div> <div>Surface <input type="checkbox"/></div> <div>Flush <input type="checkbox"/></div> <div>Semi Flush <input type="checkbox"/></div>
4.	Sheet thickness	1.6mm
5.	Colour shade	Bidder to specify
6.	Housing material	CRCA
F.	ENVIRONMENTAL CHARACTERISTICS	
1.	Ambient temperature range	0-50°C
2.	Humidity range	95%

Sr. No.	Description	Requirement
3.	Weather protection class	Min. IP 20 for indoor panels located in air condition space
G.	APPROVAL / CERTIFICATE	
1.	UL/ FM/ VDS/ EN-54/ LPCB	Required
2.	Make	Bidder to specify
3.	Model No	Bidder to specify

8.2.4.2. Fire Alarm Repeater Panel Specification

Sr. No.	Description	Requirement
A.	GENERAL	
1.	Make	Bidder to specify
2.	Model No	Bidder to specify
B.	DISPLAY ON PANEL	
1.	Type	Backlit LCD
2.	Lines X Characters	Alpha-numeric, LCD display with minimum 80 character, with LED indications
3.	Parameters to be displayed	<ol style="list-style-type: none"> 1. Addresses 2. Fire situation 3. Fire progression 4. Evacuation details 5. Fault Conditions
4.	LED indication for:	<ol style="list-style-type: none"> 1. Power ON 2. Fire alarm 3. Maintenance 4. Fault conditions
5.	Programming facility	<ol style="list-style-type: none"> 1. Keypad

Sr. No.	Description	Requirement
		2. Touch screen
6.	Password and selectable access level	Required
7.	Switches / Push buttons	Acknowledge, Silence and System reset
C.	PANEL CHARACTERISTICS	
1.	Audio indication on alarm	Required
2.	Alarm verification capability	Required
3.	Response time	10 Seconds (Max) for full loaded panel. Note: The maximum allowable response delay from activation of an initiating device to receipt and display by the receiver/ fire alarm control unit shall be 10 seconds.
4.	Memory	NON-Volatile, NON-Erasable and NON-Rewritable
5.	Networking	Required
6.	Networking protocol	RS-485 or Ethernet
D.	POWER	
1.	Supply voltage to panel	230V - 10%, 50Hz, UPS mains supply
2.	Operating current	Bidder to specify
3.	Output voltage	Bidder to specify
4.	Wattage consumption	Bidder to specify
5.	Types of batteries	Sealed Maintenance Free (SMF) Note:- Battery shall be supplied having manufacturing date nearer to the supply date of battery.
6.	Battery capacity	As per NFPA 72 Note:- Battery shall have sufficient capacity to power the fire alarm system under non alarm condition for a minimum of 24

Sr. No.	Description	Requirement
		hours and shall be capable of operating the system during emergency condition for a period of 15 minutes at maximum connected load, upon normal AC power failure. The full load shall consist of simultaneous operation of all sounders, operation of detectors at least 25% of zones (with minimum of two zones) and the operation of fault indicators.
7.	Terminal blocks for mains supply	Required
8.	Isolated earth bar for shield grounding	Required
E.	MECHANICAL CHARACTERISTICS	
1.	Dimensions	Bidder to specify
2.	Weight	Bidder to specify
3.	Mounting	<div>Wall <input checked="" type="checkbox"/></div> <div>Surface <input type="checkbox"/></div> <div>Flush <input type="checkbox"/></div> <div>Semi Flush <input type="checkbox"/></div>
4.	Sheet thickness	1.6mm
5.	Colour shade	Bidder to specify
6.	Housing material	CRCA
F.	ENVIRONMENTAL CHARACTERISTICS	
1.	Ambient temperature range	0-50°C
2.	Humidity range	95%
3.	Weather protection class	Min. IP20 for indoor panels located in air condition space
G.	APPROVAL / CERTIFICATE	
1.	UL/ FM/ VDS/ EN-54/ LPCB	Required
2.	Make	Bidder to specify

Sr. No.	Description	Requirement
3.	Model No	Bidder to specify

8.2.4.3. Fire Alarm Control Relay Module Specification

Sr. No.	Description	Requirement
A.	GENERAL	
1.	Make	Bidder to specify
2.	Model No	Bidder to specify
B.	MODULE CHARACTERISTICS	
1.	Application	Activating conventional Sounder cum Strobe <input checked="" type="checkbox"/> To operate the dry contact for third party application <input type="checkbox"/>
2.	Type	Microprocessor Based
3.	Addressable	Required
4.	Number of relay outputs in each module	1 No. <input checked="" type="checkbox"/> 2 No. <input type="checkbox"/> 4 No. <input type="checkbox"/> 8 No. <input type="checkbox"/>
5.	Type of relay contact / contact rating	Bidder to specify
6.	Cabling	Two wire signal line circuit style 6, class 'A' as per NFPA-72
7.	Built-in isolator	Not Required Note: In case of built-in isolator requirement the approval/ certification shall be VDS/ EN-54/ LPCB else UL/ FM approval/ certification shall be applicable.
C.	POWER	
1.	Operating voltage	24 VDC (Loop powered)
2.	Operating current	Bidder to specify
3.	Wattage	Bidder to specify

Sr. No.	Description	Requirement
	consumption	
D.	MECHANICAL CHARACTERISTICS	
1.	Dimensions	Bidder to specify
2.	Weight	Bidder to specify
3.	Material of Enclosure	Non Corrosive
E.	ENVIRONMENTAL CHARACTERISTICS	
1.	Ambient temperature range	0-50°C
2.	Humidity range	95%
3.	Enclosure weather protection class	For Indoor IP54 For Outdoor IP65
4.	Explosion proof enclosure	
5.	Hazardous area classification	
F.	APPROVAL / CERTIFICATE	
1.	UL/ FM/ VDS/ EN-54/ LPCB	Required

8.2.4.4. Fire Alarm Heat Detector Specification

Sr. No.	Description	Requirement
A.	GENERAL	
1.	Make	Bidder to specify
2.	Model No	Bidder to specify
B.	DETECTOR CHARACTERISTICS	
1.	Type	Microprocessor Based-Combination of Fixed Temperature and Rate of Rise of Temperature <input checked="" type="checkbox"/>

Sr. No.	Description	Requirement
		Microprocessor Based-Fixed Temperature <input type="checkbox"/> Microprocessor Based-Rate of Rise of Temperature <input type="checkbox"/>
2.	Addressable	Required
3.	LED Status	Multi colored, multi status LED
4.	Response Time	The maximum allowable response delay from activation of an initiating device to receipt and display by the receiver/ fire alarm control unit shall be 10 seconds
5.	Terminals for connecting response indicator	Required (Bidder to consider fault isolator module after every 10 Nos. detectors/ devices for UL/ FM offered panel or inbuilt fault isolator base shall be provided for EN-54/ VDS/ LPCB offered panel. Bidder to provide necessary provision to connect the response indicator for any type of fire detectors.)
6.	Sensor Coverage	Bidder to specify
7.	Alarm set point for Heat	For fixed temperature type - 55°C For rate of rise of temp. type 7°C / Minutes
8.	Sensitivity Adjustment	Required
9.	Immune to false alarm	Required
10.	Cabling	Two wire signal line circuit style 6, class 'A' as per NFPA-72
11.	Built-in isolator	Not Required Note: In case of built-in isolator requirement the approval/ certification shall be VDS/ EN-54/ LPCB else UL/ FM approval/ certification shall be applicable.
C.	POWER	
1.	Operating voltage	24 VDC (Loop powered)
2.	Operating current	Bidder to specify
3.	Wattage consumption	Bidder to specify
D.	MECHANICAL CHARACTERISTICS	

Sr. No.	Description	Requirement
1.	Dimensions	Bidder to specify
2.	Weight	Bidder to specify
3.	Material of Enclosure	Non Corrosive
4.	Colour	Bidder to specify
E.	ENVIRONMENTAL CHARACTERISTICS	
1.	Ambient temperature range	0-50°C
2.	Humidity range	95%
F.	APPROVAL / CERTIFICATE	
1.	UL/ FM/ VDS/ EN-54/ LPCB	Required

8.2.4.5. Fire Alarm Multi-Sensor Detector Specification

Sr. No.	Description	Requirement
A.	GENERAL	
1.	Make	Bidder to specify
2.	Model No	Bidder to specify
B.	DETECTOR CHARACTERISTICS	
1.	Type	Microprocessor based, combination of smoke and heat detector (Fixed and Rate of Rise of Temperature type)
2.	Addressable	Required
3.	LED Status	Multi colored, multi status LED
4.	Remote / Local Test Capability	Required
5.	Response Time	The maximum allowable response delay from activation of an initiating device to receipt and display by the receiver/ fire alarm control unit shall be 10 seconds
6.	Terminals for connecting	Required

Sr. No.	Description	Requirement
	response indicator	(Bidder to consider fault isolator module after every 10 Nos. detectors/ devices for UL/ FM offered panel or inbuilt fault isolator base shall be provided for EN-54/ VDS/ LPCB offered panel. Bidder to provide necessary provision to connect the response indicator for any type of fire detectors.)
7.	Sensor Coverage	Bidder to specify
8.	Alarm set point for Heat	For fixed temperature type - 55°C For rate of rise of temp. type 7°C / Minutes
9.	Sensitivity Adjustment	Required
10.	Immune to false alarm	Required
11.	Cabling	Two wire signal line circuit style 6, class 'A' as per NFPA-72
12.	Built-in isolator	Not Required Note: In case of built-in isolator requirement the approval/ certification shall be VDS/ EN-54/ LPCB else UL/ FM approval/ certification shall be applicable.
C.	POWER	
1.	Operating voltage	24 VDC (Loop powered)
2.	Operating current	Bidder to specify
3.	Wattage consumption	Bidder to specify
D.	MECHANICAL CHARACTERISTICS	
1.	Dimensions	Bidder to specify
2.	Weight	Bidder to specify
3.	Material of Enclosure	Non Corrosive
4.	Colour	Bidder to specify
E.	ENVIRONMENTAL CHARACTERISTICS	
1.	Ambient temperature range	0-50°C
2.	Humidity range	95%

Sr. No.	Description	Requirement
F.	APPROVAL / CERTIFICATE	
1.	UL/ FM/ VDS/ EN-54/ LPCB	Required

8.2.4.6. Fire Alarm Beam Type Smoke Detector Specification

Sr. No.	Description	Requirement
A.	GENERAL	
1.	Make	Bidder to specify
2.	Model No	Bidder to specify
B.	DETECTOR CHARACTERISTICS	
1.	Type	Reflective beam type smoke detector <input checked="" type="checkbox"/> Projected beam type smoke detector <input type="checkbox"/>
2.	Addressable	Required Note: In case bidders offers conventional beam detector, same shall be made addressable by providing addressable monitor module.
3.	LED Status	Multi colored, multi status LED
4.	Remote / Local Test Capability	Required
5.	Response Time	The maximum allowable response delay from activation of an initiating device to receipt and display by the receiver/ fire alarm control unit shall be 10 seconds
6.	Sensor Coverage	Bidder to specify
7.	Alarm set point for Heat	Bidder to specify
8.	Sensitivity Adjustment	Required
9.	Immune to false alarm	Required
10.	Cabling	Two wire signal line circuit style 6, class 'A' as per NFPA-72
C.	POWER	

Sr. No.	Description	Requirement
1.	Operating voltage	24 VDC
2.	Operating current	Bidder to specify
3.	Wattage consumption	Bidder to specify
D.	MECHANICAL CHARACTERISTICS	
1.	Dimensions	Bidder to specify
2.	Weight	Bidder to specify
3.	Material of Enclosure	Non Corrosive
4.	Colour	Bidder to specify
5.	Spacing & mounting	As per the norms of NFPA 72,2010 edition & as per manufacturer's instructions
E.	ENVIRONMENTAL CHARACTERISTICS	
1.	Ambient temperature range	0-50°C
2.	Humidity range	95%
3.	Weather protection class	For indoor application: IP 54
F.	APPROVAL / CERTIFICATE	
1.	UL/ FM/ VDS/ EN-54/ LPCB	Required

8.2.4.7. Fire Alarm Smoke Detector Specification

Sr. No.	Description	Requirement
A.	GENERAL	
1.	Make	Bidder to specify
2.	Model No	Bidder to specify
B.	DETECTOR CHARACTERISTICS	
1.	Type	Microprocessor Base- Photoelectric Type
2.	Addressable	Required

Sr. No.	Description	Requirement
3.	LED Status	Multi colored, multi status LED
4.	Remote / Local Test Capability	Required
5.	Response Time	10 Seconds Max. For Full Loaded Panel. Detectors Response Time Shall Be Suitable For The Same. Note: The maximum allowable response delay from activation of an initiating device to receipt and display by the receiver/ fire alarm control unit shall be 10 seconds.
6.	Terminals for Connecting Response Indicator	Required
7.	Sensor Coverage	Bidder to specify
8.	Sensitivity Adjustment	Required
9.	Immune to false alarm	Required
10.	Cabling	Two wire signal line circuit style 6, class 'A' as per NFPA-72
11.	Detector Mounting Base	With Isolator <input type="checkbox"/> Without Isolator <input checked="" type="checkbox"/>
C.	POWER	
1.	Operating voltage	Bidder to specify
2.	Operating current	Bidder to specify
3.	Wattage consumption	Bidder to specify
4.	Loop Powered	Required
D.	MECHANICAL CHARACTERISTICS	
1.	Dimensions	Bidder to specify
2.	Weight	Bidder to specify
3.	Material of Enclosure	Non Corrosive
4.	Colour	Bidder to specify
5.	Spacing & mounting	As per the norms of NFPA 72,2010 edition & as per manufacturer's instructions

Sr. No.	Description	Requirement
E.	ENVIRONMENTAL CHARACTERISTICS	
1.	Ambient temperature range	0-50°C
2.	Humidity range	95%
3.	Weather protection class	For indoor application: IP 65
F.	APPROVAL / CERTIFICATE	
1.	UL/ FM/ VDS/ EN-54/ LPCB	Required

8.2.4.8. Fire Alarm Monitor Module Specification

Sr. No.	Description	Requirement
A.	GENERAL	
1.	Make	Bidder to specify
2.	Model No	Bidder to specify
B.	MODULE CHARACTERISTICS	
1.	Application	To normally open dry-contact alarm activation devices
2.	Type	Microprocessor Based
3.	Addressable	Required
4.	Number of relay outputs in each module	1 No. <input checked="" type="checkbox"/> 2 No. <input type="checkbox"/> 4 No. <input type="checkbox"/> 8 No. <input type="checkbox"/>
5.	Response time	The maximum allowable response delay from activation of an initiating device to receipt and display by the receiver/ fire alarm control unit shall be 10 seconds
6.	Cabling	Two wire signal line circuit style 6, class 'A' as per NFPA-72
7.	Built-in isolator	Not Required Note: In case of built-in isolator requirement the approval/ certification shall be VDS/ EN-54/ LPCB else UL/ FM

Sr. No.	Description	Requirement
		approval/ certification shall be applicable.
C.	POWER	
1.	Operating voltage	24 VDC (Loop powered)
2.	Operating current	Bidder to specify
3.	Wattage consumption	Bidder to specify
D.	MECHANICAL CHARACTERISTICS	
1.	Dimensions	Bidder to specify
2.	Weight	Bidder to specify
3.	Material of Enclosure	Non Corrosive
E.	ENVIRONMENTAL CHARACTERISTICS	
1.	Ambient temperature range	0-50°C
2.	Humidity range	95%
3.	Enclosure weather protection class	For Indoor IP54 For Outdoor IP65
4.	Explosion proof enclosure	Bidder to specify
5.	Hazardous area classification	Bidder to specify
F.	APPROVAL / CERTIFICATE	
1.	UL/ FM/ VDS/ EN-54/ LPCB	Required

8.2.4.9. Manual Call Point (MCP) Specification

Sr. No.	Description	Requirement
A.	GENERAL	
1.	Make	Bidder to specify
2.	Model No	Bidder to specify

Sr. No.	Description	Requirement
B.	MCP CHARACTERISTICS	
1.	Type	Break glass type <input checked="" type="checkbox"/> Push and pull type <input checked="" type="checkbox"/> Lift and pull type <input checked="" type="checkbox"/>
2.	Clear and visible operating instructions on the body	Required
3.	The word "FIRE" indication on the front of MCP in raised letters, 1.75 inches (44 mm) or larger	Required
4.	Response Time	The maximum allowable response delay from activation of an initiating device to receipt and display by the receiver/ fire alarm control unit shall be 10 seconds
5.	Cabling	Two wire signal line circuit style 6, class 'A' as per NFPA-72
6.	Built-in isolator	Not Required Note: In case of built-in isolator requirement the approval/ certification shall be VDS/ EN-54/ LPCB else UL/ FM approval/ certification shall be applicable.
C.	POWER	
1.	Operating voltage	24 VDC (Loop powered)
2.	Operating current	Bidder to specify
3.	Wattage consumption	Bidder to specify
D.	MECHANICAL CHARACTERISTICS	
1.	Dimensions	Bidder to specify
2.	Weight	Bidder to specify
3.	Material of Enclosure	Non Corrosive
4.	Colour	Bidder to specify
E.	ENVIRONMENTAL CHARCTERISTICS	
1.	Ambient temperature range	0-50°C

Sr. No.	Description	Requirement
2.	Humidity range	95%
3.	Enclosure weather protection class	For Indoor IP54 For Outdoor IP65
4.	Explosion proof enclosure	Bidder to specify
5.	Hazardous area classification	Bidder to specify
F.	APPROVAL / CERTIFICATE	
1.	UL/ FM/ VDS/ EN-54/ LPCB	Required
2.	ATEX/ CCOE	Not Required (For Explosion Proof type)

8.2.4.10. SOUNDER cum STROBE Specification

Sr. No.	Description	Requirement
A.	GENERAL	
1.	Make	Bidder to specify
2.	Model No	Bidder to specify
B.	SOUNDER/ STROBE CHARACTERISTICS	
1.	Type	Loop Powered <input type="checkbox"/> Externally Powered <input checked="" type="checkbox"/> Note: Externally powered through FACP.
2.	Addressable	Required
3.	Response time	The maximum allowable response delay from activation of an initiating device to receipt and display by the receiver/ fire alarm control unit shall be 10 seconds
4.	dB level	90 db at 10 Feet from device
5.	Light intensity	15/30/75/110 cd
6.	Number of selectable tones	Minimum 4
7.	Cabling	Two wire signal line circuit style 6, class 'A' as per NFPA-72

Sr. No.	Description	Requirement
8.	Built-in isolator	Not Required Note: In case of built-in isolator requirement the approval/ certification shall be VDS/ EN-54/ LPCB else UL/ FM approval/ certification shall be applicable.
C.	POWER	
1.	Operating voltage	24 VDC
2.	Operating current	Bidder to specify
3.	Wattage consumption	Bidder to specify
4.	Power Supply	Bidder to specify
D.	MECHANICAL CHARACTERISTICS	
1.	Dimensions	Bidder to specify
2.	Weight	Bidder to specify
3.	Material of Enclosure	Non Corrosive
4.	Mounting	<div> <div>Wall</div> <div><input checked="" type="checkbox"/></div> </div> <div> <div>Surface</div> <div><input type="checkbox"/></div> </div> <div> <div>Structure beam</div> <div><input type="checkbox"/></div> </div> <p>Note: - All accessories shall be supplied and erected as applicable</p>
E.	ENVIRONMENTAL CHARACTERISTICS	
1.	Ambient temperature range	0-50°C
2.	Humidity range	95%
3.	Weather protection class	IP 65
F.	APPROVAL / CERTIFICATE	
1.	UL/ FM/ VDS/ EN-54/ LPCB	Required
2.	ATEX/ CCOE	Not Required (For explosion proof type)

8.2.4.11. Fire Alarm Fault Isolator Module Specification

Sr. No.	Description	Requirement
A.	GENERAL	
1.	Make	Bidder to specify
2.	Model No	Bidder to specify
B.	MODULE CHARACTERISTICS	
1.	Type	Microprocessor Based
2.	Addressable	Required
3.	After every numbers of detector/devices	18 nos.
4.	Automatically resets on correction of short	Required
5.	Wide viewing angle of LED	Required
6.	Cabling	Two wire signal line circuit style 6, class 'A' as per NFPA-72
C.	POWER	
1.	Operating voltage	24 VDC (Loop powered)
2.	Operating current	Bidder to specify
3.	Wattage consumption	Bidder to specify
D.	MECHANICAL CHARACTERISTICS	
1.	Dimensions	Bidder to specify
2.	Weight	Bidder to specify
3.	Material of Enclosure	Non Corrosive
E.	ENVIRONMENTAL CHARCTERISTICS	
1.	Ambient temperature range	0-50°C
2.	Humidity range	95%
3.	Enclosure Weather protection class	For Indoor IP54 For Outdoor IP65

Sr. No.	Description	Requirement
F.	APPROVAL / CERTIFICATE	
1.	UL/ FM/ VDS	Required

8.2.5 Interlocks for FDAS

8.2.5.1. Minimum 8 nos. of Potential free contacts shall be provided from the FDAS Panel through relay module for following Interlocks in the event of fire:

- a. Building Management System
- b. Sprinkler / Pumps System
- c. Access control system

8.2.6 Installation

8.2.6.1. Installation shall be in accordance with the IS 2189, NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

8.2.6.2. The complete installation hardware and cabling for FDAS system is in scope of Contractor.

8.2.6.3. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas.

8.2.6.4. Detectors shall not be installed prior to the system programming and test period.

8.2.6.5. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

8.2.6.6. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

8.2.6.7. Manual fire alarm boxes shall be suitable for surface mounting or semi-flush mounting and shall be installed not less than 42 inches (1067 mm), nor more than 48 inches (122 mm) above the finished floor.

8.2.7 Power Supply

8.2.7.1. One feeder of 240 V AC, UPS power shall be made available in the UPS for the Fire Alarm & Detection System. The Contractor shall lay cables from UPS to the FDAS system. All the other necessary power supply required for the functioning of the FDAS system shall be derived by the contractor from this power supply.

8.2.8 Power Cables

- a. The specifications for power cables shall be as below:
- b. Conductor material: Stranded Copper
- c. Insulation Material: Cables shall be PVC insulated as per application.
- d. Voltage grade: 1100 V
- e. Armouring: All power cables shall be GI wire armoured.
- f. Sheathing Material: Inner & Outer sheaths shall be FRLS PVC

8.2.9 I&C Cables

8.2.9.1. All multipair & multicore cables shall be provided with 20% (of used pairs/cores) spare pairs & cores for future use. Cables for Ethernet connectivity shall be CAT 6 cables which shall be armoured. Cables for RS-485 connection shall be twisted pair cables, shielded & armoured.

8.2.9.2. Cable Glands

All cable glands shall be of double compression type with high quality neoprene gaskets. Cable glands shall be of brass with nickel plating.

8.2.9.3. Cable trays

Cable trays shall be perforated of hot dipped galvanized steel. Cable trays shall have 50 mm collar height. The cable trays shall be covered type.

The cables coming in the beam area shall be allowed to pass through conduits.

The cables laid between two different buildings shall be laid in conduits in cable trenches.

I&C Cables and power cables shall be routed through different cable trays to avoid Electromagnetic Interference.

Minimum 300 mm distance shall be maintained between I&C cables / 24 V DC power supply cables and 415 V AC/ 230 V AC power cables.

All cable trays shall be provided with 20% spare space for future use.

8.2.9.4. Fire proof Sealing for Cable penetration

Cables/ cable tray openings in walls and floors or through pipe sleeves from one area to another or one elevation to another shall be sealed by a fireproof sealing compound. The fire-proof sealing compound shall effectively prevent the spread of fire from the flaming to non-flaming side, in the event of fire.

8.2.9.5. The specifications of cables shall be as mentioned below.

		Description	Power Cable	Control cable	Signal cable	Triad Cable
GENERAL		Type	Armoured	Screened, armoured	Twisted, screened, armoured	
		Voltage grade	1100 V	1100 V	660 V	
	CONDUCTOR		Material	Annealed Tinned Copper		
		Shape of conductor	Stranded circular			
		Size				
		No. of strands	7 nos.			
PRIMARY INSULATION		Material	Extruded Polyethylene (PE) as per BS-EN 50290-2			
		Thickness of insulation (Nominal)	0.8 mm			
		Colour code		Grey	White +ve, Black –ve (For each pair)	Brown, Black and blue
INDIVIDUAL		Twist	NA	NA	Min. 10 nos. twist / meter	

L PAIRS / TRIADS					for each pair					
		Identification		NA	NA		Numbers at not more than 250mm length			
INDIVIDUAL PAIR / TRIAD SCREENING		Material		NA	NA		AL Mylar tape applied helically with metallic side down in contact with drain wire			
		Tape thickness		NA	NA		Minimum 0.075 mm thick for single pair cables Minimum 0.05 mm thick for multipair cables			
		Overlap	NA		NA		Min .25 %	100 %	Min. 25%	100 %
		Polyester tape		NA	NA		Polyester tape of 0.05 mm thick each. two tapes with min. 25% overlap & 100% coverage			
		<u>Drain wire</u>								
		Material		NA	NA		Annealed Tinned Copper			
		Size		NA	NA		0.5mm ² , with 7 strands, each of 0.3 mm dia.			
OVERALL SCREENING		Material		NA	AL Mylar tape applied helically with metallic side down in contact with drain wire					
		Tape thickness		NA	Minimum 0.075 mm					
		Overlap	Cover age	NA	Min. 25%	100 %	Min. 25%	100 %	Min . 25 %	100%
		<u>Drain wire</u>		NA						
		Material		NA	Annealed Tinned Copper					
		Size		NA	0.5mm ² , with 7 strands, each of 0.3 mm dia.					
BINDER TAPE		Type		Non-Hygroscopic, two tapes with min. overlap of 25% & 100% coverage						
		Tape Thickness		Each tape of min. 0.023 mm thick						
INNER SHEATH		Material		Extruded flame retardant PVC type ST-2, 90°C as per IS-5831 , oxygen index over 30% and temp. index over 250 deg C.						
		Thickness (Nominal)		As per BS-EN 50288 part 7 (Note-2)						
		Colour		Black						
		Diameter over inner sheath		Bidder to Specify Note:- Cable dimensions (OD under armour, OD over armour, overall OD) shall be as per BS-EN-50288-7. Maximum tolerance in dimensions shall be +/- 2 mm.						
		Rip Chord		Non-metallic required under inner sheath						
ARMOURING		Material		Galvanised steel						
		Size		As per BS-EN 50288						

		Diameter over armour	Bidder to Specify Note:- Cable dimensions (OD under armour, OD over armour, overall OD) shall be as per BS-EN-50288-7. Maximum tolerance in dimensions shall be +/- 2 mm.		
OUTER SHEATH		Material	Extruded flame retardant PVC IEC-332, Type ST-2, 90°C as per IS-5831		
		Thickness (Nominal)	As per BS-EN 50288 part 7 (Note-2)		
		Colour	Black	Black, for Intrinsic safe light blue	Black
		Overall Diameter	Bidder to Specify Note:- Cable dimensions (OD under armour, OD over armour, overall OD) shall be as per BS-EN-50288-7. Maximum tolerance in dimensions shall be +/- 2 mm.		
		Cable identification	Running length printed at min. every 1 metre interval		
ELECTRICAL PROPERTIES		Conductor resistance	As per BS-EN 50288 part 7		
		Drain wire resistance	NA	≤ 30 ohms/km @ 20 deg c. Noise rejection ratio ≥ 76 db.	
		Insulation resistance	1 G Ω /KM as per BS EN 50288		
		Mutual capacitance	NA	≤ 110 nF/KM @ 1 KHz	
		Capacitance between core and screen	NA	≤ 400 nF/KM @ 1 KHz	
		Inductance	NA	≤ 1 mH/KM @ 1 kHz	
		L/R Ratio	NA	As per BS-EN 50288 part 7	

8.2.10 Panels Accessories & Wiring

8.2.10.1. Wiring

All inter cubical and internal wiring for all panels shall be carried out with 1100V grade, stranded tinned copper conductors with PVC insulation. The minimum size of the stranded copper conductor used for the panel wiring shall be 0.5 mm² for analog signals and 1.0 mm² for commands. For power supply, the conductor size shall be provided as per the load rating (min. 2.5 sq. mm for 230 V AC). Control & Power wiring shall be segregated and routed in PVC troughs. Different colour wires shall be used for different voltages.

Engraved core identification plastic ferrules, marked to correspond with the panel-wiring diagram shall be fitted at both ends of each wire. Cross ferruling shall be done. This shall also be applicable for fibre optic cable & cores.

All spare contacts and spare terminals of the panel mounted equipment and devices shall be wired to the terminal blocks.

8.2.10.2. Plug Points and Interior Lighting

A 5/15 Amp 230V, 1 phase, 50 Hz, AC 3 pin plug point shall be provided in the interior of each panel with ON/OFF control switch and MCB.

For interior lighting 230V, 1 Phase, 50 Hz, 40W compact fluorescent lamp with operating door switch and protective devices like MCBs shall also be provided.

Power supply for all exhaust fans shall be provided through MCBs.

8.2.10.3. Relays

All relays used for interposing shall have at least 2 nos. changeover contacts. The relays shall have status indication and shall be provided with free wheeling diodes.

8.2.10.4. Labels

All front mounted equipment, as well as equipment mounted inside the panels/control desks shall be provided with individual labels with equipment designation engraved. These shall be phenolic overlays (1.6 mm thick) with black background and white lettering and shall be fixed to the panel by stainless steel screws (counter sunk). The panels shall also be provided at the top with a label engraved with the designation. Lettering for panel designation shall be 6 mm.

The minimum lettering size for instrument/device labels shall be 3mm. The lettering on the labels shall be subject to EMPLOYER'S approval. Labels of internally mounted equipment shall be clearly visible.

8.2.10.5. Earthing

Each panel shall be provided with a safety ground bus & system ground bus made of copper securely fixed along the inside base of the panels. These buses shall be typically of 25 mm wide and 6 mm thick of copper. The safety ground bus shall be properly secured to the plant safety earthing. All metallic cases/frames of relays, instruments, other panel mounted equipment shall be connected to the safety ground bus and shields & drain wires of signal/control cables shall be connected to the system ground bus by independent copper wires of not less than 2.5 sq. mm. The system ground bus shall be electrically isolated from AC mains earthing bus. The system ground bus shall be insulated from the panel body. The insulation colour code for earthing wires shall be green with yellow bands.

8.2.11 SUMMARY OF DATA TO BE FURNISHED ALONG WITH BID AND AFTER ACCEPTANCE OF PURCHASE ORDER

The BIDDER shall ensure the following documentation are prepared and submitted to EMPLOYER for his review / record.

8.2.11.1. Technical Bid

The following drawings/ documents shall be submitted:

- a. Data sheet and catalogs of instruments/ equipments
- b. Dimensional Drawings of Panels along with estimated BOQ for each of the systems.
- c. Overall System Configuration Diagram
- d. Engineering activity and manufacturing schedule giving activity wise breakup to meet the delivery schedule.
- e. Testing & Evaluation plan for the systems offered.

8.2.11.2. Final Documents

- a. Operation and maintenance manuals.

- b. Quality assurance documentation specific for the project.
- c. Final as built documentation folder containing all items for future reference.

8.2.12 SCHEDULE FOR SUBMISSION OF DATA AND DRAWINGS BY CONTRACTOR (DATA TO BE FURNISHED AFTER THE AWARD OF CONTRACT)

The CONTRACTOR shall submit the following drawings / documents after award of contract for review & approval. CONTRACTOR shall adhere to the delivery schedule as submitted along with the BID. CONTRACTOR shall also refer to data sheets for list of deliverables to be submitted for various instruments/ panels.

<u>Sl. No.</u>	<u>Details</u>
(a)	Bar chart for the design, manufacturing, erection, commissioning, trial operation and performance testing of the system offered.
(b)	Overall System Configuration Diagram indicating all components including networking.
(c)	Unpriced purchase order copy for various bought out /sub contracted equipment / services.
(d)	Following drawings for panels:
	Front facia layout showing all instruments with cut-outs, bezel dimensions, construction details, foundation details and interior G.A. drawings showing interior layout of various modules, instruments etc.
	Internal wiring diagrams indicating termination details of each component.
	Bill of Material (B.O.M.) indicating tag no, quantity, service & model no. of the various modules/instruments/items.
(e)	FDAS Configuration and Layout drawings.
(f)	Data Sheets & catalogues for I&C cables & power cables.
(g)	Earthing diagrams
(h)	Cable Schedules and Interconnection cable schedules.
(l)	Load calculations for FDAS system
(j)	QAPs for all instruments & panels for each system, I&C cables, Power cables & fibre optic cables.
(k)	Standard FAT & SAT for the specified systems

<u>Sl. No.</u>	<u>Details</u>
(l)	‘As Built’ drawings
(m)	Instruction manual for installation and start-up (for each system)
(n)	System operation and maintenance manual

8.2.13 TRAINING

8.2.13.1.1 No. Contractor’s engineer shall be made available for 2 weeks for assistance in operation, maintenance, tuning & training of Employer’s personnel at Site after commissioning of each system.

8.2.13.2. Training shall be required on both hardware & application software development.

8.2.14 TESTING, INSTALLATION, COMMISSIONING AND ACCEPTANCE

8.2.14.1. General

On the basis of guidelines specified in this specification Bidder shall submit their own testing, installation, commissioning and acceptance procedure. The procedure shall include purpose of test, test definition, results expected and acceptance criteria. For software it shall include details of the method, list of tests, sequence of execution, results expected and acceptance criteria.

8.2.14.2. Site Acceptance Tests (SAT)

Full integrated site acceptance test shall be performed before hand over of total system to the EMPLOYER. The test shall demonstrate functionality of the entire system supplied & erected by the Contractor. The Contractor shall provide all personnel, test facilities, equipment and tools etc. for the same. All test instruments shall have calibration certificates from approved test house, valid for minimum 6 months. A test procedure is required for approval 2 weeks prior to the schedule start.

8.2.14.3. Testing Requirements

a. Tests on cables

- Check details are in accordance with the specification.
- Check for physical damage.
- Megger test between each core and armour/sheath (For electrical cables)
- Continuity check including screen continuity (For electrical cables)
- Terminations of the cables at both ends.

b. Fire Alarm System

- Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
- Open initiating device circuits and verify that the trouble signal actuates.
- Open and short signalling line circuits and verify that the trouble signal actuates.

- Open and short notification appliance circuits and verify that trouble signal actuates.
 - Ground all circuits and verify response of trouble signals.
 - Check presence and audibility of tone at all alarm notification devices.
 - Check installation, supervision, and operation of all intelligent smoke detectors using the walk test.
 - Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FDAS PANEL and the correct activation of the control points.
 - When the system is equipped with optional features, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.
- c. It shall be ensured that erection of all panels is as per approved layout drawings. Checking for tagging/identifications of all the panels shall be done. Checks for continuity and termination of all power, signal, control and fibre optic cables as per approved drawings shall be carried out. All the panels supplied & erected by the Contractor shall be checked at site by carrying out the following tests:
- Visual & Mechanical testing.
 - Power up tests
 - Checks on incoming voltage and power distribution
 - Checking of incoming power supply to the panels supplied & erected by the Contractor.
 - Switching on the incoming supply to panels by switching on MCCBs/MCBs one after the other.
 - Power 'ON' PCs for Fire Alarm System
 - Demonstration of all system functions for Fire Alarm System
 - Checking of 100% logic as per sequences
 - Checking of all HMI screens, alarms etc.
 - Checking of proper functioning of all Printers with printouts of alarm lists, reports, important alarms etc.
- d. Tests on electrical installation
- Checking of closing, tripping, supervision and interlocking of control devices.
 - Checking operation of all alarm circuits.
- e. Test on complete control system.
- On completion, the functioning of all systems shall be tested to demonstrate its correct operation in accordance with the Specification.
 - For testing, the Contractor may provide temporary means to simulate operating conditions, but the system shall not be finally accepted until

correct operation has been demonstrated to the satisfaction of the Employer.

8.2.15 Commissioning

8.2.15.1. Commissioning Procedure shall be carried out in a methodical sequence as follows

- Start-up,
- Initial running,
- Operability adjustment,
- Stable operation
- Final adjustment

8.2.15.2. The Contractor shall check the operating conditions by constantly monitoring operating data.

8.2.15.3. The Contractor shall specify for each discrete part of the system for which the operational data has to be recorded and the manner in which the data is to be taken. All the operating data shall be recorded, evaluated and submitted to the Employer

8.2.16 EQUIPMENT & SERVICES TO BE PROVIDED BY THE CONTRACTOR

8.2.16.1. This specification covers specific requirements of design, preparation of detailed drawings, manufacture, testing at manufacturer's works, inspection at Vendor's/Sub-Vendor's works, packing, forwarding, transportation, transit insurance, delivery at site, installation, testing at site, erection and commissioning of Fire Detection & Alarm System (FDAS) as per specification and data sheets enclosed.

8.2.16.2. The following shall be in the scope of the CONTRACTOR

FDAS comprising of FDAS control panel, initiating devices such as smoke Detectors, heat type Detectors, Manual Call Points (MCP), Sounders, isolators, 1 No. Repeater panel at security gate, software (to be installed in IBMS PC), A4 size monochrome LASER jet Printer, all associated cabling and installation hardware for the system as detailed in the specification and data sheets enclosed.

8.2.16.3. Cabling

- a) Contractor shall supply & lay the following cables along with all the installation hardware and accessories:
 - UPS to FDAS panel
 - FDAS system cabling
- b) Cable Trays & Conduits

8.2.16.4. Earthing

- a) Earthing for the entire system to be provided by the Contractor shall be in his scope. Separate electrical & instrumentation earth pits shall be provided by others. This earth pit shall be interconnected with electrical earth pit. Contractor shall connect the safety ground bus & system ground bus for the systems supplied by him to the respective earth pits.
- b) Single point earthing configuration shall be followed for the cable shields i.e. all signal and control cables shields shall to be grounded at one end only to avoid ground loop.

8.2.17 SPECIFIC REQUIREMENTS / INSTRUCTION TO BIDDERS

- 8.2.17.1. This is a Unit rate contract. The price/ contract value shall be arrived at based on quantities indicated in Bill of Quantity and unit rates for supply & erection quoted by the Bidder. The break-up of unit prices for various items in Bill of Quantity shall be used for future addition/deletion of the items, if any.
- 8.2.17.2. Contractor shall estimate Cable quantities based on enclosed GA drawings & layouts for bidding purpose only. However the Contractor is advised to visit Site & take actual measurements for arriving at the cable quantities actually required at Site before placement of Order.
- 8.2.17.3. The construction of this facility requires that, all CONTRACTOR'S adhere to good daily housekeeping practices. During construction the CONTRACTOR shall every day, keep all work and storage areas used by them free from accumulation of waste materials. Scrap / rubbish shall be removed from the site to the satisfaction of the EMPLOYER. The CONTRACTOR shall maintain a crew to carry out this function without any additional payment.
- 8.2.17.4. The equipment to be supplied and erected under this specification shall be in accordance with specification & data sheets.
- 8.2.17.5. Any item which may not have been specifically mentioned herein but are needed to complete the equipment / system shall also be treated as included and the same shall also be supplied and erected at no extra cost, unless otherwise specifically excluded as indicated.
- 8.2.17.6. The BIDDER shall comply with all systems / parameters wherever they are specified in data sheets. No credit will be given during tender evaluation, if parameters better than those specified are offered by the BIDDER.
- 8.2.17.7. Deviation from the specifications, if acceptable to the EMPLOYER in so far as practicable shall be converted to rupee value and added to the bid price to compensate for the deviation from the specification. In determining the rupee value of the deviations, the EMPLOYER shall use the parameters consistent with that specific in the documents and specifications and other information as necessary and available to the EMPLOYER.
- 8.2.17.8. Bidder's Offer
- a) To enable thorough and fast scrutiny of the BIDDER's offer, BIDDERS are advised to respond all their technical data in the enquiry by clearly marking out their response, wherever they want to provide additional data and / or they deviate from the specified requirements. In case of full compliance, the enquiry specification and data sheets shall remain unaltered. Each data sheet & write up in specification shall be signed and stamped by the BIDDER. This requirement is very important. Non compliance of this by the BIDDER may result in their bid being rejected.
 - b) BIDDER is advised to quote for the complete scope and partial response shall not be entertained. In case of few items which do not directly fall under BIDDER's manufacturing range and / or not available from indigenous source, BIDDER should take the responsibility upon themselves to arrange to procure them and supply to ensure that their offer is complete in all respects.

8.2.18 SPARES AND MAINTENANCE TOOLS AND TACKLES

8.2.18.1. GENERAL

- a) All spares and maintenance tools and tackles shall be designed to enable maintenance to be carried out in the least time and at the least cost and support resources without affecting the performance and safety aspects.
- b) All the spares and maintenance tools and tackles supplied shall be new and unused.
- c) The VENDOR/CONTRACTOR shall guarantee that before going out of production of spares and maintenance tools and tackles for the equipment furnished, he shall give at least 12 months advance notice to the EMPLOYER, so that the latter may order his requirement in one lot, if so desired.

8.2.18.2. SPARES

- a) All spares supplied shall be strictly inter-changeable with the parts for which these are intended to be replacements. The spares shall be treated and packed for long term storage under the climatic conditions prevailing at the site e.g., small items shall be packed in sealed transparent plastic bags with desiccator packs as necessary.
- b) Each spare shall be clearly marked or labelled on the outside of its packing with its description and purpose. When more than one spare is packed in a single case, a general description of the contents shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages shall be suitably marked and numbered for the purposes of identification.

8.3. PUBLIC ADDRESS SYSTEM

8.3.1 Scope of Work

- 8.3.1.1. The intent of the specification is to define the functional & design requirements for the PA system meant to broadcast announcements and alarm to people in the facility.
- 8.3.1.2. This specification covers specific requirements of design, preparation of detailed drawings, manufacture, testing at manufacturer's works, inspection at CONTRACTOR's/Sub- CONTRACTOR's works, packing, forwarding, transportation, transit insurance, delivery at site, installation, loading, unloading, testing at site, erection and commissioning of Public Address System (PA system) as per specification and datasheet enclosed.
- 8.3.1.3. Contractor shall supply PA system with paging amplifier/speaker, sound system, call station etc. with necessary add on items required to complete the PA system.
- 8.3.1.4. This document is specifying the minimum criteria for the Design, Supply, Installation and Commissioning & Maintenance of Access Control System. Bidder shall be responsible for detailed engineering based on products proposed. The contractor during detailed engineering shall carry out the acoustic coverage study and the results of the same shall be submitted to Employer's approval. The sound pressure level at ear level shall be 20 dB above ambient noise level. The design calculations along with the loudspeaker model selected and quantities based on the Acoustic Coverage area study for the facility shall be submitted for EMPLOYER's approval.

8.3.1.5. Public Address (PA) system shall be provided at Production and Training Block, Administration Building, Canteen Block and Utility block. Call stations shall be located as follows:

- a) Administration Building – Reception
- b) Training Block – Reception
- c) Production Block - Reception

8.3.1.6. It is not the intent to specify completely herein all details of design and construction of equipment or materials to be supplied or of services to be rendered. However, the equipment, materials and services shall conform in all respects to high standards of engineering design, workmanship and be capable of performing in continuous commercial operation in a manner acceptable to EMPLOYER who shall interpret the meaning of drawings and specifications and shall have the power to reject any work or material which in his judgement are not in full accordance therewith.

8.3.2 System Description

8.3.2.1. The public address system shall be a safety system, being critical with respect to personnel safety and shall be fully operational during emergency situations.

8.3.2.2. This PA system shall consist of speaker loop and control equipment being located in Server Room at Second floor, Administration Building.

8.3.2.3. The system shall be specifically & fundamentally designed as failsafe, with extensive system & fault status monitoring for maximum availability at all times.

8.3.2.4. The system shall be used for one-way communication only.

8.3.3 Zoning

8.3.3.1. The various areas shall be divided into zones and the PA system shall be designed to make zone wise announcements. The zoning shall be flexible and will be designed to meet the geographical layout of the Production and Training Block, Administration Building, Canteen Block and Utility block.

8.3.3.2. Intra Zone Communication

- a. PA system shall have Paging mode which shall be open line, common talking type. Paging mode shall be used for locating a person and for general instructions.
- b. Whenever the “Press to page” push button is pressed on any of the Call station, a pleasant chime shall be broadcast over all the loudspeakers except the one associated with that handset station to attract attention.
- c. Unless requested to be routed through the central exchange, announcements / communication within a zone shall not be audible in other zones.
- d. The Emergency announcements shall be routed through all zones without any selection.

8.3.3.3. The PA system shall have provision for broadcasting a wailing sound (for emergency), steady tone (for testing), and a pleasant musical chime (for calling attention prior to announcement).

8.3.3.4. The Public Address System shall be designed and configured to provide paging, alarm and messaging facility in the various blocks.

8.3.3.5. The PA system shall comprise of:

- a) Loud speakers, junction boxes and cabling.

- b) PA system Network controller.
- c) Call Station
- d) CD player

8.3.4 Loud Speakers:

- a) Indoor loudspeakers shall be located such that all blocks are provided with an adequate level of coverage where alarm tones and emergency announcements are audible.
- b) Indoor loudspeakers shall be acoustic & aesthetic in design.
- c) The Indoor loudspeakers shall also be provided for waiting reception areas, reception areas, common areas and conference halls.
- d) Physically, loudspeakers shall support zones where one or more circuits can be partitioned into a zone. Each loudspeaker shall be connected to the central exchange for amplification and control/monitor functions.
- e) The calls shall be transmitted through loudspeakers installed in the various units and buildings throughout the facility.
- f) Loudspeakers circuits shall be supervised using line monitoring equipment from control room.
- g) The loud speaker shall have 100V line transformer with multiple wattage taps.

8.3.5 Amplifiers:

The main function of the power amplifier is the amplification of audio signals for the loudspeakers

- a) Centralised amplifiers will be provided which eliminates the need for local amplifier at multiple locations in the building and also the power cabling at each location. The system will be also provided with standby amplifier with changeover circuitry to ensure continuous operation at all times.
- b) Amplifiers shall be solid state, class-D type, in built with the handset fully conforming to equivalent international standard. It shall have selectable output voltage.
- c) Amplifiers shall have 0-100% volume control setting. with facility for coarse and fine setting along with following controls which shall be located inside the Handset Station:
 - Input sensitivity control.
 - Receiver volume control.
 - Bass cut filter.
 - Anti-side tone control feature.

8.3.6 Pre-recorded digital tones and messages

- a) The PA system central control unit shall control the generation of individual signalling and alarm tones, followed by pre-recorded speech messages. The system shall be provided with alarm and test tones. Messages and alarm tones shall be fully configurable, with virtually unlimited capacity of expansion.

- b) The PA system central control unit shall have facility for playing background music in the predefined area. Separate speakers with good sound quality shall be provided for the same. The source port shall be provided for playing external music.

8.3.7 Call Stations For PA System :

Call Station shall support facilities for an operator to execute routine or emergency zone wise announcements, and initiate and terminate prioritized alarms. Panels shall provide status information on panel and external operations, and system health. Operator facilities shall be selected from a features list to meet a customer's specific operational requirements.

Call station shall be provided as follows:

- a) The Desktop call station shall be provided in Main Reception Area of Administration Block and Training & Production Block with following features:
- Minimum 12 zone select push button/alarm push button, emergency pushbutton
 - System status LED's
 - weatherproof enclosures
 - Various speech buttons
 - Gooseneck microphone/fist noise cancelling microphone.

Call Station shall have provision for :

- a) Address a call to individual zones (individual calls)
- b) Address a call to multiple zones, by activating the selected groups of zones (group calls)
- c) Transmit a general call activating all zones simultaneously

8.3.8 Microphone Specification

Sr. No.	Description	Requirement
A.	GENERAL	
1.	Make	Bidder to specify
2.	Model No	Bidder to specify
3.	Frequency range	100 Hz to 15 kHz
4.	Sensitivity (mV)	Bidder to specify
5.	Impedance: ≤ 600 Ohm	Bidder to specify
6.	Dimensions	Bidder to specify
7.	Weight	Bidder to specify

Sr. No.	Description	Requirement
8.	Colour	Bidder to specify
9.	On/off switch	Required
10.	Cable length	2 meter minimum
11.	Connector	Lockable
12.	Voltage range & current consumption for condenser type microphone	Bidder to specify
13.	Operating temperature	0° to 50° C
14.	Relative humidity	< 95%
15.	Certificate	CE
16.	Accessories	Bidder shall provide appropriate mounting accessories like microphone holder, extension cable, mounting bracket, table stand, floor stand to suit the site requirement and same shall be submitted to Employer's approval

8.3.9 Loudspeaker Specification

Sr. No.	Description	Requirement
A.	GENERAL	
1.	Make	Bidder to specify
2.	Model No	Bidder to specify
3.	Maximum power (W)	
4.	Rated power/ wattage tapping (W)	
5.	Power tapping/ Rated voltage	100V & 70V
6.	Sound Pressure Level (SPL)	
7.	Frequency Response	
8.	Colour	
9.	Rated impedance	Bidder to specify
10.	Dimensions	Bidder to specify

Sr. No.	Description	Requirement
11.	Weight	Bidder to specify
12.	Colour	Bidder to specify
13.	Material	Aluminium/ ABS
14.	Standards	CE, EN60065
15.	Operating Temperature	0° to 50° C
16.	Related Humidity	<95%
17.	IP rating	IP54
18.	Ex-proof rating	

8.3.10 Desktop Call Station

Sr. No.	Description	Requirement
A.	GENERAL	
1.	Make	Bidder to specify
2.	Model No	Bidder to specify
3.	Microphone	
a)	Frequency Response: 100 Hz to 15 kHz	
b)	Sensitivity (mV)	Bidder to specify
c)	Impedance: <600 Ohm	
d)	Type: Uni-directional Condenser Gooseneck	
e)	Signal to Noise Ratio: >60 dB	
f)	Load	Bidder to specify
4.	Loudspeaker	
a)	Rated power	Bidder to specify
b)	Signal to Noise Ratio: >60dB	
c)	Sound Pressure Level: 85 dB	
d)	Frequency Response: 100 Hz to 15 kHz	
e)	Rated impedance	Bidder to specify

Sr. No.	Description	Requirement
5.	Material	Bidder to specify
6.	Standards: CE, EN60065	
7.	Operating Temperature : 0° to 50° C	
8.	Related Humidity: <95%	
9.	Input voltage	Bidder to specify
10.	Load (W)	Bidder to specify
11.	Multi colour multi status LED: Required (for indication of active zones, emergency messages, power ON, error signals)	
12.	Attachment for add-on keypads : Required (No. of keypads shall be decided as per requirement considering no. of zones and multiprogramming key requirement)	
13.	Key station/ keypad: Required (keys shall be used for assigning zones and for multipurpose use)	
14.	Dimensions	Bidder to specify
15.	Weight	Bidder to specify
16.	Colour	Bidder to specify
17.	Mounting: Desk mountable type	
18.	Mute button: Required (for inbuilt loudspeaker)	
19.	3.5mm jack for headphone & microphone: Required	

8.3.11 EQUIPMENT & SERVICES TO BE PROVIDED BY THE CONTRACTOR

8.3.11.1. Cabling

- a) The complete cabling for PA system shall be in the scope of CONTRACTOR.
- b) Contractor shall supply & lay the following cables along with all the installation hardware and accessories:
 - PA system cabling(Cabling from loud speakers to central exchange amplifiers)
- c) The complete insulation hardware, cable trays & Conduits, structured steel for erection work shall be in scope of CONTRACTOR.

8.3.11.2. Earthing

- a) Separate electrical & instrumentation earth pits shall be provided by others. Earthing for the entire system shall be provided by the Contractor. This earth pit shall be interconnected with electrical earth pit. Contractor shall connect the safety ground bus & system ground bus for the systems supplied by him to the respective earth pits.
- b) Single point earthing configuration shall be followed for the cable shields i.e. all signal and control cables shields shall be grounded at one end only to avoid ground loop.

8.3.11.3. Interfacing with third party devices

The PA system shall be interfaced with Fire alarm system:

Informing the occupants in case of any fire situation and giving directions for safe evacuation. Pre recorded messages shall be automatically transmitted on programmed events.

8.3.12 SPECIFIC REQUIREMENTS / INSTRUCTION TO BIDDERS

- 8.3.12.1. This is a Unit rate contract. The price/ contract value shall be arrived at based on quantities indicated in Bill of Quantity and unit rates for supply & erection quoted by the Bidder. The break-up of unit prices for various items in Bill of Quantity shall be used for future addition/deletion of the items, if any.
- 8.3.12.2. Contractor shall estimate Cable quantities based on enclosed GA drawings & layouts for bidding purpose only. However the Contractor is advised to visit Site & take actual measurements for arriving at the cable quantities actually required at Site before placement of Order.
- 8.3.12.3. The construction of this facility requires that, all CONTRACTOR'S adhere to good daily housekeeping practices. During construction the CONTRACTOR shall every day, keep all work and storage areas used by them free from accumulation of waste materials. Scrap / rubbish shall be removed from the site to the satisfaction of the EMPLOYER. The CONTRACTOR shall maintain a crew to carry out this function without any additional payment.
- 8.3.12.4. The equipment to be supplied and erected under this specification shall be in accordance with specification & data sheets.
- 8.3.12.5. Any item which may not have been specifically mentioned herein but are needed to complete the equipment / system shall also be treated as included and the same shall also be supplied and erected at no extra cost, unless otherwise specifically excluded as indicated.
- 8.3.12.6. The BIDDER shall comply with all systems / parameters wherever they are specified in data sheets. No credit will be given during tender evaluation, if parameters better than those specified are offered by the BIDDER.
- 8.3.12.7. Deviation from the specifications, if acceptable to the EMPLOYER in so far as practicable shall be converted to rupee value and added to the bid price to compensate for the deviation from the specification. In determining the rupee value of the deviations, the EMPLOYER shall use the parameters consistent with that specific in the documents and specifications and other information as necessary and available to the EMPLOYER.
- 8.3.12.8. Bidder's Offer

- a) To enable thorough and fast scrutiny of the BIDDER's offer, BIDDERS are advised to respond all their technical data in the enquiry by clearly marking out their response, wherever they want to provide additional data and / or they deviate from the specified requirements. In case of full compliance, the enquiry specification and data sheets shall remain unaltered. Each data sheet & write up in specification shall be signed and stamped by the BIDDER. This requirement is very important. Non compliance of this by the BIDDER may result in their bid being rejected.
- b) BIDDER is advised to quote for the complete scope and partial response shall not be entertained. In case of few items which do not directly fall under BIDDER's manufacturing range and / or not available from indigenous source, BIDDER should take the responsibility upon themselves to arrange to procure them and supply to ensure that their offer is complete in all respects.

8.3.13 SPARES AND MAINTENANCE TOOLS AND TACKLES

8.3.13.1. GENERAL

- a) All spares and maintenance tools and tackles shall be designed to enable maintenance to be carried out in the least time and at the least cost and support resources without affecting the performance and safety aspects.
- b) All the spares and maintenance tools and tackles supplied shall be new and unused.
- c) The VENDOR/CONTRACTOR shall guarantee that before going out of production of spares and maintenance tools and tackles for the equipment furnished, he shall give at least 12 months advance notice to the EMPLOYER, so that the latter may order his requirement in one lot, if so desired.

8.3.13.2. SPARES

- a) All spares supplied shall be strictly inter-changeable with the parts for which these are intended to be replacements. The spares shall be treated and packed for long term storage under the climatic conditions prevailing at the site e.g., small items shall be packed in sealed transparent plastic bags with desiccator packs as necessary.
- b) Each spare shall be clearly marked or labelled on the outside of its packing with its description and purpose. When more than one spare is packed in a single case, a general description of the contents shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages shall be suitably marked and numbered for the purposes of identification.

8.4. CLOSED CIRCUIT TELEVISION SYSTEMS

8.4.1 Scope of Work

- 8.4.1.1. This specification covers specific requirements of design, preparation of detailed drawings, manufacture, testing at manufacturer's works, inspection at Vendor's/Sub-Vendor's works, packing, forwarding, transportation, loading, unloading, transit

insurance, delivery at site, installation, testing at site and commissioning of CCTV System.

- 8.4.1.2. This Specification and its associated Data Sheets covers the minimum technical requirements for the design, manufacture, supply, testing, installation and commissioning of Close Circuit Television System (CCTV) Equipment, which shall be supplied under this Contract.
- 8.4.1.3. Analog Type Close Circuit Television System (CCTV) is proposed for following locations.
- a) Productions and Training Block, Administration Building, Canteen Block, Executive Hostel, Girls Hostel, Boys Hostel, Staff Accommodation Building and Utility Block entrance will be provided with Outdoor type dome camera varifocal lens weather proof
 - b) Interior area of Productions and Training Block, Administration Building, Canteen Block, Executive Hostel, Girls Hostel, Boys Hostel, Staff Accommodation Building and Utility Block (Indoor type camera varifocal lens)
 - c) Outdoor area (Outdoor type camera weather proof)
 - d) Server/IT room, Fire command centre room (Indoor type dome camera varifocal lens)
- 8.4.1.4. It is not the intent to specify completely herein all details of design and construction of equipment or materials to be supplied or of services to be rendered. However, the equipment, materials and services shall conform in all respects to high standards of engineering design, workmanship and be capable of performing in continuous commercial operation in a manner acceptable to EMPLOYER who will interpret the meaning of drawings and specifications and shall have the power to reject any work or material which in his judgement are not in full accordance therewith.

8.4.2 SYSTEM DESCRIPTION

- 8.4.2.1. The provision of a CCTV system at the Technology centre, Bhiwadi is required for operation and security purposes.
- 8.4.2.2. Indoor cameras suitable for both day and night coverage shall be strategically positioned to monitor activities within buildings.
- 8.4.2.3. CCTV Surveillance shall be made available from Fire command centre at Ground Floor, Admin Building.
- 8.4.2.4. The communication between the CCTV equipment located at two different buildings shall be done using coaxial cable between camera and DVR.
- 8.4.2.5. Analog cameras with mounting adapter, Ceiling / wall mount, enclosure and all other accessories shall be provided at various location of Productions and Training Block, Administration Building, Canteen Block, Executive Hostel, Girls Hostel, Boys Hostel, Staff Accommodation Building and Utility Block. Please refer CCTV System Layout of each block and external services for location of CCTV.
- 8.4.2.6. The design of the CCTV system shall be modular, such that faults and damage experienced in one module does not render the entire system non-functional.
- 8.4.2.7. Indoor equipment shall be with a degree of protection of IP 20, while outdoor equipment shall be with a degree of protection of IP 65.

- 8.4.2.8. It shall be possible to place a camera almost anywhere. There shall be no limitations tied to physical inputs or frame grabbers.
- 8.4.2.9. Memory to maintain a record of one month (30 Days) minimum, unless local laws require a longer storage time. By storing the images on hard disks, it shall be possible to erase any old unwanted images automatically.
- 8.4.2.10. The Contractor shall guarantee satisfactory performance of the equipment under stipulated variations of voltage and frequency. The design and manufacture shall be such that equipment/components of same type and rating shall be interchangeable.
- 8.4.2.11. The Contractor shall submit the following data / drawings after award of contract:
- Detailed block schematic / configuration drawing.
 - Power wiring diagram
 - Layout drawing indicating exact location of cameras
 - Cable routing drawings
- 8.4.2.12. All systems and designs must be flexible enough to accommodate changes in size, operation, configuration, and technology updates that may become necessary due to future expansions and requirements

8.4.3 SPECIFICATIONS

8.4.3.1. CCTV Camera Specification

Sr. No.	Description	Requirement
A.	GENERAL	
1.	Make	Bidder to specify
2.	Model No	Bidder to specify
3.	Camera details	Colour - Day/ Night camera
4.	Image sensor	1/3" CCD <input type="checkbox"/> 1/3" CMOS <input checked="" type="checkbox"/>
5.	Lens type	Fixed lens <input checked="" type="checkbox"/> Varifocal lens <input checked="" type="checkbox"/> IR corrected lens <input checked="" type="checkbox"/> Motorized zoom lens <input type="checkbox"/>
6.	Lens format	Minimum 1/3", shall be compatible with image sensor
7.	IR cut filter <input checked="" type="checkbox"/> or	Required

Sr. No.	Description	Requirement
	IR corrected lens <input type="checkbox"/>	
8.	IRIS	Automatic
9.	F-STOP Range	F/1.4 to F/16
10.	Sensitivity for usable video	Minimum 0.1 Lux @(F1.2,AGC ON), 0 Lux with IR
11.	Resolution	WD1 (960×480)
12.	Automatic shutter	Required
13.	Backlight compensation	Required
14.	Wide dynamic range (WDR)	Required
15.	Signal to noise ratio (SNR)	> 50dB (minimum)
16.	Auto contrast adjustment	Required
17.	Horizontal & vertical angle of view	70° Horizontal Minimum
18.	White balance	Required
19.	Video compression H.264 <input checked="" type="checkbox"/> Motion JPEG <input type="checkbox"/>	Bidder to specify
20.	Video data rate range	Bidder to specify
21.	Frames per second for viewing	25 FPS
22.	Frames per second for recording	15 FPS Minimum
23.	Automatic gain control (AGC) 20 dB Minimum	Bidder to specify
24.	Power supply	UPS Power
25.	Housing	Box camera housing for indoor and outdoor use shall be vandal proof, rugged, durable, industrial grade, M.O.C is cast aluminium, with in-built heater /blower & sunshield.

Sr. No.	Description	Requirement
26.	IP Rating for indoor camera	IP52
27.	IP Rating for outdoor camera	IP66
28.	Operating temperature	-10 ⁰ C to 60 ⁰ C For Outdoor camera -10 ⁰ C to 50 ⁰ C For Indoor camera
29.	Operating humidity	95 RH
30.	Mounting accessories	All necessary accessories are required
31.	Tampering alarm	Required (tampering such as dis-focus/ move viewing direction/ masking)
32.	Spares	10% or 1 no. (whichever is higher) shall be provided for each type of camera
33.	Standards UL, CE	Required

8.4.3.2. CCTV MONITOR SPECIFICATION

Sr. No.	Description	Requirement
A.	GENERAL	
1.	Make	Bidder to specify
2.	Model No	Bidder to specify
3.	Display size	32"
4.	Resolution	1920 X 1080
5.	Dynamic contrast ratio	Required
6.	Wide colour enhancer	Required
7.	Aspect ratio	16:9
8.	Audio	Not required
9.	Connectivity: VGA HDMI : 2 ports (Minimum)	Required
10.	Mounting	Wall <input checked="" type="checkbox"/>

Sr. No.	Description	Requirement
		Desk <input type="checkbox"/>
11.	Power supply	110 V AC <input type="checkbox"/> 230 V AC <input checked="" type="checkbox"/>
12.	Power consumption	Bidder to specify
13.	Dimensions : (W x H x D)	Bidder to specify
14.	Weight	Bidder to specify
15.	Accessories	As required for proper operation

8.4.3.3. DVR (Digital Video Recorder) SPECIFICATION

Sr. No.	Description	Requirement
A.	GENERAL	
1.	Make	Bidder to specify
2.	Model No	Bidder to specify
B.	Video Input	
1.	Video Compression	H.264
2.	Video Input	4 Channel <input type="checkbox"/> 8 Channel <input type="checkbox"/> 16 Channel <input checked="" type="checkbox"/>
C.	Video Output	
1.	HDMI/VGA Output	1920 X 1080
2.	Encoding Resolution	WD1
3.	Frame Rate	25 FPS or better
D.	Hard Disk	
1.	SATA	2 SATA Interface
2.	Capacity	Minimum 30 Days
E.	External Interface	
1.	Network Interface	RJ45

Sr. No.	Description	Requirement
2.	Serial Interface	RS-485
3.	USB Interface	USB 2.0
F.	Power	
1.	Power Supply	12 VDC
2.	Consumption	20 W
G.	Mechanical Properties	
1.	Dimensions	Bidder to Specify
2.	Weight	Bidder to Specify
H.	Environmental Properties	
1.	Temperature	-10 ⁰ C to 50 ⁰ C
2.	Humidity	95 RH

8.4.4 RECORDING SYSTEM FEATURES

8.4.4.1. The recording system shall be based on DVR (Digital Video Recorder) technology and must support the following features:

- a) Event based recording
- b) Alarm activated recording
- c) Customizable alarm specific recording
- d) Continuous (24 X 7) recording

8.4.4.2. There shall be a facility for regular back-up of the recorded data. Back-up facility shall be deployed automatically when the recorder has reached particular data size or other operator set parameters like date / time etc. The system shall also be provided with a DVD burn /DAT recording facility for backing up particular incident data from the processor.

8.4.4.3. The replay mode shall be password protected and should not interrupt the ongoing recording of video and data.

8.4.5 SCHEDULE FOR SUBMISSION OF DATA AND DRAWINGS BY CONTRACTOR (DATA TO BE FURNISHED AFTER THE AWARD OF CONTRACT)

The CONTRACTOR shall submit the following drawings / documents after award of contract for review & approval by Department. CONTRACTOR shall adhere to the delivery schedule as submitted alongwith the BID. CONTRACTOR shall also

refer to data sheets for list of deliverables to be submitted for various instruments/ panels.

<u>Sr. No.</u>	Details
(a)	Bar chart for the design, manufacturing, erection, commissioning, trial operation and performance testing of the system offered.
(b)	Overall System Configuration Diagram indicating all components including networking.
(c)	Unpriced purchase order copy for various bought out /sub contracted equipment / services.
(d)	Following drawings for panels:
	<ul style="list-style-type: none"> • Front facia layout showing all instruments with cut-outs, bezel dimensions, construction details, foundation details and interior G.A. drawings showing interior layout of various modules, instruments etc.
	<ul style="list-style-type: none"> • Internal wiring diagrams indicating termination details of each component.
	<ul style="list-style-type: none"> • Bill of Material (B.O.M.) indicating tag no., quantity, service & model no. of the various modules/instruments/items.
(e)	Make, Model No., Catalogues, data sheets for each item/ sub-item of CCTV System.
(f)	CCTV Configuration and Layout drawings.
(g)	Data Sheets & catalogues for I&C cables & power cables.
(i)	Earthing diagrams
(j)	Cable Schedules and Interconnection cable schedules.
(k)	Load calculations for each system
(l)	QAPs for all instruments & panels for each system, I&C cables, power cables & fibre optic cables.
(m)	Standard SAT for the specified systems
(n)	'As Built' drawings
(o)	Instruction manual for installation and start-up (for each system)
(p)	System operation and maintenance manual

8.4.6 TRAINING

1 No. Contractor's engineer shall be made available for 2 weeks for assistance in operation, maintenance, tuning & training of Employer's personnel at Site after commissioning of each system. The rates of the engineer shall be indicated Schedule of personnel for supervision of erection, start-up, commissioning and performance.

Training shall be required on both hardware & application software development.

8.4.7 TESTING, INSTALLATION, COMMISSIONING AND ACCEPTANCE

8.4.7.1. General

On the basis of guidelines specified in this specification Bidder shall submit their own testing, installation, commissioning and acceptance procedure. The procedure shall include purpose of test, test definition, results expected and acceptance criteria. For software it shall include details of the method, list of tests, sequence of execution, results expected and acceptance criteria.

8.4.7.2. Site Acceptance Tests (SAT)

Full integrated site acceptance test shall be performed before hand over of total system to the EMPLOYER. The test shall demonstrate functionality of the entire system supplied & erected by the Contractor. The Contractor shall provide all personnel, test facilities, equipment and tools etc. for the same. All test instruments shall have calibration certificates from approved test house, valid for minimum 6 months. A test procedure is required for approval 2 weeks prior to the schedule start.

8.4.7.3. Testing Requirements

Tests on cables

- Check details are in accordance with the specification.
- Check for physical damage.
- Megger test between each core and armour/sheath (For electrical cables)
- Continuity check including screen continuity (For electrical cables)
- Terminations of the cables at both ends.

8.4.7.4. It shall be ensured that erection of all panels is as per approved layout drawings. Checking for tagging/identifications of all the panels shall be done. Checks for continuity and termination of all power, signal, control and fibre optic cables shall be carried out as per approved drawings. All the panels supplied & erected by the Contractor shall be checked at site by carrying out the following tests:

- Visual & Mechanical testing.
- Power up tests
- Checks on incoming voltage and power distribution
- Checking of incoming power supply to the panels supplied & erected by the Contractor.
- Switching on the incoming supply to panels by switching on MCCBs/MCBs one after the other.
- Power 'ON' PCs for CCTV System.
- Demonstration of all system functions of CCTV System.
- Checking of all HMI screens, alarms etc.
- Integrated testing of the IBMS and CCTV System.
- Checking of proper functioning of all Printers with printouts of alarm lists, reports, important alarms etc.

8.4.7.5. The Contractor shall co-ordinate with other Contractors for the other systems and integration with IBMS system.

8.4.7.6. Tests on electrical installation

- Checking of closing, tripping, supervision and interlocking of control devices.
- Checking operation of all alarm circuits.

8.4.7.7. Test on complete control system.

- On completion, the functioning of all systems shall be tested to demonstrate its correct operation in accordance with the Specification.
- For testing, the Contractor may provide temporary means to simulate operating conditions, but the system will not be finally accepted until correct operation has been demonstrated to the satisfaction of the Employer.

8.4.7.8. Commissioning

- Commissioning Procedure shall be carried out in a methodical sequence as follows
 - Start-up,
 - Initial running,
 - Operability adjustment,
 - Stable operation
 - Final adjustment
- The Contractor shall check the operating conditions by constantly monitoring operating data.
- The Contractor shall specify for each discrete part of the system for which the operational data has to be recorded and the manner in which the data is to be taken. All the operating data shall be recorded, evaluated and submitted to the Employer.

8.4.8 SPECIFIC REQUIREMENTS / INSTRUCTION TO BIDDERS

- 8.4.8.1. This is a Unit rate contract. The price/ contract value shall be arrived at based on quantities indicated in Bill of Quantity and unit rates for supply & erection quoted by the Bidder. The break-up of unit prices for various items in Bill of Quantity shall be used for future addition/deletion of the items, if any.
- 8.4.8.2. Contractor shall estimate Cable quantities based on enclosed GA drawings & layouts for bidding purpose only. However the Contractor is advised to visit Site & take actual measurements for arriving at the cable quantities actually required at Site before placement of Order.
- 8.4.8.3. The construction of this facility requires that, all CONTRACTOR'S adhere to good daily housekeeping practices. During construction the CONTRACTOR shall every day, keep all work and storage areas used by them free from accumulation of waste materials. Scrap / rubbish shall be removed from the site to the satisfaction of the EMPLOYER. The CONTRACTOR shall maintain a crew to carry out this function without any additional payment.
- 8.4.8.4. The equipment to be supplied and erected under this specification shall be in accordance with specification & data sheets.
- 8.4.8.5. Any item which may not have been specifically mentioned herein but are needed to complete the equipment / system shall also be treated as included and the same shall also be supplied and erected at no extra cost, unless otherwise specifically excluded as indicated.

- 8.4.8.6. The BIDDER shall comply with all systems / parameters wherever they are specified in data sheets. No credit will be given during tender evaluation, if parameters better than those specified are offered by the BIDDER.
- 8.4.8.7. Deviation from the specifications, if acceptable to the EMPLOYER in so far as practicable shall be converted to rupee value and added to the bid price to compensate for the deviation from the specification. In determining the rupee value of the deviations, the EMPLOYER shall use the parameters consistent with that specific in the documents and specifications and other information as necessary and available to the EMPLOYER.
- 8.4.8.8. Bidder's Offer
- a) To enable thorough and fast scrutiny of the BIDDER's offer, BIDDERS are advised to respond all their technical data in the enquiry by clearly marking out their response, wherever they want to provide additional data and / or they deviate from the specified requirements. In case of full compliance, the enquiry specification and data sheets shall remain unaltered. Each data sheet & write up in specification shall be signed and stamped by the BIDDER. This requirement is very important. Non compliance of this by the BIDDER may result in their bid being rejected.
 - b) BIDDER is advised to quote for the complete scope and partial response shall not be entertained. In case of few items which do not directly fall under BIDDER's manufacturing range and / or not available from indigenous source, BIDDER should take the responsibility upon themselves to arrange to procure them and supply to ensure that their offer is complete in all respects.

8.4.9 SPARES AND MAINTENANCE TOOLS AND TACKLES

8.4.9.1. GENERAL

- a) All spares and maintenance tools and tackles shall be designed to enable maintenance to be carried out in the least time and at the least cost and support resources without affecting the performance and safety aspects.
 - b) All the spares and maintenance tools and tackles supplied shall be new and unused.
- 8.4.9.2. The VENDOR/CONTRACTOR shall guarantee that before going out of production of spares and maintenance tools and tackles for the equipment furnished, he shall give at least 12 months advance notice to the EMPLOYER, so that the latter may order his requirement in one lot, if so desired.
- a) All spares supplied shall be strictly inter-changeable with the parts for which these are intended to be replacements. The spares shall be treated and packed for long term storage under the climatic conditions prevailing at the site e.g., small items shall be packed in sealed transparent plastic bags with desiccator packs as necessary.
 - b) Each spare shall be clearly marked or labelled on the outside of its packing with its description and purpose. When more than one spare is packed in a single case, a general description of the contents shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages shall be suitably marked and numbered for the purposes of identification.

8.5. ACCESS CONTROL SYSTEMS

8.5.1 Scope of Work

- 8.5.1.1. The scope of work shall include the design, supply, installation, commissioning, integrating, guaranteeing and maintenance of an integrated access control system. Scope shall also include laying of cabling, necessary for installation of the system as indicated in the specification and Bill of Quantities. Any openings/chasing in the wall/ceiling required for the installation shall be made good in appropriate manner.
- 8.5.1.2. Access control system shall be provided at Administration Building and Training & Production Building.
- 8.5.1.3. Attendance monitoring facility shall be provided at Entrance of Administration Building and Training & Production Building. The system shall be interfaced with Finance software for recording in/out time of employee and generate salaries accordingly.
- 8.5.1.4. Access control system shall be integrated with Fire alarm system. In case of fire occurrence, all door access shall be disabled for uninterrupted and fast evacuation of occupants.
- 8.5.1.5. This document is specifying the minimum criteria for the Design, Supply, Installation and Commissioning & Maintenance of Access Control System. Bidder shall be responsible for detailed engineering based on products proposed.

8.5.2 System Description

- 8.5.2.1. Access control system (ACS) shall be provided for the Training & Production Block and Administration Block and will be a part of the Integrated Building Management System. Integrated Building Management System (IBMS) mainly integrates the data / information from various sub systems and facilitates smooth, effective and efficient administration of day-to-day activities. It also stores the information obtained from various systems and compiles them to generate the reports for management information in a required format. It also facilitates in regulating safety and security of specified area of Training & Production Block and Administration Block.
- 8.5.2.2. A stand alone ACS shall be provided for the Training & Production Block and Administration Block. The ACS shall comprise of
 - a. Smart Cards
 - b. Smart Card readers
 - c. Controller
 - d. Electro Magnetic locks
 - e. Exit push buttons
 - f. Central server PC and printer.
- 8.5.2.3. The ACS server shall be located in the Server Room at 2nd Floor, Administration block. Reports like time-in, time-out, attendance etc. shall be generated and stored in the system. The ACS shall be provided with complete required software and hardware.

- 8.5.2.4. All doors shall be either wooden / aluminium. In case of glass doors, a U-clap and L-Bracket shall be provided around the door. Maximum thickness in either case will be 2". Doors will open only in one direction and will be equipped with automatic door closer of suitable size (depending on the type of door). Doors will be single leafed. If they are double leafed then one leaf of the door will be permanently bolted and entry for access control purposes will be necessarily through the other leaf.
- 8.5.2.5. Magna locks will be installed on the door frame at the top and will give a feedback on the door position also.
- 8.5.2.6. Exit push button will be installed just beside the door on a wooden boxing.
- 8.5.2.7. Controller for Access Control System shall be mounted on each block of each floor in the Electrical room. The controller shall be a compact panel mounted, stand-alone type of access controller with provision for controlling the doors. The Controller shall allow the opening and closing of the door with the event of authorised read for an adjustable time.

8.5.3 Access Control System Hardware Specification:

8.5.3.1. Operator Workstation – Man Machine Interface (MMI)

The function of the MMI is to provide a user friendly operator interface (GUI) and to provide data archiving facilities. For system reliability, the MMI shall not be required to perform any of the data processing for the regular functioning of the Access Control System.

8.5.3.2. Operator Interface

The entire database of the central access controller shall be definable at the operator workstation.

8.5.3.3. Operator Commands

The operator interface shall allow the operator to perform commands including, but not limited to the following

- Operator Log and Access Privileges
- Override all doors to Access Mode of Operation
- Release Overrides
- Command Door to Access Mode
- Command Door to Secure Mode
- Command Door to Temporarily open
- Silence Local Alarms
- Manage Personnel Access Levels & Time Zones
- Control Remote Processors
- System operators shall, from the operator interface, be able to manually unlock controlled doors for a variable time period, or program an event to automatically unlock and lock doors during a particular time period.

8.5.3.4. Logs & Summaries

Reports shall be generated and directed to MMI, printers or disk files. At minimum, the system shall allow the user to easily obtain the following:

- List of all cardholders

- List of all transactions currently available (Audit Trail)

8.5.3.5. Access Controllers

- a. The Access Control System Controller shall be configurable, distributed processing access control panel that communicates with a host computer and dedicated peripheral devices to perform access control functionality. It monitors a wide variety of access control input devices such as readers, door contacts, request to exit switches, etc. and controls output devices such as door locks and alarms.
- b. Built-in programming shall allow the system controller to maintain its operation in the event of loss of communications with the host computer. The system shall be modular in structure for ease of installation, maintenance and future expansion.
- c. The System shall be configured by selection of plug-in modules that offer these advantages:
 - Plug-in reader and I/O modules shall be used to configure each panel on an individual basis to satisfy the requirements for that area. Facility expansion shall be possible by adding modules to an existing panel or by adding more panels. Technicians shall troubleshoot and replace plug-in modules without disrupting the entire system. Pluggable terminal blocks shall allow modular removal without disturbing wiring connections
 - All access controller panels shall be housed in a cabinet designed for mounting directly to a wall or vertical surface. Its door shall contain a key lock. To eliminate the possibilities of compromises, due to the accessibility of the electronics, the access controller should contain a tamper switch to protect against unauthorised enclosure access. The field controller shall provide, or be capable of expansion to, the following capacities:

i. Card Readers	Minimum 8
ii. Card Capacity	500 (minimum)
iii. Alarm Points	8
iv. Access Levels	256
v. Time Zones	256
vi. Password Levels	25
vii. Card Transaction	4000 with lithium battery (Buffer) for storage and battery back up
viii. Real Time Clock	Yes
ix. Battery Back Up	Yes
x. The system shall be capable of storing 4000 transactions per access controller	
- d. The access controller shall communicate with the Reader. When a card is read at a reader, the card number and issue level are sent to the controller. The controller shall be programmed to process this data and after comparing it with the card data base resident in the access controller, shall grant access to the card holder. If access is granted, the controller shall send a signal to the

appropriate electronic lock to activate the door. If access is denied, the transactions will be recorded in the controller and an alarm is raised identifying time date, Controller name & card name at HMI.

- e. The system shall be flexible to designate certain readers to control entry or exit, and shall require a card holder using a card at any entry reader to subsequently use it at any exit reader before again entering the secured area. This shall prevent “passing back” a card to an un-authorised second user. Individual cards may be programmed for special privileges to override access level and time zone parameters. In event of a power loss, a battery backup shall be provided full controller operation for up to 8 hours. Cards shall be programmed into system / controller individually.
- f. The access controller shall provide a buffer to store 4000 historical transactions if communication is lost with the MMI.

8.5.3.6. Reader Interface Modules (RIM)

- a. The Smart type Card Readers shall be attached to the RIM. The RIM shall control the electric lock, visual access indicators, access and shunt timers. The RIM shall monitor door status via a door contact sensor and lock status via a lock contact. An alarm shall be reported when the door is not closed or when the door is forced open. An alarm shall be reported when the lock is not closed properly. Readers shall be flush mounted.
- b. In case RIM is not provided a multipair cable shall be laid from the Door lock, Card reader's up to the Controller in the Control room.

8.5.3.7. Smart Cards & Card readers

- a. The cards for this access control system shall be of top quality, highly durable and resilient material designed for use with Smart card readers. Each card shall be encoded with a digit unique to the access system, and individual card number. Supply of suitable programming device and printing units for the cards shall be included in the scope of bidder, so that no external agencies shall be involved after getting the basic equipment for ACS except the dummy cards. The manufacturer shall have the capability to provide custom printed dummy cards, in accordance to the manufacturer's guidelines, to meet the needs specified by the system Employer.
- b. Cards shall be size of a credit card and have the feature to laminate a photo or other identifying information on it. The cards should be ISO thickness capable of being printed directly. The access cards must have the ability to print the card holder's video image directly on the cards surface. The card is simply presented within 100 mm of the reader. The reader as a minimum must have LED indication upon presentation of the Access card.

8.5.3.8. Basic Access Control Software Features:

The basic access control software features shall be as follows:

- a. User database
- b. Database system settings & partitioning
- c. Control access to areas via text
- d. Timed control access
- e. Backup and archive

- f. Password protection and operator level privileges
- g. Data import / export
- h. Anti Pass back – Soft or Hard
- i. Personnel movement tracking
- j. Display of alarm & sensor status
- k. Context sensitive help screens
- l. Audit Trail archiving & retrieval
- m. Custom reports such as attendance statement with first in and last out timings, weekly/quarterly/monthly/summaries based on employees' code/plant/area/gate/ time or any other parameter that is tagged in to the database.
- n. Networkable either via a LAN, WAN or leased line

8.5.3.9. Electro Magnetic Lock

600lbs / magnetic lock, Single / Double EM locks should be designed to meet fire/life safety applications by providing an auxiliary locking mechanism that has no moving parts to bind or wear out for trouble free operation. This should ensure inhibited release at all times where they have become extremely prevalent in applications other than fire/life safety. Suitable for access controlled & secure areas within buildings with Single / double leaf doors. The Magnetic Lock should consist of Magnet mounted frame onto door frame and a steel plate attached to the top of the door. This will be strongly bonded when magnet get energized and holding the steel plate. Instant release should be possible when power supply is cut-off, in an emergency situation.

- Holding Force – 600 lbs / magnet
- Operating Voltage – 12V / 24V Selectable
- Current Draw – 300-500 mA
- Operating Temperature - -10 to 55 Deg C

8.5.3.10. Exit Push Button

Exit Push Button with Includes break glass switch assembly use to egress swinging or sliding doors that are electrically or electronically locked. In perimeter protection systems that involve the central control of electric locking devices, an on-site emergency release may be required. The “break glass” concept may be preferred over the pull station, because it is less vulnerable to misuse or tamper actuation. It shall be Surface mount in a standard 3-gang enclosure. It shall be Compatible with all Fail Safe type electronic locking systems. It shall be Models with LED or audible alarm. Also clearly marked signage indicating purpose of the release.

8.5.4 Power Supply

- 8.5.4.1. Feeders (1 no.) of 230 V AC, UPS power shall be made available in the UPS Room for the Access Control System. UPS will be located in the Electrical room as shown in the Location layout drawing. Contractor shall lay cables from UPS to each of the system panels.

8.5.5 Power Cables

- 8.5.5.1. The specifications for power cables shall be as below:

- Conductor Material : Stranded Copper

- Insulation Material : Cables shall be PVC insulated as per application.
- Voltage Grade : 1100 V
- Armouring : All power cables will be GI wire armoured.
- Sheathing Material : Inner & Outer sheaths shall be FRLS PVC

8.5.6 I&C Cables

8.5.6.1. All multipair & multicore cables shall be provided with 20% (of used pairs/cores) spare pairs & cores for future use. Cables for Ethernet connectivity shall be CAT 6 cables which shall be armoured. Cables for RS-485 connection shall be twisted pair cables, shielded & armoured.

8.5.6.2. Cable Glands

All cable glands shall be of double compression type with high quality neoprene gaskets. Cable glands shall be of brass with nickel plating.

8.5.6.3. Cable trays

Cable trays shall be perforated of hot dipped galvanized steel. Cable trays shall have 50 mm collar height. The cable trays shall be covered type.

The cables coming in the beam area shall be allowed to pass through conduits.

The cables laid between two different buildings shall be laid in conduits in cable trenches.

I&C Cables and power cables shall be routed through different cable trays to avoid Electromagnetic Interference.

Minimum 300 mm distance shall be maintained between I&C cables / 24 V DC power supply cables and 415 V AC/ 230 V AC power cables.

All cable trays shall be provided with 20% spare space for future use.

8.5.6.4. Fire proof Sealing for Cable penetration

Cables/ cable tray openings in walls and floors or through pipe sleeves from one area to another or one elevation to another shall be sealed by a fireproof sealing compound. The fire-proof sealing compound shall effectively prevent the spread of fire from the flaming to non-flaming side, in the event of fire.

8.5.6.5. The specifications of cables shall be as mentioned below.

		Description	Power Cable	Control cable	Signal cable	Triad Cable
GENERAL	1.	Type	Armoured	Screened, armoured	Twisted, screened, armoured	
	2.	Voltage grade	1100 V	1100 V	660 V	
CONDUCTOR	3.	Material	Annealed Tinned Copper			
	4.	Shape of conductor	Stranded circular			
	5.	Size				
	6.	No. of strands	7 nos.			
PRIMARY INSULATION	7.	Material	Extruded Polyethylene (PE) as per BS-EN 50290-2			
	8.	Thickness of insulation (Nominal)	0.8 mm			
	9.	Colour code		Grey	White +ve, Black -ve	Brown, Black and

						(For each pair)		blue		
INDIVIDUAL PAIRS / TRIADS	10	Twist		NA	NA		Min. 10 nos. twist / meter for each pair			
	11	Identification		NA	NA		Numbers at not more than 250mm length			
INDIVIDUAL PAIR / TRIAD SCREENING	12	Material		NA	NA		AL Mylar tape applied helically with metallic side down in contact with drain wire			
	13	Tape thickness		NA	NA		Minimum 0.075 mm thick for single pair cables Minimum 0.05 mm thick for multipair cables			
	14	Overlap	NA		NA		Min .25 %	100%	Min .25 %	100%
	15	Polyester tape		NA	NA		Polyester tape of 0.05 mm thick each. two tapes with min. 25% overlap & 100% coverage			
	16	Drain wire								
	17	Material		NA	NA		Annealed Tinned Copper			
	18	Size		NA	NA		0.5mm ² , with 7 strands, each of 0.3 mm dia.			
OVERALL SCREENING	19	Material		NA	AL Mylar tape applied helically with metallic side down in contact with drain wire					
	20	Tape thickness		NA	Minimum 0.075 mm					
	21	Overlap	Coverage	NA	Min .25 %	100%	Min. 25%	100%	Min .25 %	100%
	22	Drain wire		NA						
	23	Material		NA	Annealed Tinned Copper					
	24	Size		NA	1 mm ² , with 7 strands, each of 0.3 mm dia.					
BINDER TAPE	25	Type		Non-Hygroscopic, two tapes with min. overlap of 25% & 100% coverage						
	26	Tape Thickness		Each tape of min. 0.023 mm thick						
INNER SHEATH	27	Material		Extruded flame retardant PVC type ST-2, 90°C as per IS-5831 , oxygen index over 30% and temp. index over 250 deg C.						
	28	Thickness (Nominal)		As per BS-EN 50288 part 7 (Note-2)						
	29	Colour		Black						
	30	Diameter over inner sheath		Bidder to Specify Note:- Cable dimensions (OD under armour, OD over armour, overall OD) shall be as per BS-EN-50288-7.						

			Maximum tolerance in dimensions shall be +/- 2 mm.		
	31	Rip Chord	Non-metallic required under inner sheath		
ARMOURING	32	Material	Galvanised steel		
	33	Size	As per BS-EN 50288		
	34	Diameter over armour	Bidder to Specify Note:- Cable dimensions (OD under armour, OD over armour, overall OD) shall be as per BS-EN-50288-7. Maximum tolerance in dimensions shall be +/- 2 mm.		
OUTER SHEATH	35	Material	Extruded flame retardant PVC IEC-332, Type ST-2, 90°C as per IS-5831		
	36	Thickness (Nominal)	As per BS-EN 50288 part 7 (Note-2)		
	37	Colour	Black	Black, for Intrinsic safe light blue	Black
	38	Overall Diameter	Bidder to Specify Note:- Cable dimensions (OD under armour, OD over armour, overall OD) shall be as per BS-EN-50288-7. Maximum tolerance in dimensions shall be +/- 2 mm.		
	39	Cable identification	Running length printed at min. every 1 metre interval		
ELECTRICAL PROPERTIES	40	Conductor resistance	As per BS-EN 50288 part 7		
	41	Drain wire resistance	NA	≤30 ohms/km @ 20 deg c. Noise rejection ratio ≥ 76 db.	
	42	Insulation resistance	1 G Ω/KM as per BS EN 50288		
	43	Mutual capacitance	NA	≤ 110 nF/KM @ 1 KHz	
	44	Capacitance between core and screen	NA	≤ 400 nF/KM @ 1 KHz	
	45	Inductance	NA	≤ 1 mH/KM @ 1 kHz	
	46	L/R Ratio	NA	As per BS-EN 50288 part 7	

8.5.7 Panels Accessories & Wiring

8.5.7.1. Wiring

All inter cubical and internal wiring for all panels shall be carried out with 1100V grade, stranded tinned copper conductors with PVC insulation. The minimum size of the stranded copper conductor used for the panel wiring shall be 0.5 mm² for analog signals and 1.0 mm² for commands. For power supply, the conductor size shall be provided as per the load rating (min. 2.5 sq. mm for 230 V AC). Control & Power wiring shall be segregated and routed in PVC troughs. Different colour wires shall be used for different voltages.

Engraved core identification plastic ferrules, marked to correspond with the panel-wiring diagram shall be fitted at both ends of each wire. Cross ferruling shall be done. This shall also be applicable for fibre optic cable & cores.

All spare contacts and spare terminals of the panel mounted equipment and devices shall be wired to the terminal blocks.

8.5.7.2. Relays

All relays used for interposing shall have at least 2 nos. changeover contacts. The relays shall have status indication and shall be provided with free wheeling diodes.

8.5.7.3. Labels

All front mounted equipment, as well as equipment mounted inside the panels/control desks shall be provided with individual labels with equipment designation engraved. These shall be phenolic overlays (1.6 mm thick) with black background and white lettering and shall be fixed to the panel by stainless steel screws (counter sunk). The panels shall also be provided at the top with a label engraved with the designation. Lettering for panel designation shall be 6 mm.

The minimum lettering size for instrument/device labels shall be 3mm. The lettering on the labels shall be subject to EMPLOYER'S approval. Labels of internally mounted equipment shall be clearly visible.

8.5.7.4. Earthing

Each panel shall be provided with a safety ground bus & system ground bus made of copper securely fixed along the inside base of the panels. These buses shall be typically of 25 mm wide and 6 mm thick of copper. The safety ground bus shall be properly secured to the plant safety earthing. All metallic cases/frames of relays, instruments, other panel mounted equipment shall be connected to the safety ground bus and shields & drain wires of signal/control cables shall be connected to the system ground bus by independent copper wires of not less than 2.5 sq. mm. The system ground bus shall be electrically isolated from AC mains earthing bus. The system ground bus shall be insulated from the panel body. The insulation colour code for earthing wires shall be green with yellow bands.

8.5.8 SUMMARY OF DATA TO BE FURNISHED ALONG WITH BID AND AFTER ACCEPTANCE OF PURCHASE ORDER

The BIDDER shall ensure the following documentation are prepared and submitted to EMPLOYER for his review / record.

8.5.8.1. Technical Bid

The following drawings/ documents shall be submitted:

- a. Data sheet and catalogs of instruments/ equipments
- b. Dimensional Drawings of Panels along with estimated BOQ for each of the systems.
- c. Overall System Configuration Diagram
- d. Engineering activity and manufacturing schedule giving activity wise breakup to meet the delivery schedule.
- e. Testing & Evaluation plan for the systems offered.

8.5.8.2. Final Documents

- a. Operation and maintenance manuals.
- b. Quality assurance documentation specific for the project.
- c. Final as built documentation folder containing all items for future reference.

8.5.9 SCHEDULE FOR SUBMISSION OF DATA AND DRAWINGS BY CONTRACTOR (DATA TO BE FURNISHED AFTER THE AWARD OF CONTRACT)

The CONTRACTOR shall submit the following drawings / documents after award of contract for review & approval. CONTRACTOR shall adhere to the delivery schedule as submitted along with the BID. CONTRACTOR shall also refer to data sheets for list of deliverables to be submitted for various instruments/ panels.

<u>Sl. No.</u>	Details
(a)	Bar chart for the design, manufacturing, erection, commissioning, trial operation and performance testing of the system offered.
(b)	Overall System Configuration Diagram indicating all components including networking.
(c)	Unpriced purchase order copy for various bought out /sub contracted equipment / services.
(d)	Following drawings for panels:
	<ul style="list-style-type: none"> Front facia layout showing all instruments with cut-outs, bezel dimensions, construction details, foundation details and interior G.A. drawings showing interior layout of various modules, instruments etc.
	<ul style="list-style-type: none"> Internal wiring diagrams indicating termination details of each component.
	<ul style="list-style-type: none"> Bill of Material (B.O.M.) indicating tag no., quantity, service & model no. of the various modules/instruments/items.
	<ul style="list-style-type: none"> Make, Model No., Catalogues, data sheets for each item/ sub-item of Access Control System.
	<ul style="list-style-type: none"> ACS Configuration and Layout drawings.
	<ul style="list-style-type: none"> Data Sheets & catalogues for I&C cables & power cables.
	<ul style="list-style-type: none"> Data sheets & catalogues for Fibre Optic cables, RS-485 to Fibre Optic Converters, F/O convertors & all connectors.
	<ul style="list-style-type: none"> Earthing diagrams
	<ul style="list-style-type: none"> Cable Schedules and Interconnection cable schedules.
(e)	Load calculations for each system
(f)	QAPs for all instruments & panels for each system, I&C cables, power cables & fibre optic cables.
(g)	Standard FAT & SAT for the specified systems
(h)	'As Built' drawings

<u>Sl. No.</u>	Details
(i)	Instruction manual for installation and start-up (for each system)
(j)	System operation and maintenance manual as described in specification.

8.5.10 TRAINING

8.5.10.1.1 No. Contractor's engineer shall be made available for 2 weeks for assistance in operation, maintenance, tuning & training of Employer's personnel at Site after commissioning of each system.

8.5.10.2. Training shall be required on both hardware & application software development.

8.5.11 TESTING, INSTALLATION, COMMISSIONING AND ACCEPTANCE

8.5.11.1. General

On the basis of guidelines specified in this specification Bidder shall submit their own testing, installation, commissioning and acceptance procedure. The procedure shall include purpose of test, test definition, results expected and acceptance criteria. For software it shall include details of the method, list of tests, sequence of execution, results expected and acceptance criteria.

8.5.11.2. Factory Acceptance Tests (FAT)

- a. Contractor shall demonstrate functional integrity of the various items in the systems supplied by him, including the system hardware and software covered in this specification. No material or equipment shall be transported until all required tests are completed & Employer gives the dispatch clearance.
- b. Employer reserves the right to involve and satisfy himself at each and every stage of testing. They shall be free to request specific tests on equipment considered necessary by them, although not listed in this specification. The cost of performing all tests shall be borne by the Contractor.
- c. Bidder to note that acceptance of any equipment or the exemption of inspection testing shall in no way absolve the bidder of the responsibility for delivering the equipment meeting all the specified requirements.
- d. It shall be Contractor's responsibility to modify and/or replace any item (hardware or software) if the specified functions are not completely achieved satisfactorily during FAT.
- e. Contractor shall not replace any component/module/subsystem unless it has failed and a log of such failures & analysis of the failure generated in form of a report shall be maintained during FAT. If a malfunction of module/component in a subsystem repeats, the test shall be terminated and contractor shall replace the faulty component/module. Thereafter test shall start all over again. If a subsystem fails during FAT and is not repaired and made successfully operational within 4 hours of active repair time after the failure, the test shall be suspended and restarted all over again only after contractor has replaced the device into acceptable operational condition.

- f. The FAT for the various items shall be performed in accordance with the approved QAPs.
- g. Testing & FAT shall be carried out in two phases. The minimum requirement for testing during these two phases shall be as follows:

Under the first phase bidder shall perform tests at his works to ensure that all components function in accordance with the specifications. A test report shall be submitted for the Employer's review within one week of completion of this test. Bidder shall perform the following minimum tests for the various systems and reports shall be forwarded to the Employer:

- i. Quality control test which shall be carried out to assure quality of all components and modules
- ii. Visual check of panels, all instruments, all modules, fibre optic converters etc.
- iii. High voltage test as per relevant IS standard
- iv. Megger test
- v. System power-up test, which shall test functionally all hardware, racks, cabinets etc.
- vi. Functional testing. This shall include the simulation of each item in the various systems supplied & wired by the Contractor and achieving the functional requirements as called for in the specifications and to verify proper system response. This is applicable for the Fire Alarm System. All testing for fire alarm system shall be in accordance with NFPA 72.
- vii. Functional testing of networking.

8.5.11.3. After the Contractor has performed the tests satisfactorily, the Contractor shall perform tests on all the items to be witnessed by Employer as per approved QAPs. Contractor shall notify the Employer at least three (3) weeks prior to factory acceptance test. This shall be the second phase of testing which shall be carried out systematically, fully and functionally test all hardware and software in the presence of Employer's representative.

All test instruments shall have calibration certificates from approved test house, valid for minimum 6 months.

8.5.11.4. Site Acceptance Tests (SAT)

Full integrated site acceptance test shall be performed before hand over of total system to the EMPLOYER. The test shall demonstrate functionality of the entire system supplied & erected by the Contractor. The Contractor shall provide all personnel, test facilities, equipment and tools etc. for the same. All test instruments shall have calibration certificates from approved test house, valid for minimum 6 months. A test procedure is required for approval 2 weeks prior to the schedule start.

8.5.11.5. Testing Requirements

- a. Tests on cables
 - Check details are in accordance with the specification.
 - Check for physical damage.
 - Megger test between each core and armour/sheath (For electrical cables)
 - Continuity check including screen continuity (For electrical cables)
 - Terminations of the cables at both ends.

- b. It shall be ensured that erection of all panels is as per approved layout drawings. Checking for tagging/identifications of all the panels shall be done. Checks for continuity and termination of all power, signal, control and fibre optic cables shall be carried out as per approved drawings. All the panels supplied & erected by the Contractor shall be checked at site by carrying out the following tests:
 - Visual & Mechanical testing.
 - Power up tests
 - Checks on incoming voltage and power distribution
 - Checking of incoming power supply to the panels supplied & erected by the Contractor.
 - Switching on the incoming supply to panels by switching on MCCBs/MCBs one after the other.
 - Power 'ON' PCs for Access Control System.
 - Demonstration of all system functions Access Control System.
 - Checking of all HMI screens, alarms etc.
 - Integrated testing of the IBMS and Access Control System.
 - Checking of proper functioning of all Printers with printouts of alarm lists, reports, important alarms etc.
- c. The Contractor shall co-ordinate with other Contractors for the other systems and integration with IBMS system.
- d. Tests on electrical installation
 - Checking of closing, tripping, supervision and interlocking of control devices.
 - Checking operation of all alarm circuits.
- e. Test on complete control system
 - On completion, the functioning of all systems shall be tested to demonstrate its correct operation in accordance with the Specification.
 - For testing, the Contractor may provide temporary means to simulate operating conditions, but the system will not be finally accepted until correct operation has been demonstrated to the satisfaction of the Employer.

8.5.12 Commissioning

8.5.12.1. Commissioning Procedure shall be carried out in a methodical sequence as follows

- Start-up,
- Initial running,
- Operability adjustment,
- Stable operation
- Final adjustment

8.5.12.2. The Contractor shall check the operating conditions by constantly monitoring operating data.

- 8.5.12.3. The Contractor shall specify for each discrete part of the system for which the operational data has to be recorded and the manner in which the data is to be taken. All the operating data shall be recorded, evaluated and submitted to the Employer

8.5.13 EQUIPMENT & SERVICES TO BE PROVIDED BY THE CONTRACTOR

8.5.13.1. This specification covers specific requirements of design, preparation of detailed drawings, manufacture, testing at manufacturer's works, inspection at Vendor's/Sub-Vendor's works, packing, forwarding, transportation, transit insurance, delivery at site, installation, testing at site, erection and commissioning of Access control System (ACS) as per specification and data sheets enclosed.

8.5.13.2. The following shall be in the scope of the CONTRACTOR

ACS comprising of Access cards (smart type), card readers, magna locks, exit push buttons, Access Management controller, PC with 15" Flat TFT LCD monitor, software, all associated cabling and installation hardware for the system.

8.5.13.3. Cabling

- a) Contractor shall supply & lay the following cables along with all the installation hardware and accessories:
 - UPS to ACS panel
 - ACS system cabling
- b) Cable Trays & Conduits shall be routed above the false ceiling.

8.5.13.4. Earthing

- a) Earthing for the entire system to be provided by the Contractor. Separate electrical & instrumentation earth pits shall be provided by Others. This earth pit shall be interconnected with electrical earth pit. Contractor shall connect the safety ground bus & system ground bus for the systems supplied by him to the respective earth pits.
- b) Single point earthing configuration shall be followed for the cable shields i.e. all signal and control cables shields shall be grounded at one end only to avoid ground loop.

8.5.13.5. Interfacing with third party devices

The Access control system shall be interfaced with the Integrated Building Management system (IBMS) at the Server Room, 2nd Floor, Admin Block.

8.5.14 SPECIFIC REQUIREMENTS / INSTRUCTION TO BIDDERS

8.5.15.1. This is a Unit Rate contract. The price/ contract value shall be arrived at based on quantities indicated in Bill of Quantity and unit rates for supply & erection quoted by the Bidder. The break-up of unit prices for various items in Bill of Quantity shall be used for future addition/deletion of the items, if any.

8.5.15.2. Contractor shall estimate Cable quantities based on enclosed GA drawings & layouts for bidding purpose only. However the Contractor is advised to visit Site & take actual measurements for arriving at the cable quantities actually required at Site before placement of Order.

8.5.15.3. The construction of this facility requires that, all CONTRACTOR'S adhere to good daily housekeeping practices. During construction the CONTRACTOR shall every

day, keep all work and storage areas used by them free from accumulation of waste materials. Scrap / rubbish shall be removed from the site to the satisfaction of the EMPLOYER. The CONTRACTOR shall maintain a crew to carry out this function without any additional payment.

- 8.5.15.4. The equipment to be supplied and erected shall be in accordance with specification.
- 8.5.15.5. Any item which may not have been specifically mentioned herein but are needed to complete the equipment / system shall also be treated as included and the same shall also be supplied and erected at no extra cost, unless otherwise specifically excluded as indicated.
- 8.5.15.6. The BIDDER shall comply with all systems / parameters wherever they are specified in data sheets and specification. No credit will be given during tender evaluation, if parameters better than those specified are offered by the BIDDER.
- 8.5.15.7. Deviation from the specifications, if acceptable to the EMPLOYER insofar as practicable, will be converted to rupee value and added to the bid price to compensate for the deviation from the specification. In determining the rupee value of the deviations, the EMPLOYER will use the parameters consistent with that specific in the documents and specifications and other information as necessary and available to the EMPLOYER.
- 8.5.15.8. Bidder's Offer
 - a) To enable thorough and fast scrutiny of the BIDDER's offer, BIDDERS are advised to respond all their technical data in the enquiry by clearly marking out their response, wherever they want to provide additional data and / or they deviate from the specified requirements. In case of full compliance, the enquiry specification and data sheets will remain unaltered. Each data sheet & writeup shall be signed and stamped by the BIDDER. This requirement is very important. Non compliance of this by the BIDDER may result in their bid being rejected.
 - b) BIDDER is advised to quote for the complete scope and partial response will not be entertained. In case of few items which do not directly fall under BIDDER's manufacturing range and / or not available from indigenous source, BIDDER should take the responsibility upon themselves to arrange to procure them and supply to ensure that their offer is complete in all respects.

8.5.15 SPARES AND MAINTENANCE TOOLS AND TACKLES

8.5.16.1. GENERAL

- a) All spares and maintenance tools and tackles shall be designed to enable maintenance to be carried out in the least time and at the least cost and support resources without affecting the performance and safety aspects.
- b) All the spares and maintenance tools and tackles supplied shall be new and unused.
- c) The VENDOR/CONTRACTOR shall guarantee that before going out of production of spares and maintenance tools and tackles for the equipment furnished, he shall give at least 12 months advance notice to the EMPLOYER, so that the latter may order his requirement in one lot, if so desired.

8.5.16.2. SPARES

- a) All spares supplied shall be strictly inter-changeable with the parts for which these are intended to be replacements. The spares shall be treated and packed for

long term storage under the climatic conditions prevailing at the site e.g., small items shall be packed in sealed transparent plastic bags with desiccator packs as necessary.

- b) Each spare shall be clearly marked or labelled on the outside of its packing with its description and purpose. When more than one spare is packed in a single case, a general description of the contents shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages shall be suitably marked and numbered for the purposes of identification.

8.6. IT & TELEPHONE SYSTEMS

8.6.1 Scope of Work

New Technology Centre (TC) is planned at Bhiwadi, Rajasthan. TC shall have building blocks like Admin Building, Canteen Area, Boys Hostel, Girls Hostel and Staff accommodation, Guest House, Utility Area and Training & Production Area. These blocks shall have data connectivity for operating computer System, Network Equipment and also provide connectivity to safety and security system such as CCTV Surveillance system, Access control System, Fire Alarm System, Time & Attendance System and telephone and intercom system for communication. System Architecture for data network is shown in figure 1.1 and data and intercom telephone points are listed in Table 1.1 below.

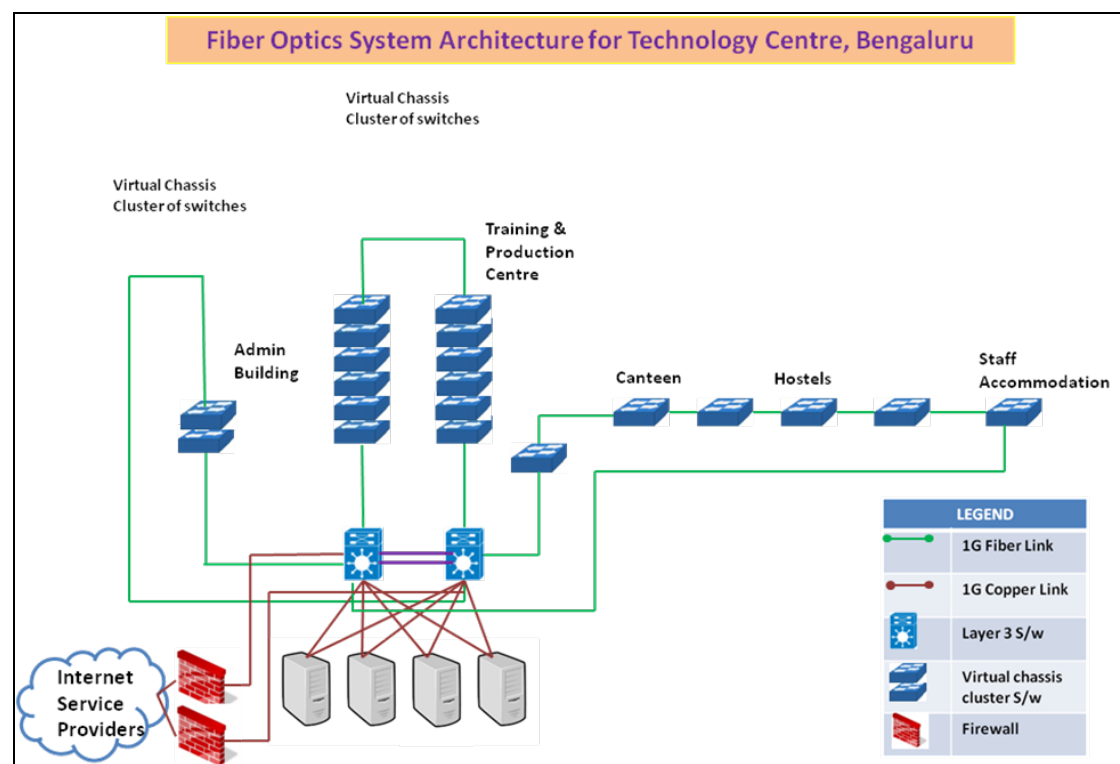


Figure: 1.1: Architecture Diagram for Data Network

Table 1.1: Data and Telecom points

Sr. No.	Location / Area	Qty	Connections required			Total Connections required		
			DATA	Tele	TV	DATA	Tele	TV
1	Admin & Conference Block							
1.1	Ground Floor							
a	Sr. Manager/ DGM Sr. Engg. Cabin	6	2	2	0	12	12	0
b	Office Area	4	3	2	0	12	8	0
c	Conference Room	2	1	1	1	2	2	2
l	Reception	1	2	2	1	2	2	1

			8	7	2	28	24	3
1.2	First Floor							
a	Conference Hall	1	4	3	0	4	3	0
b	Pantry	1	0	1	0	0	1	0
c	Lunch Room	1	0	1	1	0	1	1
d	House keeping Room	1	0	1	0	0	1	0
			4	6	1	4	6	1
1.3	Second Floor							
a	Server Room	1	12	2	0	12	2	0
b	IT Department	1	4	2	0	4	2	0
			16	4	0	16	4	0
	Total Admin Block					48	34	4
2	Training & Production Block							
2.1	Ground Floor							
a	HOD & Sr. Manager Cabin	2	2	2	0	4	4	0
b	Manager Room	1	2	2	0	2	2	0
c	Training Office	1	9	2	0	9	2	0
d	Placement Cell	1	4	2	0	4	2	0
e	Reception Training Block	1	2	2	0	2	2	0
f	Counselling & Room	2	1	1	0	2	2	0
g	Utility Block	1	8	4	0	8	4	0
h	EMS/Production Units	13	20	1	0	260	13	0
i	Testing lab/Calibration Lab	9	10	1	0	90	9	0
j	Laboratory	12	30	1	0	360	12	0
			88	18	0	741	52	0
2.2	First Floor							
a	Class Rooms	8	2	0	0	16	0	0
b	Labs	16	10	1	0	160	16	0
d	Production Office	1	30	15	0	30	15	0
e	Faculty Room	1	6	2	0	6	2	0
			48	18	0	212	33	0
2.3	Second Floor							
a	Library	1	4	2	0	4	2	0
			4	2	0	4	2	0
	Total Training Block					957	87	0
3	Canteen Building	1	2	4	2	2	4	2
4	Executive Hostel	1	0	4	4	0	4	4
5	Staff Accommodation	1	0	8	8	0	8	8
6	Hostel	2	6	6	2	12	12	4
	Total					14	28	18
	Total					1019	149	22

8.6.2 Technical Specifications of the components required

8.6.2.1. Layer 3 Core Switch Specifications

1. 24 1G SFP slots equipped with 12 1G copper ports for server connectivity, additional 4 10G SFP+ slots, equipped with internal Redundant Power System(RPS)
2. Should support active-active clustering Virtual Switching System (VSS) / equivalent technology for higher availability of Layer 2 and Layer 3 (RIP, RIPng, OSPF, OSPFv3, BGP, PIM) including video applications
3. The switch should have provision to support VSS/ equivalent clustering bandwidth 80Gbps per switch with two switches in virtual chassis
4. **Layer 2 Features:** GVRP, VLAN creation based on protocol and Ports, IEEE 802.1Q Virtual LAN (VLAN) bridges, IEEE 802.1v , port IEEE 802.3ac VLAN tagging, Q In Q, Up to 4K configurable VLAN's, IEEE 802.1D MAC bridges, IEEE 802.1s Multiple Spanning Tree Protocol (MSTP), IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)
5. **Layer 3 Features:** Should support Static routing, RIP, RIPng, OSPF, OSPFv3, PIM v4 SM, DM and SSM, PIMv6-SM, BGP, BGP4, IEEE 802.3az, IEEE 802.3ac
6. Should support IEEE 802.17/ERPS/equivalent for sub 50ms ring protection in following scenario : single, dual fibre cuts in ring and when fibre cut at common shared link in between two or more rings
7. **Security:** Should support ACLs, DHCP snooping, IP source guard and Dynamic ARP Inspection (DAI), MAC address filtering and MAC address lock-down, Tri-authentication: MAC-based, web-based and IEEE 802.1x,
8. **Management :** CLI, GUI, USB interface for taking backup of software release files configurations, digital optical monitoring, time domain reflectometry (TDR) diagnostic, sFlow or equivalent
9. The High available switch shall also act as an Centralized management / provisioning console for dynamic policy roll out across the switches or for selected switches in the network using instant access/equivalent technology
10. The High available switch shall support automated scheduled back up of running configuration files from all the network switches which will be deployed in network to ensure ease of management.
11. The High available switch shall also act as an Centralized management / provisioning console to ensure Zero touch replacement of field switches across network in case of any switch failure and also ensure the last running configuration is pushed through the central chassis upon successful detection of the new replaced field unit without any human intervention
12. The Virtual chassis cluster should also provide the functionality of centralized Software firmware roll and management to all the switches across the network to ensure consistent software image is maintained centrally across the network switches.
13. The Centralized Management / Provisioning console for Zero touch replacement , Dynamic Policy roll out , Dynamic Network provisioning / Centralized Software Firmware roll out shall support these technical functionalities over the LAN and WAN network

14. Switch should be capable of inbuilt wireless controller functionality for the management of min 40 Wi-Fi access points.

For ease of integration, all switches, AP, firewall, SFP's should be of same OEM.
Approved Makes: Cisco, HP, Juniper, Allied Telesis

8.6.2.2. 48 Port Access Switch

1. 48 100/1000 Base-T Ports Additional 4x1G SFP slots. The 4 1G SFP ports should be scalable to support 10G SFP+ modules
2. Switching Capacity: Non-Blocking Forwarding Rate: Wire Speed
3. Should support active-active clustering VSS / equivalent technology for higher availability of Layer 2 and Layer 3 including video applications
4. The Active - Active Virtual chassis cluster should support technology functionality locally or over geographically diversified locations For Diversified Data centre high availability operations
5. The Active - Active Virtual chassis bandwidth between the 2 high available cluster switches should be of min of 20Gbps when clustered locally or over geographically diversified locations
6. **Layer 3 Features:** Should be upgradable to support Static routing, RIP, RIPng, OSPF, OSPFv3, PIM v4 SM, DM and SSM, PIMv6-SM,
7. **Layer 2 Features:** GVRP, VLAN creation based on protocol and Ports, IEEE 802.1Q Virtual LAN (VLAN) bridges, IEEE 802.1v VLAN classification by protocol and port IEEE 802.3ac VLAN tagging, Q In Q, Up to 4K configurable VLAN 's, IEEE 802.1D MAC bridges, IEEE 802.1s Multiple Spanning Tree Protocol (MSTP), IEEE 802.1w Rapid Spanning Tree Protocol (RSTP), IEEE 802.3az, PVST+ compatibility mode
8. **Resiliency:** Should support IEEE 802.17/equivalent for sub 50ms ring protection in following scenario : single, dual fibre cuts in ring and when fibre cut at common shared link in between two or more rings
9. **Security:** Should support ACLs, DHCP snooping, IP source guard and Dynamic ARP Inspection (DAI), MAC address filtering and MAC address lock-down, Tri-authentication: MAC-based, web-based and IEEE 802.1x, DHCPv4 (server, relay and client)
10. **IPv6 Features:** DHCPv6 relay, DHCPv6 client, DNSv6 relay, DNSv6 client, IPv4 and IPv6 dual stack, IPv6 QoS and hardware ACLs, SNMPv6, Telnetv6, SSHv6 and Syslogv6, NTPv6 client and server, IPv6 static unicast and multicast routing
11. **Multicast Features:** IGMP snooping (v1, v2 and v3), MLD snooping (v1 and v2), PIM-SM and SSM for IPv6, Bootstrap Router (BSR) mechanism for PIM-SM IGMP query solicitation, PIM Dense Mode (DM)
12. **Management Features:** SNMPv1, v2c and v3, IEEE 802.1AB Link Layer Discovery Protocol (LLDP), Web GUI, sFlow, CLI, GUI, SNMPv3, SNMP Console management port, Port mirroring locally with in switch and across Virtual chassis cluster, TFTP, NTP, Syslog , An USB or equivalent memory card socket , allowing software release files, configuration and other files to be stored for backup and

- distribution to other switches, DDM – Optical digital diagnostic monitoring as per SFF – 8472 or equivalent standards, time domain reflectometry (TDR) diagnostic
- 13. Should support functionality to continuously monitor the received optical power of fibre ports and send SNMP trap when received optical power crosses predefined threshold level to avoid physical intrusion on fibre links
- 14. Should seamlessly integrate with core switch
- 15. Certifications: UL,
- 16. Approved Makes: Cisco, HP, Juniper, Allied Telesis

8.6.2.3. 24 Port Access Switch

1. 24 100/1000 Base-T Ports Additional 4x1G SFP slots. The 4 1G SFP ports should be scalable to support 10G SFP+ modules
2. Switching Capacity: Non-Blocking Forwarding Rate: Wire Speed
3. Should support active-active clustering VSS / equivalent technology for higher availability of Layer 2 and Layer 3 including video applications
4. The Active - Active Virtual chassis cluster should support technology functionality locally or over geographically diversified locations For Diversified Data centre high availability operations
5. The Active - Active Virtual chassis bandwidth between the 2 high available cluster switches should be of min of 20Gbps when clustered locally or over geographically diversified locations
6. **Layer 3 Features:** Should be upgradable to support Static routing, RIP, RIPng, OSPF, OSPFv3, PIM v4 SM, DM and SSM, PIMv6-SM,
7. **Layer 2 Features:** GVRP, VLAN creation based on protocol and Ports, IEEE 802.1Q Virtual LAN (VLAN) bridges, IEEE 802.1v VLAN classification by protocol and port IEEE 802.3ac VLAN tagging, Q In Q, Up to 4K configurable VLAN 's, IEEE 802.1D MAC bridges, IEEE 802.1s Multiple Spanning Tree Protocol (MSTP), IEEE 802.1w Rapid Spanning Tree Protocol (RSTP), IEEE 802.3az, PVST+ compatibility mode
8. **Resiliency:** Should support IEEE 802.17/equivalent for sub 50ms ring protection in following scenario : single, dual fibre cuts in ring and when fibre cut at common shared link in between two or more rings
9. **Security:** Should support ACLs, DHCP snooping, IP source guard and Dynamic ARP Inspection (DAI), MAC address filtering and MAC address lock-down, Tri-authentication: MAC-based, web-based and IEEE 802.1x, DHCPv4 (server, relay and client)
10. **IPv6 Features:** DHCPv6 relay, DHCPv6 client, DNSv6 relay, DNSv6 client, IPv4 and IPv6 dual stack, IPv6 QoS and hardware ACLs, SNMPv6, Telnetv6, SSHv6 and Syslogv6, NTPv6 client and server, IPv6 static unicast and multicast routing
11. **Multicast Features:** IGMP snooping (v1, v2 and v3), MLD snooping (v1 and v2), PIM-SM and SSM for IPv6, Bootstrap Router (BSR) mechanism for PIM-SM IGMP query solicitation, PIM Dense Mode (DM)
12. **Management Features:** SNMPv1, v2c and v3, IEEE 802.1AB Link Layer Discovery Protocol (LLDP), Web GUI, sFlow, CLI, GUI, SNMPv3, SNMP Console management port, Port mirroring locally with in switch and across Virtual chassis

- cluster, TFTP, NTP, Syslog , An USB or equivalent memory card socket , allowing software release files, configuration and other files to be stored for backup and distribution to other switches, DDM – Optical digital diagnostic monitoring as per SFF – 8472 or equivalent standards, time domain reflectometry (TDR) diagnostic
- 13. Should support functionality to continuously monitor the received optical power of fibre ports and send SNMP trap when received optical power crosses predefined threshold level to avoid physical intrusion on fibre links
- 14. Should seamlessly integrate with core switch
- 15. Certifications: UL,
- 16. Approved Makes: Cisco, HP, Juniper, Allied Telesis

8.6.2.4. Firewall Specifications:

1. Internet Gateway router / Next Generation Firewall and Security gateway device with min 2 * 10/100/1000 T or 2 * SFP combo WAN ports and Min 8 * 10/100/1000T LAN ports with 2 * WAN By Pass ports for high availability
2. **Performance Requirements:**
 - a. Min Firewall throughput of 1500 Mbps or more
 - b. Min Concurrent sessions support up to 1,00000 sessions
 - c. Min IPS throughput of 600 Mbps or more
 - d. Min IP Reputation throughput of 800 Mbps or more
 - e. Min Malware Throughput of 1180 Mbps or more
 - f. Min VPN Throughput of 700 Mbps or more
3. **Layer 3 features:**
 - a. Static routing, RIP and RIP ng, OSPFv2 and OSPFv3, BGP4 and BGP4+
 - b. IGMP, PIMv4 and PIMv6 , Bridging (LAN / WAN)
 - c. PPPoE , DHCPv4/v6 client, server, relay, Static, IPsec traversal, Dynamic NAPT, RADIUS / TACACS+
4. **Network Resilience:** VRRP and VRRPv3 , Spanning Tree, RSTP, MSTP
5. **Firewall Features**
 - a. DPI firewall, Application control , web control, Traffic shaping
 - b. DMZ, Port forwarding, Dynamic NAT
 - c. Static PPP, L2TPv3 Ethernet pseudo-wires, GRE for IPv4 and IPv6
6. **Management features**
 - a. USB Slot media, RADIUS, TACACS+, SNMP v1 / v2 and V3 support
 - b. SSHv1/v2, Syslog & Syslogv6, SNMPv2 & v3
 - c. Full environmental monitoring of PSU, fan, temperature and internal voltages.
 - d. Should be able to send SNMP traps alert to network managers in case of any failure
 - e. Safety Standards: UL60950-1, CAN/CSA-C22.2 No. 60950-1-03, EN60950-1, EN60825-1, AS/NZS 60950.1, UL,
7. Approved Makes: Cisco, HP, Juniper, Allied Telesis

8.6.2.5. Network Management System Specifications:

1. Automatic topology discovery and creation of network maps for Layer 3 and Layer 2 network , All the available VLANS

2. Should have high level Network Inventory polling capability for IP Network nodes including the security appliance, All available line cards , Modules , ports , Physical links , VLAN interfaces and all the other SNMP capable devices in the network
3. Should have powerful administration control
4. Detailed performance monitoring and management
5. Should have extensive fault management capabilities with Real time Event and Alarm notifications , System Logs and Audit trials
6. Creation and management of security and QOS policies
7. Scheduled Device configuration back-up and restore functionality
8. Automatic Detection of configuration changes for easy trouble shooting and Isolation
9. Should support 3rd party devices and end points
10. Should have the functionality of Group provisioning / Scheduled configuration roll out management
11. Should have the ability to perform scheduled or unscheduled network wide software or Firmware upgrades
12. Should have the ability to customize the NMS dash boards as per the requirements of technical team
13. Should have the ability to perform / create group of devices for applying same task
14. Should have extensive Event notification capability
15. Should provide the flexibility to the network administrator to assign task to an Individual network engineer and assign ownership / track the status of the issue resolution
16. Should have extensive centralized trouble shooting tools in built
17. The NMS solution should be preferably from the same Active switching vendor , in case vendors proposing for 3rd party NMS solution should provide all the interop reports certified by both the NMS vendor and Active switching on seamless interoperability
18. All the required Hardware / Software licenses for the NMS solution should be proposed by the bidder
19. Approved Makes: Cisco, HP, Juniper, Allied Telesis

8.6.2.6. Specifications for 12C Single Mode Fiber Optic Cables:

12C Single mode Optical Fiber cable shall have following features,

- Gel-free design for water blocking capability using craft-friendly water-swellaable materials
- Flexible, craft-friendly buffer tubes to route in closures easily
- S-Z stranded, loose tube design which isolates fibers from installation and environmental rigors and facilitates mid-span access
- Dielectric central strength member and requires no bonding or grounding
- Medium-density PE jacket to be rugged, durable and easy to strip
- Meets industry standards and specifications including ICEA-640, Telcordia GR-20

Typical Outdoor Fiber Cable Loose Tube

Following are the typical specifications for OS2 Outdoor Single mode Fibre supporting speeds in excess of 10Gbps:

General Specifications:

- | | |
|----------------------------|---------------------|
| - Cable Type | Stranded loose tube |
| - Construction Type | armoured |
| - Subunit Type/Buffer tube | Gel-free |

Construction Materials:

- | | |
|------------------------|---|
| - Cable Type | zero water peak single mode fiber
(G.652.D or G.652.D OS2) |
| - Jacket Material | PE |
| - Fiber Type, quantity | 12 |
| - Jacket Color | Black |
| - Jacket UV Resistance | UV stabilized |

Physical Characteristics:

- | | |
|--|-----------------------------|
| - Cladding Diameter | $125.0 \pm 0.7 \mu\text{m}$ |
| - Core/Clad Offset | $\leq 0.5 \mu\text{m}$ |
| - Coating Diameter (Uncolored) | $245 \pm 1.0 \mu\text{m}$ |
| - Coating Diameter (Colored) | $254 \pm 7 \mu\text{m}$ |
| - Coating/Cladding Concentricity Error, Max. | $12 \mu\text{m}$ |
| - Clad Non-Circularity | $\leq 1 \%$ |

Optical Characteristics, General:

- | | |
|--------------------------------|--|
| - Point Defects, Max. | 0.10 dB |
| - Cut-off Wavelength | ≤ 1260 |
| - Zero Dispersion Wavelength | 1,302-1,322 nm |
| - Zero Dispersion Slope, Max. | 0.090 ps/[km-nm-nm] |
| - Polarization Mode Dispersion | $\leq 0.06 \text{ ps/sqrt (km)}$ Link Design Value |
| - Backscatter Coefficient | -79.6/-82.1 dB @ 1310/1550 nm |
| - Index of Refraction | 1.467/1.468 @ 1310/1550 nm |

Environmental Characteristics:

- | | |
|--|---|
| - Temperature Dependence | -76°F to $185^{\circ}\text{F} \leq 0.05 \text{ dB}$ (-60 to 85°C) |
| - Temperature Humidity Cycling | 14°F to $185^{\circ}\text{F} \leq 0.05 \text{ dB}$ up to 95% RH |
| - Water Immersion, 73.4°F (23°C) | $\leq 0.05 \text{ dB}$ |
| - Heat Aging, 185°F (85°C) | $\leq 0.05 \text{ dB}$ |

8.6.2.7. Specifications for EPABX System:

Required EPABX System shall support for minimum 1 PRI, 8 Trunk, 140 Analog Extension, 10 VoIP extensions, 4 Digital Extensions. ISDN-GSM-VoIP PBX with DC Power Supply & CPU Card, Single Cabinet, 10 universal slots, Built-in auto attendant, Ethernet Port, Remote Programming, Inbound & outbound Conference facility, Hot swappable,

1. The equipment shall be electronic type. It shall have microprocessor / micro controller based on Stored Program Control Technique.

2. It shall employ PCM/TDM, 100% non-blocking, digital switching technology.
3. It shall have distributed processing architecture, SLIC and SMT Design.
4. System power supply should be inbuilt and SMPS type.
5. The system should be built on a universal slot architecture and modular in design to enable seamless growth, by adding the desired necessary cards as and when required. Any peripheral card can be inserted in any slot of the platform, whereby it is possible to increase or decrease the trunk lines or subscriber lines of the system as per the requirement in future as per mentioned maximum requirement.
6. It should be suitable for DTMF as well as the FSK type of telephone instruments.
7. The EPABX system supplied shall be with 150 extensions, 1 PRI, 8 C.O. lines and can scale up to 200 extensions, 6 PRI and 100 C.O. lines on the same platform
8. It should have built-in conference facility
9. EPABX shall support E & M Port to connect E & M Lines
10. System Shall support Intercom Line Card
11. The system shall have the inbuilt auto attendant facility and shall be able to answer minimum 5 calls simultaneously.
12. The system shall have an ISDN Digital platform and shall be compatible with ISDN PRI line of Local Service Provider.
13. The system shall have multiple port interfaces such as analog extension lines, digital key phone, IP Extension, C.O. Line, GSM/3G, E & M Line, PRI/E1 and VoIP. All interfaces shall be in the form of expansion cards and can be plugged into the universal slots of the system as and when require in the future.
14. The system should have in-skin GSM card so that the multiple SIMs can be inserted on the GSM card plugged on to the PBX platform. Hence, the calls on GSM mobile can be routed through this SIMs and contribute in reduction of overall telecom bill.
15. All the peripheral cards (extension cards, trunk cards (GSM/VoIP/ISDN etc.) should be hot-swappable.
16. The EPABX should support Radio Connectivity with the in-skin card.
17. The offered exchange should be an ISDN & VoIP ready switch. The system platform should always be ready for ISDN & VoIP and only the necessary in skin ISDN & VoIP cards need to be added for functionality.
18. The system should support SMPP protocol to send/receive SMS using in-skin GSM SIMs within EPABX. Any software required to send/receive SMS shall also to quote separately.
19. The system shall have at least 2 RS232 ports for SMDR/PMS/CAS Interface.
20. The system shall have a built-in remote maintenance facility. The system can be programmed remotely over the internet without any modem required on the PBX side.
21. The call ringing sequence would be programmable and have options such as simultaneous, hunting off, round robin and delayed simultaneous.
22. EPABX should have built-in one number of public address port and external music port.
23. Caller line identification (CLI) on Analog and digital/PRI trunks shall be built-in for both DTMF and FSK telephone instrument.
24. The system shall integrate in-skin voice mail card with 72 hours of storage capacity and dedicated mailbox for each extension.
25. Detail reports of all system parameters should be generated through the SMDR or CDR port of EPABX.
26. The offered system should be QSIG ready (for PRI) for Networking and Feature Transparency between two or more exchanges.

27. Each port of the system shall be programmable. It shall have programmable features port-wise/extension-wise.
28. The system shall support flexible numbering for extensions such as it may have extensions with 1 digit, 2 digits and up to 6 digits numbers as well as in combination of all.
29. The system shall have built-in web based software programming tool for system administration.
30. Access codes, system timers and access to features shall be programmable.
31. Storage of outgoing, incoming and internal call reports shall be generated on SMDR port of the system. It shall also be available online through Ethernet Port.
32. The system should have built-in outgoing Call Log buffer of 2000 calls, incoming call log buffer of 2000 and call log buffer of 1000 internal calls.
33. Features given to an extension shall be accessed from any other extension by dialling the secret codes.
34. System features shall have class of service, night service, conference, auto diagnostic etc. Class of service shall be unrestricted. STD restricted and semi restricted.
35. Extension features shall have an extension to extension call, extension to central office, extension to operator, automatic call back, call transfer, call forward, follow me, executive/secretary, do not disturb, barge-in, raid, Boss ring, Priority, emergency reporting etc.
36. Operator features shall have the assistance to extension, attended call transfer, call intercept, indication of call waiting, night service control etc.
37. The system shall have features as CLI based routing, call duration control, least cost routing i.e. time, number or combination of both.
38. The system shall have a conversational recording in the mail box should be available with voice mail system card of EPABX. Conversation recording should be possible on Analog/Digital/IP as well as Mobile SIP Smartphone (Android/iPhone).
39. The system shall provide IP functionality to support IP extensions and trunks over SIP protocol. It should be possible to support IP Trunks and Extension with the single VoIP expansion card further expansion of VoIP channels shall be possible with an expansion card.
40. Varied type of open SIP IP Terminals such as IP Phone, SIP soft phone and Mobile SIP Client shall be supported.
41. The manufacturer should also have an application for Android and iPhone so that the enterprise mobility can be extended for the Smartphone users.
42. The system shall also be required to supply IP Phones of the same manufacturer.
43. IP functionality of the system shall be in the form of in-skin interface card and can be inserted in the any slots on the platform.
- 44. The system must support following features of IP telephony:** Dynamic DNS, Registrar Server, Proxy Server, Presence Server, NAT and STUN.
- 45. The system must have following features:**
 - Modular architecture, Gateway Functionality, Built-in Auto-Attendant
 - Easy integration with other SIP devices such as VoIP gateways, SIP servers and SIP phones
 - Built-in auxiliary ports (Analog Input-Output ports)
 - Hybrid expansion card to meet any requirement
 - Networking of multiple sites and offices
 - Mobile Close User Groups (CUG)
 - On-site and Off-site Mobility
 - Multiple Call Groups
 - Open standard SIP support

- Least Cost Routing Algorithm
- Centralized Maintenance and Administration
- Unified Messaging – Voice mail to Email
- Call back on trunk, Return call to original caller (RCOC), DID
- Automatic DISA with Built-in DISA card
- Multi-party conference
- Conference Dial-in
- Built-in CLI (DTMF and FSK) on ISDN and analog trunk lines
- CLI based routing
- Conversation recording
- Allowed and Denied call lists
- Call logs to identify missed Calls
- Emergency numbers
- Voicemail system
- Handover and Handoff support with Android/iOS Soft phone Application
- Return call to original caller (RCOC)
- Failover resiliency
- Multiple systems networking through ISDN QSIG and SIP
- SNMP v1/v2c/v3
- Mobile Extension through GSM/3G Mobiles
- Third-party PMS/CAS support
- CTI (TAPI 2.1)
- Routing of calls to only permissible legal networks (Logical Partitioning)
- SMDR through Ethernet Port

8.7. APPROVED MAKE LIST OF MAKES

NOTE:

- All materials and products shall conform to the relevant standards and shall be of approved make and design. A list of manufacturers/ vendors is given separately herein below for guidance. The Engineer shall give the approval of a manufacturer/ vendor/ only after review of the sample/ specimen. In case the same is not available in the market or in case of change in trade name, equivalent makes/ re-designated manufacturer then an equivalent approved make shall be used with the approval of Employer/ Engineer. The complete system and installation shall also be in conformity with applicable Codes & Standards and Tender specifications.
- Only “First” class quality materials shall be used.
- Employer reserves the right to choose any of the approved make / vendors as per this list.
- In case of products not indicated in this list, bis marked products shall be preferred.
- Specification of manufacturer’s item shall be checked against tender item / specifications before selecting any product or brand name. In case of any discrepancy, tender item/ specifications shall prevail, and any such brand of item shall not be used which is not conforming to tender specifications even if it is listed in this list.
- For use of material from a bis listed/ certified manufacturer, the contractor shall furnish a copy of the BIS certificate to Employer before procuring the material.
- In case non-availability of any item/ material among approved manufacturers/ brands at a particular site/ region, alternate manufacturers/ brands conforming to BIS/ BS etc. shall be used subject to approval by Employer.
- In case of non-availability of any manufacturer among approved manufacturers at a particular site/ region, alternate manufacturer’s name shall be proposed along-with required credentials for Employer’s approval.
- In case of any item/ product neither covered in this list nor having A BIS specifications, the contractor shall submit the proposed item/ product along-with technical details/ specifications (as per bid), test certificates etc. And other credentials of the manufacturer for Employers approval.

LIST OF APPROVED MAKES FOR PRODUCTS AND MATERIALS FOR BMS AND RELATED WORKS ARE INDICATED IN THE TABLE BELOW. HOWEVER, ANY OTHER MAKE WHICH IS EQUIVALENT AND MEETING THE TENDER SPECIFICATIONS ARE ALSO ACCEPTABLE WITH PRIOR APPROVAL OF THE ENGINEER

Item	Makes
Control Panel Enclosure	Rittal / APW President / Pyrotech
PC for IBMS Server/Operator Station	Compaq / HP
Printer	HP-Laserjet

Item	Makes
Cable Glands	Comet/ Baliga
BMS	Honeywell / Siemens / Johnson Controls
Push Buttons	L&T / Siemens / Tecknic / Kaycee
I&C cables & Power cables	Delton/ Associated Flexibles & Cables/ Finolex/ Universal/ Uniflex
Cable trays	Indiana/ West Coast Engg. Pvt. Ltd.,
Cable Glands	Comet/ Baliga
Relays	OEN/ Siemens / Omron
Fire Detection and Alarm System	Cooper / Edwards EST3 / Ravel / GST
PA System	Bosch limited / Honeywell / Nelco
Fibre Optic Cables	Finolex/ Uniflex
CCTV System	HIKVISION / CP PLUS / Dahua
Access control system	Bosch/ GODREJ and Boyce/Honeywell
Layer 3 & Layer 2 Switches	Cisco, Juniper, HP, Allied Telesis
Network Rack	WQ, Rittal, Valrack
EPABX	Progility, Panasonic, Matrix
CAT6 Cable	Molex, Dlink, Belden
Connectors & Accessories	Molex, Legrand, DigiLink

TECHNICAL SPECIFICATION
EXTERNAL SERVICES

EXTERNAL SERVICES WORKS

SEWAGE TREATMENT PLANT

10.1. SCOPE

- i. This specification covers the general requirements of design, preparation of detailed drawings, construction, supply of material, manufacture, testing, inspection at BIDDER'S works, packing, forwarding, transportation, transit insurance, delivery at site, erection / installation, testing, commissioning at site and carrying out performance / acceptance tests of the equipment, materials and services for Sewage Treatment Plant (STP).
- ii. Prepare and submit as-built drawings as per document and drawing submission & distribution schedule.
- iii. Piping inside and around pump house including suction and delivery piping, delivery header, recirculation piping.
- iv. All the valves in above piping.
- v. Supporting arrangements needed (indoor & outdoor) for the piping, valves and instrumentation mentioned above.
- vi. The equipment to be supplied and erected under this specification is detailed in BOQ and these shall be in accordance with Specification and the relevant data sheets section.
- vii. Any item which may not have been specifically mentioned herein but are needed to complete the equipment / system shall also be treated as included and the same shall also be furnished and erected, unless otherwise specifically excluded as indicated.
- viii. STP has to be constructed underground under vehicle parking area.
- ix. 100% power backup is to be provided.
- x. A 50 KLD treated wastewater storage tank has to be provided to meet flushing and horticulture demand.
- xi. An overflow pipe from the treated wastewater tank has to be connected to the existing sewerage line/ nala located outside the boundary of plot.
- xii. Space for treated water pump has to be provided. (A treated water pump has been proposed for pumping of treated wastewater into the recycled water network. The water has to be use for flushing and horticulture purpose.
- xiii. Cut-outs have to provide in the roof slab of STP for operation and maintenance purposes and for lifting of pumps.
- xiv. Entry and Exit staircase have to be provided to access the STP.
- xv. Minimum 2.0 m level difference should be provided in between the bottom of STP top slab and top of tanks for movement of workers/supervisors.

10.2. SPECIFIC REQUIREMENTS / INSTRUCTION TO BIDDERS

10.2.1 WASTEWATER QUANTITY AND CHARACTERISTICS

The total maximum waste water inlet at Wastewater Treatment Plant (STP) has been calculated as 100 KLD. The STP is being proposed to be constructed on Moving Bed Bio Reactor (MBBR) technology. The treatment plant should be of modular type and should be capable of handling flow variations up to 60% of the maximum capacity.

The expected Characteristics of the wastewater generated as are as given below (Table 1.1)

Table 1.1: Characteristics of Wastewater

S. no.	Parameter	Unit	Quantity
1	pH	-	6.5 – 8.5
3	TSS	mg/L	250
4	COD (max)	mg/L	450-500
5	BOD (5 days)	mg/L	250-300
6	Oil & Grease	mg/L	45
7	Feacal Coliform	MPN/100 ML	10^{12} - 10^{16}

10.2.2 TREATMENT SCHEME:

The treatment scheme would in essence comprise of the following:-

a) Coarse Screen, Oil and grease trap, Grit Chamber and Fine Screen

Mechanical screens of 20 mm openings are proposed to effectively remove material that could interfere with the satisfactory operation of the treatment plant or equipment. It would also reduce clogging by rags and other floating material which could affect functioning efficiency of downstream units.

Considerations in the design of screening installations should include:

- Location
- Approach Velocity
- Clear Openings Between Bars or Mesh Size
- Head Loss Through The Screens
- Screenings Handling, Processing, and Disposal
- Controls

The screen channel should be designed to prevent the settling and accumulation of grit and other heavy materials.

Grit chamber is proposed to remove grit, consisting of sand, gravel, cinders or other heavy solid materials that have subsiding velocities or specific gravities substantially greater than those of the organic putrescible solids in wastewater. Grit removal is proposed to protect the downstream units with moving mechanical equipment and pump elements from abrasion and accompanying wear and tear. Removal of grit reduces the outage for cleaning of settling tanks and digesters. The Waste water flow should pass through an oil & grease trap for removal of all oil and grease content present in waste water prior to entering in fine screen.

Mechanical screens of 6 mm openings and a standby manual screen of 10 mm openings are proposed to effectively remove material that could interfere with the satisfactory operation of the treatment plant or equipment.

b) Collection / Equalisation Tank

The wastewater flow generated from the plant facility shall be received in the equalisation chamber after coarse screen, oil and grease trap, grit chamber & fine screen. Collection / Equalization tank would serve the purpose of dampening the flow fluctuations. It would be sized keeping in consideration the range of fluctuation between the peak and lean period flows and it would be designed for ultimate flow. Wastewater from equalisation tank will be pumped into Moving Bed Bio Reactor (MBBR) tank through submersible pump (2 Nos, 1W+1S). Coarse bubble aeration is proposed in the equalization tank for mixing removing any smell in the fresh wastewater.

Biological Treatment

The secondary treatment proposed would include a MBBR tank and a secondary tube settler clarifier. The MBBR is an aerobic, attached growth, fluidized bed system employing structured Polypropylene (PP) Fill media (cylindrical shaped) with high specific surface for developing and retaining bacterial mass. The MBBR shall be designed by selecting suitable BOD loading rate by the bidder. Maximum BOD loading rate proposed is 5.0 Kg BOD/m³/d. The minimum specific area proposed for media is 400 m²/m³

Oxygen is proposed to be supplied diffused air aeration systems employing diffusers. The type and material of construction of diffusers shall be decided by the Bidder.

c) Secondary Clarifier

A hopper bottom clarifier would be provided for this purpose. A sludge return line shall be provided. There should be provision for recirculation / waste pumps for sludge circulation is required. The inlet in the clarifier would be from side through inlet baffle.

The efficiency of the secondary settling tanks defines the final quality of the treated effluent. The clarifier should be fitted with tube settler made of UV stabilized PVC. The maximum surface loading rate (SLR) proposed is 2.0 m³/hr/m². The length of settlers and installed should be decided to achieve maximum removal efficiency.

Hopper bottom in the clarifier should be designed for sludge removal without mechanical arrangement.

d) Disinfection / Chlorination Tank

The secondary treated wastewater shall be disinfected by using chlorine in a chlorine contact tank. Chlorine shall be added here from chlorine dosing tank by means of Chlorine dosing pumps.

e) Polishing

The disinfected wastewater after chlorine contact tank shall be pumped through filter feed pumps to Pressure Sand filter (PSF) and Activated Carbon Filter (ACF) in order to meet stringent discharge standards. Final effluent will then be stored in Treated Waste water Tank which may either be used for horticulture or for flushing purpose.

f) Sludge Handling

The waste sludge from secondary clarifier shall be pumped to sludge holding tank for thickening of sludge. The supernatant of the sludge holding tank shall be recycled back to Equalization tank. The sludge from the SHT shall be well digested and shall be fed to Filter Press for dewatering and forming dry sludge cakes. This dried sludge can either be used as manure or can be disposed off in designated secured landfill site.

The process flow diagram for the proposed STP is attached (refer drawing no. TCE.10106A-162-GA-6001)

g) Disposal of Treated Effluent.

The treated effluent from Treated Wastewater Tank is proposed to be either used for horticulture or used for flushing purpose.

10.2.3 TREATED WASTE WATER CHARACTERISTICS:

The treated wastewater should conform to characteristics given below (Table 1.2)

Table 1.2: Characteristics of treated wastewater

S. no.	Parameter	Unit	Quantity
1	pH	-	6.5-7.5
2	TSS	mg/L	<10
3	BOD (5 days)	mg/L	<10
4	COD	mg/L	<50
5	Faecal Coliform		< 100/100 ml*

Note: *The microbial quantity to be achieved would be as per Category A after chlorination as per WHO guidelines

10.2.4 STP - CIVIL WORKS

The scope of work will consist of sizing of various units as per the list given below along with preparation and submission of civil GA and RCC/ Structural drawings on the basis of which the construction work shall be carried out.

The design calculations will be submitted by the BIDDER along with the drawings for approval.

The various tanks/chambers needed to be constructed for the wastewater treatment system and their details are as follows-

SR. NO.	DESCRIPTION	SIZE/ CAPACITY	QTY. Nos.	M.O.C.
1	Coarse screen, Oil and grease trap, Fine screen and Grit Chamber	By Bidder	1	R.C.C. / As specified/approved by client.
2	Equalization Tank	By Bidder	1	R.C.C./ As specified/approved by client.
3	MBBR Tank	By Bidder	1	R.C.C./As specified/approved by client
4	Secondary Clarifier (tube settler with hopper bottom)	By Bidder	1	R.C.C./ As specified/approved by client
5	Chlorine Contact Tank	By Bidder	1	R.C.C. / As specified/approved by client.
6	Treated Waste Water Tank	By Bidder	1	R.C.C/ As specified/approved by client.
7	Sludge Holding Tank	By bidder	1	R.C.C/ As specified/approved by client.

In addition the following works shall be carried out by the Bidder:

SR. NO.	DESCRIPTION	SIZE/ CAPACITY	QTY. Nos.	M.O.C.
1	Foundation of all pumps & motors, tanks, skids and pipe work,	By Bidder	As required during detailed engineering	As specified/ approved by the Client
2	All drain trenches up to battery limit (Bidder's scope)	By Bidder	As required during detailed engineering	As specified/ approved by the Client
3	Supports for electrical cables and pipes	By Bidder	As required during detailed engineering	As specified/ approved by the Client

10.2.4.1 Equipment, Piping, Electrical and Instrumentation Work

The scope of work will consist of design, engineering, manufacture/procurement, supply erection and commissioning of various components as per the lists given subsequently.

The various equipments required to be provided for the wastewater treatment system and their details are as follows-

SR. NO.	DESCRIPTION	SIZE/ CAPACITY (PROPOSED)	QTY. Nos.	M.O.C.
1	Coarse Screen (For ultimate flow)	20 mm opening	1	SS-316
2	Mechanical screens of 6 mm	6 mm opening	1	SS-316

SR. NO.	DESCRIPTION	SIZE/ CAPACITY (PROPOSED)	QTY. Nos.	M.O.C.
	openings and a standby manual screen of 10 mm			
3	Media for MBBR	400 m ² /m ³ surface area (Minimum)	Cum (By Bidder)	PP
4	Tube settler media	By Bidder	Cum (By Bidder)	UV stabilized PVC
5	Air Blowers for Equalization Tank & MBBR Tank	By Bidder	(1W + 1S)	By Bidder
6	Coarse Bubble Air Diffusers for Equalization Tank.	By Bidder	By Bidder	By Bidder
7	Air Diffusers for MBBR Tank	By bidder	By Bidder	By Bidder
8	Submersible pump (with VFD, to work between 5 to 7 m ³ /hr)	5-7 m ³ /hr @ 12 m head / bidder to reconfirm	1W + 1S	SS 316
9	Chlorine dosing system consisting of 1 no. Dosing tank and 1 no. Hypochlorite dosing pump	By Bidder	1 Set	By Bidder
10	Pressure Sand Filter	By Bidder	1	MS Epoxy Coated / FRP
11	Activated Carbon Filter	By Bidder	1	MS Epoxy Coated / FRP
12	Sludge recirculation / Waste Pump	By Bidder	1W+1S	By Bidder
13	Pressure Sand Filter (PSF) and Activated Carbon Filter (ACF) feed pump	By Bidder	1W+1S	By Bidder
14	Supernatant transfer Pump from Sludge Holding Tank to Equalization Tank if required	By Bidder	1	By Bidder
15	Treated sewage transfer pump	By Bidder	1	By Bidder
16	Filter Press Feed Pump	By Bidder	1	By Bidder
17	Filter Press	By Bidder	1	By Bidder
18	Drain pit Pump	By Bidder	1	By Bidder
19	Mechanical Ventilation System	By Bidder	1 Set	By Bidder

In addition to the above listed equipments, the following would be in the scope of the bidder:

SR. NO.	DESCRIPTION	SIZE/ CAPACITY	QTY. Nos.	M.O.C.
1	Interconnecting piping & Valves as required	By Bidder	1 Lot	Jindal Hissar / Prince / Supreme
2	ELECTRICAL WORK			
2a	Power cables from main STP Panel (provided by client) to all motors.	By Bidder	1 Lot	Specification as approved by Client
2b	Push button stations near each motor.	By Bidder	1 Lot	Specification as approved by Client
2c	Control cables	By Bidder	1 Lot	Specification as approved by Client
2d	Earthing	By Bidder	1 Lot	Specification as approved by Client
2e	Separate KWh Meter (provided by client)	By client	1 Lot	
3	INSTRUMENTS			
3a	Level switches in tanks with provision for alarm at high level in the tank and alarm as well as tripping of pumps at low level	By Bidder	1 Lot	Specification as approved by Client
3b	Flow meter magnetic type with indicator and totalizer	By Bidder	1 Lot	Specification as approved by Client
3c	Pressure gauges	By Bidder	1 Lot.	Specification as approved by Client

Note:

The Bidder should design and arrive at the sizing, capacities, MOC, type and other details of various equipments as listed above.

The bidder is required to bring out the disparity/ ambiguity (if any) in the information mentioned herein before submission of the bid. The design philosophy mentioned is tentative and can be changed at the Bidder's end (with proper justification) to achieve the desired treated effluent characteristics.

10.2.4.2 Following activities / items will be in the scope of the Bidder.

- Foundation bolts for all equipments, companion flanges with nuts, bolts, gaskets at terminal points.
- Final painting at site.
- Packing, forwarding, delivery to site, unloading at site.

- d) All consumables till the plant is handed over to the EMPLOYER/ENGINEER. Chemicals, Instruments and equipment required for the installation and performance test should be arranged by Bidder.
- e) Provision of auxiliary steel/supporting steel for supporting the equipment and piping, Access platforms, ladder, handrail and steel supporting base etc. common for all accessories as well as related drilling, welding work, painting of supports etc.
- f) All erection tools and tackles, cranes, hoisting equipments, etc as required.
- g) One (1) set of commissioning spares and maintenance tools.
- h) One (1) set of essential spares.
- i) Service water shall be made available by EMPLOYER/ENGINEER at one point of STP limit.

10.2.4.3 Erection and Commissioning Services

Following activities / items will be in the scope of the Bidder.

1. Receiving material/ equipment at site, unloading all the equipment and material at site from carriages, checking against damages, storing in storage area provided by the EMPLOYER/ENGINEER, shall be in the in the scope of bidder.
2. Movement of equipment and materials to erection at site by bidder.
3. Minor modification on the foundation as required such as chipping, levelling etc required to install the pumps.
4. Erection of all equipments and materials supplied under this contract.
5. Grouting of equipment foundations.
6. Hydro test and air leak test at site after completion of erection.
7. Trial runs, testing, start-up, performance recalibration, commissioning and performance / Acceptance tests covered in the specification
8. Proper tagging of all civil units, equipments should be done by Bidder with much care
9. The Bidder shall arrange following at his own cost.
 - a) Adequate quantum of welding electrodes including special electrodes and welding units required for erection.
 - b) All consumable required for erection and commissioning.
 - c) All erection tools and tackles, cranes, hoisting equipment, etc as required
 - d) All skilled, semi-skilled and unskilled labour required for erecting any facility, as required, for the labour force such as accommodation, transport, medical facility, insurance etc.
 - e) First fill of lubricants and grease etc.
 - f) Commissioning of the entire STP and accessories and handing over to EMPLOYER/ENGINEER.
 - g) Training of the STP personnel for proper operation and maintenance.

10.2.4.4 Layout

The Bidder should provide the area required for the plant. All Supports for all equipment and platforms, walkways, stairways for all equipment as required are in bidder's scope.

The interconnecting pipe shall be laid out in such a way that they are easily accessible for any maintenance or repair and also permits easy movement of the personnel. Easily accessible dismantling joints shall be provided for maintenance purposes.

The exact layout considering the actual equipment dimensions, handling facilities, clearances as required for easy operation and maintenance, pipe support locations etc shall have to be firmed up by the bidder for satisfactory operation of the systems covered under the scope of work.

The proposed layout for STP is attached (refer drawing no. TCE.10106A-161-SI-6003)

10.2.4.5 Piping Material Specification

All the material of construction of piping should be should be compatible with the requirement.

10.2.4.6 Painting

All surfaces such as light gauge / glasses, required for clear visual observation shall be cleaned after paint application.

Special care shall be taken to avoid any paints from dropping on the machined moving parts of equipment, name plates or indicator dials of instruments and control valves. Prior to paint application or spraying paint removable adhesive tape shall be used to cover these.

On final completion of all work, the BIDDER shall leave the entire premises within the site of his operation clean and free from all rubbish resulting from his painting operation and shall remove any paint or other blemishes caused by him on adjacent walls, windows, equipment and finished surface.

All piping shall be painted after hydro test only. The iron and steel surfaces shall be thoroughly cleaned of all rust, scale, grease or oil and then primer coat shall be applied.

The EMPLOYER/ENGINEER reserves the right to inspect the cleaning down and painting operations at any stage and if required by EMPLOYER/ENGINEER unsatisfactory surface preparation or paint application shall be remedied at BIDDER'S expense.

On job site, no painting shall be carried out in a dust laden atmosphere or under unsuitable weather conditions viz. when raining or when metal surfaces are damp or when condensation is likely to affect the paint film before it is dry.

All the exposed non-insulated carbon steel surfaces of equipment, piping and structural & auxiliary steel for pipe and equipment support shall be painted as indicated below:

- (a) Surface preparation – removal of dust, dirt, oil, grease, scale and other foreign material by manual or power tools.
- (b) Primer –2 coat of red oxide primer (conforming to IS: 2074) with minimum dry film thickness (DFT) 25 microns per coat.
- (c) Finish–2 coat of synthetic enamel (conforming to IS: 2932) with minimum dry film thickness (DFT) 50 microns per coat.

10.2.4.7 Codes and Standards

All the equipment, systems and works covered under this specification shall comply with the relevant Indian Standards, regulations and prevailing safety codes in the locality where the equipment will be installed. All the equipment shall comply in all respects with the requirements of latest edition of codes and standards.

In the event of any conflict between the codes and standards referred to in the specification and the requirements of this specification, the more stringent of this requirement shall govern.

10.2.4.8 Performance Test And Guarantees

The BIDDER/Contractor shall guarantee the outlet requirements of the STP system as specified in the section and shall carry out performance guarantee tests for a minimum period of one month (1 month) continuous operation to prove the following performance guarantees (a) Throughout (capacity) of the STP in m³/day (b) treated water parameters.

Quality of the treated water at the outlet shall be as specified in “Treated Wastewater Quality”. (The quality requirement as specified above shall be confirmed by the BIDDER/Contractor).

Guaranteed power and chemical consumption of STP per day in kWh (as measured at a point before input into MCC). The BIDDER/Contractor shall guarantee the power/chemical consumption for the STP Plant.

In case the performance guarantee cannot be proved due to the reasons attributable to the BIDDER/Contractor, then the BIDDER/Contractor shall carry out the required modifications/repairs/replacement to the plant at BIDDER’s cost expeditiously and repeat the performance test runs until all specified guarantees are fully met.

The time period allowed for modifications/repairs/replacement of the STP system in the case as described in above shall be two months (60 days) from the date of commencement of performance tests.

The BIDDER/Contractor shall incorporate features including necessary instrumentation and controls to run the plant at lower loads and at the same time shall maintain the quality of treated water at the battery limit of STP as stipulated in this specification. The necessary sensors required for loading the plant at lower loads shall be in the BIDDER/Contractor's scope of supply.

10.2.4.9 Uptime Guarantee

The contractor shall guarantee for the installed system an uptime of 98%. In case of shortfall in any month during the defects liability period, the Defects Liability period shall get extended by a month for every month having shortfall and no reimbursement shall be made for the extended period.

10.2.4.10 Maintenance Requirements

In order to carry out preventive maintenance, it should be possible to readily disassemble, repair, and reassemble the equipment in the shortest period and to attend to any defect by a minimum disassembly.

The Bidder shall furnish one complete set of any special maintenance tools required for normal maintenance of equipment.

The Bidder shall confirm that space shown for the equipment is adequate from point of view of access, easy maintenance and for day to day operation.

All system must have convenient maintenance characteristics including:
Care should be taken to cause minimum disturbance to production during preventive maintenance.

The bidder shall ensure easy access to replacement part, which can be installed by personnel of minimum skill.

10.2.4.11 Availability Requirements

All equipment and accessories shall be designed for maximum reliability and availability, particularly in respect of the following:

The equipment shall be of proven design, using materials established as appropriate to the service intended. Fabrication / manufacturing processes shall be subjected to quality surveillance and tests.

10.2.4.12 Noise and Vibration

Noise level produced by any equipment individually or collectively shall not exceed 85 dB (A) measured at a distance of 1.5 metres from the source in any direction.

The overall vibration level shall be as per zones A and B of ISO 10816-1. Vibration isolators shall be provided.

10.2.4.13 Chemical Consumption and Power Requirement

Bidder has to indicate the Chemical consumption and the Power required for the plant in the following format.

CHEMICAL CONSUMPTION

Sl. No.	Chemical	Consumption (g/m3)	kg/day
1.			
2.			
3.			
4.			

POWER CONSUMPTION

Sl. No.	Equipment	Numbers Working	Numbers Standby	kW (Rating)	I.kW (Input)	BkW	No. of Working Hours	Total Power Consumption (Kwh)
1.								
2.								
3.								
4.								

Bidder to furnish the above information for each of the equipment in the STP system

10.2.4.14 Data to Be Furnished By Bidder

SUMMARY OF DATA TO BE FURNISHED ALONG WITH BID AND AFTER ACCEPTANCE OF PURCHASE ORDER

The BIDDER shall ensure the following documentation are prepared and submitted to EMPLOYER/ENGINEER for his review / record.

ALONG WITH BID:

- a) Description of the systems offered along with P&IDs, catalogues, leaflets, layout drawings, area requirements etc. The P & I diagram shall clearly indicate all the equipment, line sizes, valves, instrumentation and controls etc. which form a part of the system offered by the BIDDER. The STP BIDDER shall tag all lines, instruments

and valves as per the guide lines.

- b) All DATA SHEETS duly filled in. The BIDDER has to attach additional data sheets for the items which are not covered in the attached data sheets. Technical details of all the items should be described comprehensively in the offer.
- c) Layout drawing enclosed for locations of equipment & provision of space for operation & maintenance.
- d) Bar chart schedule indicating the date of completion of various activities so as to complete the contract within the time frame stipulated in the tender specification.
- e) Performance curves / rating charts used for selection of equipment for all the systems shall be furnished along with the bid, with the duty points duly marked on them.
- f) Guaranteed Chemical consumption for the STP plant.
- g) Makes of all bought out equipment, piping and instruments.
- h) Control Philosophy

AFTER AWARD OF CONTRACT:

- a) Foundation details and drawings for all equipment in the system in scope with loading details.
- b) General Arrangement drawing of the agreed scheme with the client showing all equipment, drains, pipe/cable trench, operation / maintenance space. The Bidder shall check with the EMPLOYER/ENGINEER for the land allocated to set up the STP and prepare the GA drawings and other details in conformance with the same.
- c) Piping layout drawing (Plan & sections) for all piping within scope of the BIDDER clearly indicating locations of supports & loading details.
- d) The P & I diagram clearly indicating all the equipment, line sizes, valves, instrumentation and controls etc. which form a part of the system offered by the BIDDER. The BIDDER shall tag all lines, instruments and valves as per the guide lines.
- e) Isometric drawing up to battery limit
- f) Maximum allowable loads and moments (as applicable)
- g) Drawings and data sheets for all equipment as listed in various data sheet C enclosed with specification.
- h) Quality assurance plan
- i) As-built drawings.
- j) Basic Engineering Package (BEP) including unit sizing and hydraulic calculations and Structural design of STP units.

The BIDDER/Contractor shall furnish calibration certificates for the instruments to be used for inspection, testing and commissioning at shop & site. The calibration certificates furnished by the BIDDER/Contractor shall not be more than 12 months old.

10.2.4.15 Final Documents:

BIDDER shall submit the three copies of operation and maintenance manuals at the time of commissioning in addition to one copy two weeks before despatch. The

manual shall be in sufficient detail with step by step instructions to enable others to inspect erect, commission, maintain, dismantle, repair, reassemble and adjust all parts of the equipment. Each manual shall also include a complete set of approved as built drawings together with performance / rating curves / charts of the equipment, maintenance schedule and test certificates wherever applicable.

The BIDDER shall submit Quality assurance documentation specific for the project.

10.3. STP-ELECTRICAL REQUIREMENTS

10.3.1 SCOPE AND BRIEF DESCRIPTION OF WORK

The scope of Contractor shall include supply, installation, testing and commissioning all electrical systems and equipment required for the STP.

The major equipment/system covered under scope of work shall be as follows:

- (a) 415 V switchgear
- (b) LT power & control and instrumentation cables and cable trays, trenches, cable racks with necessary fire barriers, fire proof sealing and coating systems, Supporting structures, cable laying & Termination and all other cable accessories.
- (c) Control Panel
- (d) Drive motors (LT) for all rotating mechanical equipment.
- (e) Total illumination system with LDB lighting fixtures, lamps etc.
- (f) Earthing and lightning protection.
- (g) Electrics for mechanical equipment (Feeders for hoists, ventilation system and welding).
- (h) Civil works for electrical equipment such as foundation, panel opening, trenches, etc.
- (i) Essential spares and special tools and tackles required for installation, operation and maintenance of electrical equipment.

10.3.2 DETAILED SCOPE OF WORK - ELECTRICAL

a. Power Supply Scheme

The 415 V supply is used to feed the pump motors at pumping station.

b. Lt Switchgear

415 V, 3 phase, 3 wire LT PMCC shall feed all LV loads of each pump house auxiliary loads. The PMCC shall have incomer and required number of outgoing feeders. The LT PMCC shall be sheet metal enclosed, compartmentalised and draw out type. Fault interrupting rating shall be 50 kA for 1sec for 415V switchgear.

c. Motors

Induction motors for the pumps shall be rated for 415 V, 3 phase, 50 Hz. All the motors shall be suitable for supply variation conditions of +/- 10% voltage, +/- 5%

frequency and 10% combined voltage and frequency. Starting current of the motors rated up to 60kW shall be 700% of full load current inclusive of tolerance.

d. Cables

LV cables shall be of 1100V grade, copper conductor, XLPE insulated, PVC inner sheath, armoured/unarmoured and FRLS PVC outer sheath. The control cables shall be 1100 V, 1.5 sq.mm stranded copper conductors, PVC insulated, PVC inner sheathed, armoured and FRLS PVC outer sheathed. All power cables shall be sized based on continuous current capacity, short-circuit rating and voltage drops. The suitable derating factors to account for grouping of cables, depth of lying, etc. shall be considered.

e. Lighting System

All indoor and outdoor areas shall be provided with AC lighting. The lighting system shall comprise of HPSV, medium bay fixtures for pump houses, fluorescent/LED fixtures for indoor rooms and HPSV street light fixture for road lighting. The wiring of lighting circuit shall be done by wires in GI conduit for indoor areas and by armoured cables as per clause 2.4 above in outdoor areas. The illumination levels for various areas shall be as per BIS.

f. Earthing And Lightning

Earthing system shall be generally designed on the basis of IS 3043 code of practice for safety earthing. The material of earthing conductors above ground shall be galvanised steel to prevent atmospheric corrosion and shall be of mild steel when buried in the ground or embedded in concrete. The earthing conductor shall be sized considering system fault level, corrosion factor and fault clearing time. Lightning protection shall be provided for buildings/structures covered under this package as applicable as per relevant standards.

g. Civil Buildings And Connected Civil Works

All civil works for electrical equipment, i.e. foundations, rooms, buildings, etc., covered under this package shall be carried out by the Contractor. Switchgear room shall be pressurised ventilated. The layout of this building shall consider operation / maintenance space as per IE rules. The dimension of building shall be subject to Purchaser's approval.

10.3.3 ELECTRICAL SYSTEM DESIGN

a) General Standards

The design, manufacture, assembly and testing as well as performance of the equipment shall conform to the relevant IS specifications (latest revision). In case the Contractor is not in a position to comply fully with certain IS specifications, or in respect of certain items for which there are no IS specifications, the Contractor may base his proposals on IEC/BS/VDE/DIN recommendations or other reputed national or international standards subject to the approval of the purchaser.

All equipment supplied and all work done including system design and detailed engineering shall also comply with the statutory requirements of Indian Electricity Rules.

b) Climatic Conditions

The climatic conditions generally prevailing at site have already been described in main volume. Electrical equipment selection and derating shall generally be based on

ambient temperature of 50 deg. c. For specific hot areas the ambient temperature conditions shall be taken into consideration and equipment suitably derated where necessary. In hot areas of higher temperature conditions, the equipment shall be adequately protected against damage from radiant heat and hot air.

The equipment offered shall be suitable for smooth efficient and trouble free service in the vicinity of sea.

c) Make and Interchangeability

The make of major equipment shall be limited to preferred makes indicated under chapter 'List of preferred makes'. If the Bidder prefers to supply other than from the Preferred Makes list, it should be with the approval of the Purchaser.

Makes of all other equipment and accessories are subject to prior approval by the purchaser. Similar equipment and components shall be of same make, equipments of same type and rating shall be interchangeable.

The purchaser has the option of selecting the manufacturers of electrical equipment, instruments and controls and any other specialized items in the interest of standardization and the Contractor shall have to supply equipment of the particular make, if so required.

10.3.4 DESIGN CRITERIA

Standard voltage levels

The standardised voltage levels as given in the Table below shall be adopted:

Sl. No.	Description	Voltage level
1.	Incoming supply	415 V, 3 phase, 3 wire, 50Hz, effectively earthed.
2.	A.C. Drive motors	415 V, 3 phase, 3 wire system effectively earthed.

Permissible variations:

The system unit/plant equipment shall be designed suitable for variation in voltage and frequency as indicated in the table below:

Variation in voltage and frequency

Basic insulation levels

SL. No	Description	Voltage	Frequency
1.	Permissible variation with rated performance/rated current	+/- 10%	+/- 3 Hz
2.	Permissible voltage dip at LT switchgear bus for starting of LT motors	-15%	-

Symmetrical short circuit ratings

The three phase symmetrical short circuit ratings of the switchgear at 415 V shall be as indicated in the Table below:

Symmetrical short circuit rating

Sl. No.	Voltage level	Symmetrical Breaking capacity	Making Capacity
1.	415 V	50 kA	125 kA

The rated short circuit withstand duration for 415V shall be 1 sec.

Criteria for selection of voltage levels for motors: A.C squirrel cage induction motors of ratings up to 7.5 kW shall be fed at 415 V, 3 phase, 50 Hz, with DOL start as applicable.

Degree of protection for various electrical equipment shall be as follows

Sl. No.	Equipment	Degree of Protection
1	Motors located Indoor	IP 54/55
2	LT Switchgear	IP 54

10.4. LIST OF APPROVED BIDDERS \ MAKES FOR STP

10.4.1 GENERAL

This section provides details of the Approved BIDDERS \ Approved makes for bought-out items, which form a part of this enquiry package.

BIDDER shall clearly indicate the makes of all bought-out items and at no point in time during execution shall deviate from those indicated in the offer document.

10.4.2 LIST OF APPROVED BIDDERS \ MAKES FOR STP

List of approved makes for products and materials for STP are indicated in the table below. However, any other make which is equivalent and meeting the tender specifications are also acceptable with prior approval of the engineer.

SL	ITEMS	MANUFACTURER
1.	Butterfly valves	Audco/ Tyco/ Kirloskar/ Fouress Eng./ Hawa or Equivalent
2.	Ball valves	BDK/ KSB/ Audco/ Venus/ Hawa/ IVC/ Leader or Equivalent
3.	Paint\ Epoxy	Berger / Asian paints/ Shalimar paint/ Nerolac or Equivalent
4.	Level Switch	Pune Techtrol\SB Electromechanical\Fitzer

SL	ITEMS	MANUFACTURER
5.	Electromagnetic Flow meter	Krohne Marshall\Rockwin Flowmeter
6.	Sight Flow indicator	Techno flow or Equivalent
7.	Valves	
	a) CI Gate valve\Check Valve	L&T\Kirloskar\BDK\AUDCO
	b) Non Return Valve	Audco\BDK\Fischer\Intervalve
8.	Pumps	
	a) Pumps	Mather & Platt\Becon\GRUNDFOS\Kirloskar\ KSB
	b) Dosing Pump	Asia LMI\ Milton roy or Equivalent
9.	Motors	Siemens\ Crompton Greaves\ NGEF\ ABB
10.	Air Blower	Kay\ Everest\USHA
11.	Pipes and Accessories	
12.	MS / GI / uPVC	Jindal Hissar / Prince / Supreme
13.	Pressure gauges	Wika\ Stauff\ Bell\ Forbes Marshall\ H guru (K.I)\ General Instruments
14.	Diffusers	OTT\ Misuzu\Equivalent
15.	Level indicator\ Transmitter	LEVCON or Equivalent
16.	Electrical Wiring	Polycab / Finolex

10.5. AIR BLOWER

SCOPE

This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at the manufacturer's works and delivery at site of Air Blowers.

CODES AND STANDARDS

The design, materials, construction, manufacture, inspection, testing and performance of air blowers shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to the latest applicable Indian or equivalent standards. Other international standards are also acceptable, if these are established to be equal or superior to the listed standards. Nothing in this specification shall be construed to relieve the BIDDER of this responsibility.

CONSTRUCTION FEATURES

Each air blower shall be a complete unit with casing, inlet and outlet, impeller or rotor, shaft, stuffing box and drive unit etc

CASING

Casing shall be of robust construction. It shall be made from casting or fabricated from heavy gauge steel sheets or plates. Castings shall be free from all defects and blowholes and shall be machined to close tolerance. In case of fabricated casings, it shall be rigidly reinforced and supported by structural members. Weld seams shall be continuous to have air-tight enclosure. Casings shall also have smooth interior to avoid accumulation of dense particles. Inlet shall be spun to have a smooth contour. For large blowers, gasketed and bolted split casings are preferable. Using gaskets shall prevent leakage of air from casing joints.

If necessary, provision for ready access to the interiors of casings and other possible trouble points shall be made by means of readily removable, bolted on plates or by hinged and latched doors.

IMPELLER OR ROTOR

Impeller or rotor shall have die formed blades welded to the rim and back plate. Rim shall be spun to have a smooth contour. Blades shall be of backward, radial or forward type. Rotor assembly shall be securely keyed to the shaft by key and/or nuts. Suitable means shall be provided to prevent loosening during operation. Rotor along with any other rotating parts shall be statically and dynamically balanced to ensure efficient, vibration-free performance and long bearing life. **SHAFT, SLEEVES AND BEARINGS**

The shaft shall be finished to close tolerance at the rotor, coupling, pulley and bearing diameters. The size of shaft shall be calculated on the basis of maximum combined shear stress. This shear stress shall not exceed 30 percent of the elastic limit in tension or 18 percent of ultimate tensile strength.

The design of shaft shall also take into consideration the critical speed of the shaft, which shall be at least 20% above the operating speed or 60 to 75% of the operating speed, to minimise vibrations.

Replaceable shaft sleeves shall be provided to protect the shaft where it passes through stuffing box. The end of the shaft sleeve shall extend through the packing gland. Shaft sleeves shall be securely locked or keyed to the shaft to prevent loosening or rotating.

The bearings may be ball, roller or sleeve bearing. If sleeve bearings are used these shall be machined for close running fit. The bearings shall be designed to take the

necessary radial load as well as the net axial thrust. Bearings shall be lubricated properly and sized for a minimum of 40,000 hours of continuous operation.

STUFFING BOX

Stuffing box shall be provided to ensure leak-proof seal between shaft and casing. Stuffing box shall be designed such that it can be repacked without removing any part other than the gland.

DRIVE-UNIT

The drive-unit shall be complete with drive motor and coupling or secondary transmission. Secondary transmission may be chain drive with chain and sprocket or belt drive with V-belts and pulleys. Coupling shall be of flexible type. The BIDDER shall furnish both halves of the coupling. Coupling halves shall be bored and keyed to fit shafts of the blower and the motor by BIDDER. A common base plate shall be provided for blower assembly and motor. It shall be rigidly constructed, adequately braced and provided with finish pads for mounting the motor and blower. Suitable holes shall be provided for grouting and these shall be so located that the base plate can be grouted in place without disturbing the blower and motor. Even if the PURCHASER supplies drive motor, the BIDDER shall supply both the halves of coupling duly machined and keyed and base plate with motor mounting bolt holes.

GENERAL REQUIREMENTS

Blower shall also be suitable to operate as an exhaustor for the vacuum specified.

Air filter if specified in data sheet A shall have filtering efficiency of 99% down to a particle size of 5 microns.

Drive motor shall be rated as least 15% higher than the power requirement at duty point or 10% higher than the maximum power requirement at selected speed, whichever is higher. Starting torque requirements of blower shall also be considered while selecting the motor.

All rotating parts such as coupling, chain or belt drives etc. shall be covered with suitable protective guards. Guards shall be easily removable type.

Noise level produced by any rotating equipment individually or collectively shall not exceed 85 dBA measured at a distance of 1.5 metres from the source in any direction. The overall vibration level shall be as per zones A and B of ISO 10816-1. Balance quality requirement shall be G-6.3 conforming to ISO 1940/1. Vibration dampening pads if required, shall be provided.

Suitable drain connection shall be provided.

PERFORMANCE GUARANTEE

Performance parameters to be guaranteed by the BIDDER and tolerances permitted shall be as indicated in section C. The BIDDER shall confirm acceptance of these by indicating values in data sheet B. Blower or any portion thereof is liable for rejection, if it fails to give any of the guaranteed performance parameters.

DATA SHEET C

DATA TO BE FURNISHED BY THE BIDDER

AFTER THE AWARD OF CONTRACT

1. List of drawings and documents to be submitted for review, approval, and information with scheduled submission dates
2. Quality Assurance Plan (QAP)
3. Calculations for capacity, drive motor rating, selection of speed reducers and couplings
4. Performance curves for blower with duty point marked. In addition to curves for operating conditions, characteristic curves shall be submitted considering minimum and maximum ambient temperature, minimum and maximum humidity and minimum and maximum frequency conditions
5. Torque - Speed curve
6. Detailed to-scale dimensioned general arrangement drawing of blower and motor giving foundation details, loading data like static and dynamic loads, unbalanced forces and moments if any, pocket details etc. Drawings shall also include all data and information furnished in data sheets B
7. Part list of blower components such as casing, impeller or rotor, inlet and outlet, shaft etc. with materials and codes of construction
8. Overall space and headroom requirement with details of handling during erection, operation and maintenance of the equipment
9. Relief valve and other instrument data sheets, if applicable
10. Erection, operation and maintenance manual with lubrication schedule.

		DATA SHEET A		SHEET: 1 OF 2	
		AIR BLOWERS			
GENERAL	1. DESIGNATION: Refer Table-1	DESIGN DATA (CONTD.)	20. MAXIMUM SPEED OF BLOWER: <input type="text"/> RPM		
	2. NUMBER REQUIRED: Refer Table-1		21. SPARK RESISTANT CONSTRUCTION		
	3. TAG NUMBERS: By Bidder		TYPE AS PER AMCA: <input type="text"/> A/B/C		
			22.		
	4. LOCATION: INDOOR	MATERIALS AND CODES OF CONSTRUCTION	23. CASING: PP		
	5. DUTY: CONTINUOUS		24. IMPELLER OR ROTOR: PP		
	Hrs/Day				
	6. LOCATION IN HAZARDOUS AREA:		25. SHAFT: EN-8		
	NO		26. SHAFT SLEEVE: <input type="text"/>		
	7. HAZARDOUS AREA CLASSIFICATION		27. STUFFING BOX: IS 2062/ <input type="text"/>		
	AS PER IS 5572 ZONE 0/1/2/		28.		
	8. ARRANGEMENT NUMBER AS PER		ACCESSORIES	29. INLET GUARD: YES/ NO	
	AMCA: (NOTE 1)	30. INLET VANE: YES/ NO			
	9.	31. INLET BOX: YES/ NO			
10. TYPE OF BLOWER: CENTRIFUGAL	32. AIR FILTER - PAPER /HDPE: YES/ NO				
	33. INLET CONNECTION: FLANGED/				
11. TYPE OF BLADE: BACKWARD/					
RADIAL/FORWARD	34. OUTLET CONNECTION: FLANGED/				
12. MEDIUM HANDLED: AIR/AIR WITH					
DUST (NOTE 2)	35. RELIEF VALVE: YES/ NO				
13. SUCTION TEMPERATURE: Ambient °C	36. OUTLET DAMPER: YES/ NO				
14. DESIGN TEMPERATURE: Ambient °C	37. VIBRATION DAMPENING PADS: YES/ NO				
15. SUCTION PRESSURE: <input type="text"/> Kg/cm ² g/	38. COMMON BASE FRAME: YES/ NO				
TO CREATE _____ cm.Hg. VACUUM	39. FOUNDATION BOLTS: YES/ NO				
WHEN USED AS AN EXHAUSTER	40.				
16. SUCTION HUMIDITY (RH %): MAX	41.				
17. SPECIFIC GRAVITY OF MEDIUM AT	DRIVE DATA	42. MOTOR: VENDOR			
SUCTION TEMPERATURE:		AS PER TCE.M4-203-01/02			
18. CAPACITY (FAD)		43. STARTER: /VENDOR			
18.1 NORMAL: M ³ /Hr		44. TYPE OF COUPLING: FLEXIBLE/			
18.2 MAXIMUM: M ³ /Hr		V BELT/ <input type="text"/>			
19. DISCHARGE PRESSURE: Kg/cm ² g		45.			

		DATA SHEET A		SHEET: 2 OF 2											
		AIR BLOWERS													
PAINTING	46. PRIMER: RED OXIDE /EPOXY	TESTS AND INSPECTION	50. TCE.M4-904 AND/OR TCE.M4-185-01												
	46.1 NUMBER OF COATS:		AND TCE.M4-185-39 OR TCE.M4-186-08												
	46.2 DRY FILM THICKNESS PER COAT:		(NOTE 3)												
			51.												
	47. FINISH PAINT:	CODES AND STANDARDS	52.												
			53. FOR DESIGN, TESTING AND												
	47.1 NUMBER OF COATS:		INSPECTION: IS 4894/BS 848/												
	47.2 DRY FILM THICKNESS PER COAT:		AMCA 203/AMCA 210												
		54.													
SPARES AND MAINTENANCE TOOLS AND TACKLES	48. REFER TCE.M4-907	PERFORMANCE GUARANTEES	55. CAPACITY (FAD):												
	49. ESSENTIAL SPARES		(+) (-) M ³ /Hr												
	49.1		56. DISCHARGE PRESSURE:												
	49.2		(+) (-) Kg/cm ² g												
	49.3		57. POWER CONSUMPTION:												
	49.4		(+) (-) KW												
	49.5		58.												
	49.6	COST LOADING AND PENALTY	59. POWER CONSUMPTION:												
	49.7		Rs. /KW												
	49.8		60.												
	49.9		61.												
NOTES:															
1.	REFER AMCA STANDARD 99-2404-78 IN AMCA STANDARDS HANDBOOK.														
2.	COMPOSITION OF AIR WITH DUST:														
3.	FOLLOWING ADDITIONAL TESTS INDICATED AS 'B' IN TCE.M4-186-08 SHALL ALSO BE CARRIED OUT WHEN TCE.M4-186-08 IS APPLICABLE														
	Indicates Bidder to Specify TABLE – 1 <table border="1"> <thead> <tr> <th>Sl. No.</th> <th>Item Description</th> <th>Quantity</th> <th>Capacity(Cum/hr)</th> <th>Head(M)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Air Blowers for Equalization Tank & MBBR Tank</td> <td>1W+1S</td> <td>By bidder</td> <td>By bidder</td> </tr> </tbody> </table>					Sl. No.	Item Description	Quantity	Capacity(Cum/hr)	Head(M)	1	Air Blowers for Equalization Tank & MBBR Tank	1W+1S	By bidder	By bidder
Sl. No.	Item Description	Quantity	Capacity(Cum/hr)	Head(M)											
1	Air Blowers for Equalization Tank & MBBR Tank	1W+1S	By bidder	By bidder											

10.6. HORIZONTAL CENTRIFUGAL PUMPS

10.6.1 SCOPE

This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at manufacturer's works and delivery at site of Horizontal Centrifugal Pumps.

10.6.2 CODES AND STANDARDS

The design, materials, construction, manufacture, inspection, testing and performance of horizontal centrifugal pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to latest applicable Indian or equivalent standards. Other international standards are also acceptable, if these are established to be equal or superior to the listed standards. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

10.6.3 DESIGN REQUIREMENTS

- a) Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division. Components of identical pumps shall be interchangeable.
- b) Flow rate versus head curve shall have stable and continuously rising characteristics towards the shut-off head. In case of unstable (drooping) characteristics the duty point shall be well away from the unstable region. Besides the actual flow rate versus head curve, curves for minimum and maximum impeller diameters shall also be shown.
- c) The shut-off head shall be at least 110% of the differential head.
- d) The required NPSH at duty point shall be at least one (1) metre less than the available NPSH.
- e) The rating of the pump driver shall be the larger of the following :

The maximum power required by the pump from zero discharge to run-out discharge at site climatic conditions.

110% of the power required at the duty point at site climatic conditions.

- a) The corrosion allowance for pressure parts shall be 3 mm.
- b) Pumps shall run smooth without undue noise and vibration. Noise level produced individually or collectively shall not exceed 85 dB(A) measured at a distance of 1.86 metres from the source in any direction. The overall vibration level shall be as per zones A and B of ISO 10816-1.

- c) In case of fire water pumps, pumps and drivers with all the accessories shall meet the requirements of Tariff Advisory Committee (TAC). Pump type shall be as approved by TAC.

10.6.4 CONSTRUCTION FEATURES

- a) In addition to static balancing, impeller and balancing drum shall be balanced dynamically at or near the operating speed.
- b) Pump shall be provided with renewable type casing ring. Pump having capacity 1,000 M3/Hr and above shall be provided with impeller ring in addition to casing ring. The hardness of impeller ring shall be 50 BHN higher than that of casing ring.
- c) Pump casing shall be provided with drain and vent connection with plugged or valve connection.
- d) Bearing shall be oil-lubricated or grease-lubricated and shall have a life of 40,000 hours of working. In case of oil-lubricated bearing, constant oil leveller with magnetic drain plug shall be provided.
- e) Replaceable shaft sleeves shall be provided to protect the shaft where it passes through stuffing box.
- f) Stuffing box shall be of such design that it can be repacked without removing any part other than the gland and lantern ring.
- g) Mechanical seals shall be provided. If required, a flushing line shall be furnished, complete with strainer and orifice, from the pump discharge to the sealing face. When pumping liquid is not suitable for this purpose, a flushing connection shall be provided so that it can be connected to an external source. Auxiliary piping and plan shall be in accordance with appendix - D of API 610.
- h) The allowable loads on the pump nozzles shall be at least twice the values listed in the relevant tables of API 610 without reference to any other criterion. The base plate shall be designed to cater to the above increased loads.
- i) All pumps, except for back-pull out type, shall be provided with flexible coupling. Back-pull out type pumps shall be provided with spacer type coupling.
- j) Coupling guard made of expanded metal and bolted to the base plate shall be furnished for all coupled pumps.
- k) All incidental piping and valves required for sealing, lubrication and cooling for stuffing box packing and/or bearing of pump shall be furnished by the VENDOR.
- l) Leakage from the pump shall be led to the nearest surface drain by OTHERS. Pump VENDOR shall provide necessary arrangement like drip tray, base plate drain connection etc.

10.6.5 TESTS AND INSPECTION

- a) Hydro test pressure on casing shall be 1.5 times maximum discharge head or twice differential head whichever is higher. (Maximum discharge head = shut-off head + maximum suction head). Unless otherwise stated in data sheet A, the hydrostatic tests on the casing shall be conducted for a minimum duration of 30 minutes.
- b) The pumps shall be tested as per IS 5120, at rated speed at MANUFACTURER's works to measure capacity, total head, efficiency and power. The negative tolerance on efficiency shall be limited to 2.5% and not 5% as indicated in IS 5120. These tests shall form the basis for acceptance of pumps except for vibration and noise. The pumps shall be tested over the range covering from shut-off head to the maximum flow. The duration of the test shall be minimum one (1) hour. Minimum five (5) readings approximately equidistant shall be taken for plotting the performance curves.
- c) After installation, the pumps shall be subjected to testing at site also. If the site performance is found not to meet the requirements regarding vibration and noise as specified, the equipment shall be rectified or replaced by the VENDOR, at no extra cost to the PURCHASER.

10.6.6 PERFORMANCE GUARANTEE

Performance parameters to be guaranteed by the VENDOR and tolerances permitted shall be as indicated in section C. BIDDER shall confirm acceptance of these by indicating values in data sheet B. Pump or any portion thereof is liable for rejection, if it fails to give any of the guaranteed performance parameters.

10.7. SUBMERSIBLE PUMPS

10.7.1 SCOPE

This Specification covers the requirements of design, material, construction features, manufacture, inspection and performance testing of Submersible Pump for Waste Water.

10.7.2 DESIGN FEATURES

- a. Pump shall be submersible & non-clog type. Pump shall be suitable for wet or dry pit installation, fixed or portable type and shall be suitable for working with the minimum liquid level. Components of identical pumps shall be interchangeable.
- b. The pump shall be designed to handle solid sizes as required in design.
- c. Fixed type pump set shall be with control panel with all safety devices.

10.7.3 FEATURES OF CONSTRUCTION

- a. Impeller shall be non-clog type with smooth blunt edges and large water ways so as to allow free passage of the large size solids. It shall be free from sharp corners and projections likely to catch and hold rags and stringy materials. The impeller shall be statically and dynamically balanced.
- b. Double Mechanical seals shall be provided to protect the motor from ingress of waste water along the shaft. The preliminary and secondary seals shall be oil-lubricated with tungsten carbide or silicon-carbide faces and they should be equipped with an electrical monitoring system for seal failure detection.
- c. Motor and pump shall have a common shaft with bearings. The bearing shall be permanently greased and maintenance free.
- d. Portable type submersible pump should be equipped with pump base stand / legs, adequate length of chain and flexible type discharge hose pipe suitable for directly lowering into the well.
- e. Fixed type submersible pump shall be provided with a 90° duck foot bend for fixing to the concrete floor of the well. The joint between the pump discharge flange and the delivery piping shall be made by merely lowering the pump into guide system at the access level. It shall be provided with all necessary fixings for guiding the pumps during lifting/lowering.

10.7.4 INDUCTION MOTOR FOR SUBMERSIBLE PUMPS

The submersible motor shall confirm to IS:9283:1995.

10.7.5 PERFORMANCE AND CHARACTERISTICS

- a. Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under varying voltage and frequency supply conditions as called for in Data Sheet.
- b. Motors shall be suitable for full voltage direct-on-line starting or star-delta starting.
- c. The starting current of motor shall not exceed 200% of rated full load current for star/delta starting and 600% of rated full load current for DOL starting, under any circumstances.
- d. Motors shall be capable of starting and accelerating the load with the applicable method of starting, without exceeding acceptable winding temperatures, when the supply voltage is in the range 85% of the rated motor voltage to maximum permissible voltage, for category B type motors.
- e. The locked rotor current of the motor shall not exceed 600% of full load current (subject to tolerance as per the applicable standard).

- f. Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation.
- g. The motor vibrations shall be within the limits specified in applicable standard unless otherwise specified for the driven equipment.
- h. Except as mentioned herein, the guaranteed performances of the motor shall be met with tolerances specified in applicable standard (IS:9283:1995).
- i. Protection against increase in stator winding temperature, bearing temperature, leakage in stator housing and terminal box shall be provided. Minimum 3 nos. thermistors in series to be provided to sense the stator winding temperature. Sensors to be provided to detect leakage of waste water into oil housing.

10.7.6 SUBMERSIBLE CABLE

- a. The cable shall be PVC insulated and PVC sheathed, flexible, 3 core flat type. The size of the conductor shall be adequate for continuous use under water and air.
- b. In case a joint is required to be made between the lead cable supplied with the motor and the user's cable connectors, a detailed procedure of cable jointing to make a watertight joint shall be provided by the manufacturer.
- c. The size of the conductor and length of cable should be suitably selected so that the voltage drop at motor terminals does not exceed 3 percent of the rated voltage.

10.7.7 EARTHING

- a. Earthing of the motor shall be done in accordance with the relevant provisions of IS: 3043:1987.
- b. For fixed installation, earthing connection may be made to discharge pipe clamp.

10.7.8 INSULATION

- a. Any joints in the motor insulation such as at coil connections or between slot and end winding sections shall have strength equivalent to that of the slot sections of the coil.
- b. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The tropicalising treatment shall be as per the applicable standard.

10.7.9 TEMPERATURE RISE

The temperature-rise test of the motor shall be taken with the motor coupled to the suitable pump to give the full load output of the motor. When the various temperatures are stabilized, the set is stopped and the temperature-rise of the stator winding by the resistance method shall not exceed 35°C at rated voltage and 45°C at 85% of the rated voltage. During the test, the temperature of the cooling water may not exceed 45°C. As the cable resistance will also be substantial, it is necessary that while calculating the temperature rise by resistance method, due care is taken to account for the correct hot and cold resistance of windings.

10.7.10 CONSTRUCTION FEATURES

The motor shall be suitable for continuous use in fully or partially submerged condition. A built-in cooling system if required shall be provided to allow the motor to operate continuously at its rated output regardless of whether the electric motor is submerged or not by providing either external or internal cooling arrangement.

10.7.11 TESTS AND INSPECTION

Pump testing and inspection shall be as per manufacturer recommendation.

10.7.12 DRAWINGS

1. The following drawings shall be submitted by the BIDDER along with their proposal.
2. Preliminary outline dimensional drawing showing details of pump set, installation details, civil foundation, clearances, minimum submergence, etc.
3. Performance curves for capacity vs. total head, efficiency, and input to motor. The capacity range shall be zero flow to run out flow.
4. Typical cross sectional drawing showing constructional details.

10.8. VALVES AND SPECIALITIES GENERAL REQUIREMENTS

10.8.1 SCOPE

The following paragraphs describe general requirements for valves and specialities.

CODES AND STANDARDS

Valves and specialities shall be generally as per the following standards:

- | | | | |
|---|-------------|---|--|
| 1 | ANSI B16.1 | : | Cast Iron Valve Ratings |
| 2 | ASME B16.34 | : | Ratings of Valves-Flanged, Threaded and Welding Ends |

3	API 594	:	Wafer and Wafer - Lug Check Valves
4	API 600	:	Steel Flanged and Butt Welding End Gate Valves
5	API 602	:	Steel Gate Valves, Threaded and Socket Welding Ends
6	API 609	:	Butterfly Valves
7	BS 1414	:	Steel Gate Valves, Flanged and Butt Welding Ends
8	BS 1868	:	Steel Check Valves, Flanged and Butt Welding Ends
9	BS 1873	:	Steel Globe Valves, Flanged and Butt Welding Ends
10	BS 5156	:	Diaphragm Valves
11	BS 5351	:	Steel Ball Valves
12	BS 5352	:	Steel Gate, Globe and Check Valves, 50 mm and Smaller
13	IS 778	:	Bronze Valves
14	MSS-SP 67	:	Butterfly Valves

2.0 GEAR OPERATORS

Gear operators shall be provided on the following basis:

2.1 GATE AND GLOBE VALVES

Up to and including ANSI 300 class	-	350 mm and larger
600 class and higher	-	200 mm and larger

2.2 OTHER VALVES

Plug and ball	-	150 mm and larger
Butterfly	-	200 mm and larger

2.3 Gear operators shall be suitable for a differential pressure corresponding to the maximum valve rating at room temperature.

2.4 All gear operators shall be of the enclosed type.

3.0 INTEGRAL BYPASS

3.1 Gate valves shall be provided with integral bypass valve, as per MSS-SP 45, as follows:

Classes 150 and 300	-	350 mm and larger
Class 600 and higher	-	200 mm and larger

- 3.2 Type of bypass valve shall generally be the same as the main valve. Bypass pipe shall be at least schedule 80 and material of construction of bypass valve and pipe shall be compatible with the main valve.

4.0 VALVE STEMS

Valve stems shall be of wrought materials. Castings are not acceptable.

5.0 BACKSEAT

All gate, globe and piston valves shall be provided with back seating arrangement to facilitate replacement of gland packing with the valve in service.

6.0 CHECK VALVES

Check valves of sizes 350 mm and larger shall be provided with features to prevent slamming and hammering. These can be in the form of springs or external dash pot.

7.0 HARDNESS

13% chromium steel seat surfaces shall have a minimum hardness of 250 BHN and a differential hardness of 50 BHN.

8.0 NAME PLATES

The details on name plates shall be as per MSS-SP 25.

9.0 TAG PLATES

Tag plates shall be of stainless steel type 304 or aluminium.

10.0 TESTING

Strength and leak tests shall be as per any of the standards MSS-SP-61, API 598 or BS EN 12266-1 and 2 at the test pressures indicated in data sheet-A. Stainless steel valves shall be tested using potable water.

11.0 NDT REQUIREMENTS

- 11.1 All cast steel valves shall be subject to radiography in all accessible areas, as defined in ASME B16.34, on the following basis:

- | | | | |
|-----|----------------------|---|-------------------------|
| (a) | Class 600 and higher | - | All sizes |
| (b) | Class 300 | - | Sizes 450 mm and larger |
| (c) | Class 150 | - | Sizes 600 mm and larger |

- 11.2 All cast steel valves of class 600 and higher shall also be subject to magnetic particle or liquid penetrant examination as per ASME B16.34.

11.3 All cast steel valves of class 300 shall have radiography quality castings irrespective of size.

11.4 Acceptable levels of defects shall be as per ASME B16.34.

12.0 FACE-TO-FACE OR END-TO-END DIMENSIONS

12.1 Face-to-face dimensions of flanged-end valves and end-to-end dimensions of butt welding-end valves shall be as per ASME B16.10.

12.2 For valves not covered by ASME B16.10, the dimensions shall be as per applicable valve standards.

13.0 PREPARATION FOR DESPATCH

13.1 COATING

All carbon steel and cast iron exposed surfaces shall be given one coat of primer and two coats of aluminium finish paint after release has been given for painting and before despatch. Machined surfaces shall be coated with easily removable rust protective except that this is not applicable for austenitic stainless steel components.

13.2 END PROTECTION

After completion of the requirements of para 14.1, body end ports, flange faces and welding ends shall be covered with suitable close fitting protectors to protect the machined ends and prevent ingress of dirt and moisture.

13.3 DISC

The disc shall be closed before despatch except in the case of soft-seated valves where the disc shall be backed off to relieve the pressure on the seal.

13.4 PACKING

Valves and specialities shall be so packed as to minimise the possibility of damage during storage or transit. The packing shall be suitable for tropical conditions.

			DATA SHEET A					SHEET : 1 OF 1			
			BUTTERFLY VALVES								
GENERAL	1.	TAG NO.:	NIL	4.	FLUID :	WATER	SIZE	QUANTITY			
	2.	SIZE RANGE:	≥ 50 NB & ≤ 150 NB	5.	DES. PR. :	7.0 Kg/ cm ² (g)					
	3.	RATING:	PN 1.0	6.	DES. TEMP. :	AMBIENT	mm	P0			

	17.	BOLTS, STUDS & NUTS	:	ASTM A 193 Gr. B7 / A 194 Gr. 2H					
	18.								
TESTS & INSPECTION	19.	SHELL HYDRO	:	By Bidder					
	20.	SEAT HYDRO	:	By Bidder					
	21.	SEAT AIR	:	By Bidder					
	22.	INSPECTION :AS PER (a) TCE.M4-904 AND (b) TCE.M4-185-30 TCE.M4-186-04 (STRIKE OUT WHAT IS NOT APPLICABLE)							

NOTES: 1. GENERAL REQUIREMENTS : AS PER TCE.M4-103-99.
2. THE FOLLOWING ADDITIONAL TESTS, INDICATED AS "B" IN TCE.M4-186-04, SHALL ALSO BE CARRIED OUT : NIL

				DATA SHEET A			SHEET : 1 OF 1			
				CHECK VALVES						
GENERAL	1.	TAG NO.	:		SIZE	QUANTITY				
	2.	SIZE RANGE	:	≥ 50 NB						
	3.	RATING	:	PN 1.0						
	4.	GRADE	:	GA, CA	mm	P0	R0	R1	R2	
CONSTRUCTION FEATURES	5.	TYPE	:	DUEL PLATE WAFER	50	Bidder to estimate				
	6.	ENDS	:	WAFER TO SUIT ANSI B 16.5, 150# RF FLANGE	65					
	7.	CAP/ COVER	:	BOLTED	80					
	8.	SEAT	:	BODY : RENEWABLE	100					
			:	DISC : INTEGRAL						
	9.	DASH POT ARRANGEMENT FOR SIZES								
	10.	OTHER REQUIREMENTS	:							
MATERIALS	11.	BODY/ CAP/ COVER	:	CI IS 210 GR FG 260						
	12.	DISC	:	CARBON STEEL						
	13.	BODY SEAT	:	NITRILE						
	14.	DISC SEAT	:	NYLON EPDM						
	15.	HINGE PIN	:	SS 304						
	16.	CAP/ COVER GASKET	:	SPIRAL WOUND SS304 + ASBESTOS						
	17.	SPRING	:	SPRING STEEL						
TESTS & INSPECTION	18.	SHELL HYDRO	:	By Bidder						
	19.	SEAT HYDRO	:	By Bidder						
	12.	INSPECTION :AS PER (a) TCE.M4-904 AND (b) TCE.M4-185-30 OR TCE.M4-186-04 (STRIKE OUT WHAT IS NOT APPLICABLE)								
NOTES: 1. GENERAL REQUIREMENTS : AS PER TCE.M4-103-99. 2. THE FOLLOWING ADDITIONAL TESTS, INDICATED AS "B" IN TCE.M4-186-04, SHALL ALSO BE CARRIED OUT WHEN TCE.M4-186-04 IS APPLICABLE : FOLLOWING TESTS ARE APPLICABLE A) RADIOGRAPHY FOR PRESSURE PARTS B) DYE PENETRANT TEST FOR PRESSURE PARTS C) HARDNESS TEST FOR TRIMS.										

TECHNICAL SPECIFICATION
LANDSCAPE WORKS

LANDSCAPE WORKS

11.1. SCOPE OF WORK

- 1.1 The Scope consists of clearance of the Site of Works and preparation of the same to commence the proposed landscape execution activities. Wherever applicable, this is deemed to include all preliminary works like Dismantling/Demolition, Site Clearance, and General Leveling etc.
- 1.2 The drawings shall be read in conjunction with the specifications and matters referred to, shown or described in one are not necessarily repeated in the other.
- 1.3 In the event of any element of specification not available in any of the documents the instructions of the Engineer-in-Charge in writing shall be followed by the Contractor.
- 1.4 The work shall be carried out in accordance with the drawings and designs as would be issued to the Contractor by the Project manager duly signed and stamped by him. The Contractor shall not take cognizance of any drawings, designs, specifications, etc. not bearing Project manager signature and stamp.
- 1.5 The work shall be executed and measured as per metric dimensions given in the Schedule of Quantities, drawings etc.

11.2. GENERAL ITEMS

The more important Codes, Standards and publications applicable to this section are listed hereinafter.

11.2.1 Setting out the works

- The Contractor shall supply without additional charges the requisite number of persons with the means and material necessary for the purpose of setting out works and checking, weighing and assisting in the measurement or examination at any time and from time to time, of the work or the materials. Failing this, the same may be provided by the client's designated representative In-charge at the expense of the Contractor and the expenses shall be deducted from any money due to the Contractor under the contract or from his security deposit.
- The Contractor shall arrange for a qualified surveyor to set out the works and obtain certification of its accuracy from the surveyor. The Contractor shall then set out the works and shall be responsible for the true and perfect setting out of the same and for the correctness of the positions, levels, dimensions, and alignment of all parts thereof and for provision of all necessary instruments, appliances and labour in connection therewith. The Contractor shall submit to the client and the Landscape Architects, margins and the verifications of layout within seven days from the date of getting site layout from Landscape Architects / client.
- Mark the layout on the site. All bench marks, levels should be properly established and preserved for future use.

- Clearly check the surveyed map provided by the client and mark all drainage lines, water pipe lines, electrical lines, etc. client has been asked to remove the electrical lines and electrical poles. It needs to be checked by Contractor to satisfy him / herself from safety point of view before starting of work.
- The checking of any setting out or of any line or level by the Landscape Architects and CLIENT's representative or their representative shall not in any way relieve the Contractor of his responsibilities, for the correctness thereof. The Contractor shall carefully protect and preserve all benchmarks and other things used in setting out of the work.

11.2.2 Site Clearing / Excavation / Site Grading

- Light irrigation, by flooding the whole site with water. The water should penetrate up to depth of 15-20 cm only so that the weeds can germinate. Remove all grasses, small shrubs/weeds etc. with roots. Excavating the site as marked on the drawing/as instructed at the site, up to any lead and lift.
- Verify the levels and bench-marks from the up-dated surveyed drawing made available by the client. If there are any discrepancies between the site and the survey drawing, the same are to be brought to the client's notice by addressing a letter to the client and copy marked to the Landscape Architects.
- Grading and levelling of site as shown in drawing / specified on site by Landscape Architects. This will include spreading manually or by help of soil unloaded at different working areas in the site so as to obtain basic datum levels and grades.
- Excavated material shall be stacked off in the manner indicated at the site including stacking of excavated material up to any lead and lift. The rate shall only cover the cost of excavation, stacking and/or spreading of the material, if required at the site.
- Clearing the area of unwanted materials including the weeds, stones, masonry pieces etc. and all such matter that may cause damage to growth of the plant materials immediately or in future.

11.3. EARTH WORKS

- Earthworks shall involve the grading of soil for earth mounding, the excavation of trenches and soil for formation levels of pathways and foundations, and the fine grading of earth banks and landscape areas roughly graded by others.
- Excavation shall be carried out to the depth shown on or implied in the drawings or to such greater or lesser depths as the Landscape Architect may direct. The Contractor shall supply and fit all shoring, sheeting, strutting and walling required to maintain the sides of excavations as long as necessary and to remove them as required. The Contractor is to allow for making all necessary adjustments to existing manholes in accordance to bring them to the same level as the required profiled grades. No claim shall be entertained for either bulking or compacting and all other quantities shall be measured net from the drawings.
- The stripping and replacement of the subsoil shall only be done in dry weather and ground conditions unless in exceptional circumstances the Landscape Architect authorizes otherwise. Subsoil in heaps or dumps shall not be sited so as to damage or

impede water courses or other drainage so long as they are capable of remaining in operation. Any weeds which may grow on the heaps of subsoil shall be sprayed with an approved selective weed-killer to prevent seeding.

- Notwithstanding the general description for the type of material to be excavated, if original bed rock is encountered during these operations which can only be removed by blasting or compressed air tools this work will be paid for separately as an extra over item for that given for normal excavation. This work shall only be undertaken when authorized in writing by the Landscape Architect.
- During excavation it is expected that the Contractor will take every prudent step or precautions such as tests or borings in order to prove the nature or type of material underneath or the ground bearing capacity in order to protect his workmen, plant or machinery employed in these operations.
- In the event of the Contractor excavating below the proper levels or otherwise in excess of the dimension given, he shall at his own expenses, remove all loose excavated material and replace the soil excavated in error.
- If, in the opinion of the Landscape Architect the bottoms of any excavation or any material to be excavated become unsuitable due to the Contractor's operations, the Contractor shall, at his own expenses, carry out any necessary excavation and make up in a similar manner to the above.
- If, in the opinion of the Landscape Architect the weather conditions are such as to preclude the satisfactory completion of any operation or cause unnecessary nuisance or disturbance to other parties, the Contractor shall, on receiving directions from the Landscape Architect suspend operations on that particular portion of the work until the Landscape Architect considers that weather conditions are satisfactory, or issues a direction to re-commence operations. The absence of such a direction shall in no way constitute the basis of a claim for delay or remedial work to a formation which is unsuitable.

11.3.1 Major Grading

- Site shall be complete with rough dressing including the base levels by civil contractor before handed over to landscape contractor for execution.
- Role of Landscape contractor involves major grading forming earth mounds / hillocks from imported fill materials where specified, or from the site debris and soil generated by excavations. The soil shall be graded using suitable earth moving machinery to the contoured earth forms indicated on the drawings. Soil, when in a dry enough state for easy working, shall be distributed to the correct areas and laid in layers not exceeding 100mm thick and compacted by at least 2 passes of the earth moving machine in each direction for each 100mm layer.
- Earth slopes are to be formed from the compacted mounds to the gradients and levels shown on the drawings, accounting for the topsoil depths to be included after subsoil formation is complete. If insufficient fill is available to complete the levels shown, additional suitable subsoil is to be imported to make up the required quantities. Importation of additional fill shall only be carried out with written permission of the Landscape Architect.

- Earthworks levels are to be carried out to the contours shown on the drawings to a maximum tolerance of 150mm measured vertically, and to a maximum gradient of 1:2. All subsoil levels are to account for the later additional of specified depths of topsoil.
- The Contractor shall be responsible for protection of completed subsoil mounds and shall take preventative measures to control erosion and siltation restore or replace any portion of the earthwork areas which erodes, slumps, silts or is otherwise damaged by the out-washing of soil.

11.3.2 Excavation for Formation Levels and Trenches

- For footpath areas or other paving areas, excavate subsoil to create a smooth formation for taking the sub-base for the paved area, to levels shown on the drawings accounting for the depth of the paving build up.
- Firmly compact sub-grade with a smooth wheeled vibratory roller to achieve an even level. Finished sub-grade is to be protected until the path sub-base or other construction such as pool sub-base is laid. If sub-grade is too dry to be compacted, water shall be added until suitable texture is achieved. If sub-grade is too wet, the material shall be left to dry out until workable.
- A completed sub-grade/formation on which there is standing water, soft spots or slurry shall be deemed to be unsuitable and shall be rectified at the Contractor's expense including making up of additional material as required to bring the formation to line and level again.
- Where soft or wet ground is encountered prior to preparation of the sub-grade and this soft or wet ground cannot satisfactorily be compacted, the Contractor shall submit a written request for this to be inspected and the area to be dug out and replaced with suitable material shall be evaluated by the Landscape Architect and directed accordingly.
- Surplus material resulting from excavations for path formation or drainage trenches shall be taken off site at Contractor's own expense unless otherwise directed by the Landscape Architect in writing.
- Excavation of drainage or formation trenches shall be carried out after the major grading has been completed and approved. Trenches shall be cut to lines and gradients shown on the drawings. Planking and strutting shall be carried out as required to make the sides of the trenches safe. The Contractor will be responsible for ensuring that drainage trenches are kept free from mud and water and side slippage.

11.3.3 Fine Grading and Shaping

- Slight unevenness, ups and downs and shallow depressions shall be removed by fine dressing the surface to the formation levels of the adjoining land, as directed by Project manager and adding suitable quantities of Good earth, brought from approved source, if necessary.
- Fine grading shall be carried out using small sized earth moving equipment or by hand, and shall involve final modeling of the earth contours produced by the major grading exercise. The shaping will follow the contours shown on the plans in general terms, but the final forms will be developed by eye to create smoothly flowing and pleasing contours.

- The Fine Grading will provide the detailed earth contouring prior to cultivation of soil. Soil cultivation and the application of topsoil mixes shall not take place until the Fine Grading is completed.

11.4. SOILS: MATERIALS AND PREPARATION

11.4.1 Soils: Subsoil

- Subsoil shall be a free draining soil, generally from horizon over 300mm below the original surface to be used as fill materials, either excavated from areas of the site, or imported.
- The Contractor shall:
 - I. Furnish the source of top soil to Client.
 - II. Study the soil report provided with the tender document, providing soil details such as pH, alkalinity, total soluble salts, porosity, sodium content and organic matter.
 - III. Use the restored soil at site for landscape purpose, manure mixture, Neemcake, weedicide shall be added if required.
 - IV. Not consider any external soil source unless the existing soil conserved from site is lacking in quality and/or quantity.

11.4.2 Topsoil Mixes

- The components of the Topsoil Mixes shall be as follows:
- Topsoil shall be a free draining organic soil from horizons less than 300mm from the original surface, of a workable crumbly and lump free loamy character and shall contain no grass or weed growth of any kind or other foreign material or stones exceeding 25mm in diameter. Total stone content shall be no greater than 15% by volume. A 1 litre sample with back up soil test data is required before installation, or mixing.
- TOPSOIL SPECIFICATION: The following criteria shall be tested at an approved laboratory before use on site.
 - pH: 5.5 - 7.8
 - Electrical conductivity: 1:2.5 (w/v)
 - Soil-water extracts not exceeding 1500 micromho/cm (1500 micro-Siemens/cm)
 - Soil texture:
 - Sand (0.05 - 2.00mm): Max. 75% Min. 20%
 - Silt (0.002 - 0.05mm): Max. 60% Min. 5%
 - Clay (less than 0.002mm): Max. 30% Min. 5%
- Soil Conditioner shall be dried treated sludge, organic compost or other fibrous approved organic matter suitable for mixing with topsoil to make a friable growing medium for

plants, resistant to rapid decay, free of soluble salts below 900ppm, pH 6-7, free of large lumps or debris.

- Organic Compost shall be organic vegetable compost produced by a thorough horticultural or industrial composting process or Farm Yard Manure (Cow Dung Manure). Compost is to have a clean, un-decomposed smell free from any rotting substances, debris, refuse, clay or visible fungus. A sample is to be submitted for approval before usage. All composts are to be sterilised before being packed for transport and odorous materials used on site will be rejected. Any vermin resulting from use of organic composts will have to be controlled by the Contractor within 12 hours of any infestation.
- Sand shall be a clean, coarse grained and angular material sourced from a river bed with a minimum 1mm diameter section. It shall be well graded, free from soluble salts ranging in size so that 80-100% passes the 3mm sieve and 0-50% passes the 2mm sieve, with 0% passing through a 1mm sieve.
- Lightweight Aggregate shall be an approved low density inert material such as expanded shale or clay or volcanic scoria or other porous aggregate capable of being compacted within the soil zone to 90% compaction without being crushed, free from dust and debris, pH 6-6.5, free of soluble salts. A 2 litres sample shall be submitted and tested as part of the soil mix for physical and chemical performance. Materials are to be approved in writing before installation.

11.4.3 Soil Mixes

- The following soil mixes are to be used for different areas and for different types of planting. Minor changes to the proportions shown for particular species may be required, as specified by the Landscape Architect from time to time.
- i. Soil Mix A: for use in natural ground level areas shall comprise the components listed below, which shall be mechanically cultivated to the correct proportions, prior to placement on site or backfilling. Soil Mix A shall comprise the following proportions by volume:
 - Topsoil: 50%
 - Sand: 20%
 - Soil Conditioner: 15%
 - Organic Compost: 15%
 - ii. Soil Mix B: for use in podium area shall be prepared under controlled mixing conditions such as a concrete floor to ensure even mixing. Soil Mix B shall comprise the following proportions by volume:
 - Topsoil: 30-50%
 - Sand: 10-30%
 - Conditioner: 0-20% (as required)
 - Lightweight Aggregate: 0-20% (as required)
 - Organic Compost: 20%

- iii. Soil Mix C: for use in planter boxes. Soil Mix C shall comprise the following proportions by volume:

Topsoil: 40%

Sand: 30%

Charcoal: 20%

Organic Compost: 20%

11.4.4 Soil Preparation and Application of Soil Mixes

- All subsoil areas to be topsoiled shall be cleaned free of rubbish, weeds, all stones exceeding 50mm in diameter and builders debris shall be removed from site. Any areas which are contaminated by petrol, soil or other toxic substances shall be excavated to 300mm below the contamination and have the excavated material removed from site. The excavated areas shall be back filled with imported topsoil as specified. These operations shall take place immediately before topsoiling (with soil mixes) commences.
 - Where directed by the Landscape Architect, the ground shall be decompacted by ripping to a depth of 300mm. All obstructions to cultivation or deleterious material brought to the surface shall be removed from the site and any voids left by this operation shall be backfilled with imported subsoil as specified.
 - Subsoil shall be formed to the finished levels and contours after settlement and with overall even compaction.
 - No topsoil or soil mixes shall be spread or cultivation carried out until the subsoil operations have been approved by the Landscape Architect.
 - Topsoil or soil mixes shall be spread on the designated areas to the depth shown on the drawings. The loose depth of the topsoil shall be sufficient to allow the area to conform to the levels shown on drawings after natural settlement has taken place. Soil Mixes shall not be compressed or rolled to achieve levels. Conversely if levels drop below specified levels, additional soil mixes are to be added to achieve levels.
 - Soil Mixes are to be carefully spread by machine or hand in a moist condition. Very wet or dry soil mixes must not be used. Heavy compaction of soil mixes is to be prevented and compacted soil will be rejected. Soil Mixes are to be spread to the following minimum depths in open ground areas:
 - i. Lawn / Turf areas: 300mm
 - ii. Shrub areas: 450mm deep
 - iii. Tree pits: 1000 x 1000 x 1000mm
- Unless directed otherwise or as shown on the drawings
- The prepared topsoil mix shall be compacted to 80% of maximum density to the depth shown on the drawings in 150mm layers. When planter is filled, water topsoil mix thoroughly to ensure proper and uniform compaction. After 2 weeks, fill with additional topsoil mixture and compact to level and before pavers are laid indicated on drawings.

- When in the opinion of the Landscape Architect site conditions are unsuitable for working, soiling operations shall cease and shall only be resumed when authorized by him.
- Contractor shall be responsible for soil protection and shall take preventative measures to control erosion and siltation of all areas and shall restore or replace any portion of the site which erodes, silts up or is otherwise damaged by out-washing of soil.

11.4.5 Fertilizers

- Chemical fertilizers shall be approved granular slow release compound fertilizers. They shall be stored in waterproof sealed bags under shelter away from water and direct sunlight. Samples of the same to be submitted by contractor before use at site.
- Organic fertilizers shall be organic products such as organic liquid fertilizer, pellets or granules manufactured primarily from organic materials. These products are to be from accredited sources and technical data indicating sources or origin and manufacturing process must be submitted before use. Animal by products must be sterilized before being packed for transport and odorous materials used on site will be rejected. Any vermin resulting from use of organic fertilizers will have to be controlled by the Contractor within 12 hours of any infestation. A sample shall be submitted for review by the Landscape Architect before use on site.

11.4.6 Mulches

- Mulches shall be approved friable composted organic materials. Coco-Peat will not be allowed on its own unless mixed in a proportion of 50-50 with another mulching material free from soluble salts or toxic materials and resistant to rapid decay. Mulches shall have a pH of between 5.5 - 7.0. Samples to be submitted and approved before use.
- Mulches are to be applied in a minimum 50mm layer over the entire surface of shrub and ground cover areas.
- Mulches is to be re-applied to all planting areas every 3 months after initial installation until the end of the maintenance period or until complete surface cover by vegetation is achieved.
- Initial mulching is to take place within 2 days of installation of planting.

11.5. **SUBSOIL DRAINAGE**

11.5.1 Subsoil, Field Drains and Trench Drains

- Before beginning installation of drain lines establish invert elevation of city storm drains at points where tree drains will tie in and prepare schematic layout for approval of Landscape Architect before digging trench.
- Surplus material resulting from excavations shall be carted to other fill areas within the site. If no additional fill sites are available the Contractor shall remove all surplus material from site and deposit it in a Local Authority approved tip.

- The Contractor shall survey the gradient levels of all trench bases to ensure that all falls are continuous from the highest point down to the outlet point at the sump. These findings shall be submitted to the Landscape Architect for verification before any further work is undertaken, either pipe laying or backfilling.
- All trenches when completed and approved shall be lined with approved filter membrane laid over the base of the trench and up the sides with sufficient membrane to wrap over the top of the gravel backfilling with a minimum overlap of 300mm.
- The base of each drainage trench shall have a layer not less than 30mm and not more than 50mm depth of fine stone chippings 8-12mm diameter or coarse sand laid to accurate falls for bedding the perforated pipes.
- The drainage pipes to the sizes shown on the drawings shall be prefabricated subsoil drainage system or similar approved type. PVC pipes with drilled holes will not be permitted. Drainage pipes shall be laid to the lines to the falls shown on the drawings and accurately boned in to correct gradients before backfilling.
- All pipe junctions shall be as supplied by the selected manufacturer and shall be fitted to the manufacturer's instructions to provide smooth flow and to fit the correct pipe sizes. Where changes in pipe diameters occur the correct junctions shall be used to match the changed pipe diameters.
- Connect drainage system to percolation pits.
- Where subsoil drainage pipes pass under paths or structure the pipe shall be of non perforated pipe joined at either end to the perforated pipe, and be surrounded by 100mm of concrete haunching.
- Trenches shall be backfilled to within 100mm of the finished level with clean coarse grained sand or crushed stone chippings 8-12mm diameter free of any fine particles. The gravel backfill shall be lightly compacted in 100mm depth layers.
- All drains shall be tested on completion to ensure a satisfactory water flow. Any pipes that do not flow are to be taken up and re-laid at the Contractor's expense.
- After testing has been approved, remaining depth of the trench shall be filled with a layer of coarse grained sand up to the finished soil level (after final settlement). Where the top layer is specified as such, clean graded gravel 20-40mm stone chippings free from fine particles shall be placed up to the finished surface mix, free from clay lumps or any item likely to inhibit drainage.

11.6. SOFTSCAPE WORKS

The scope of services covers all horticultural operations and services including, labour, equipment, services and transport for all plant materials, Good earth, top soil conservation, manures, pesticides etc. completing the entire work within the scheduled time, maintaining the entire Softscaping work for one year after virtual completion of the work.

The Contractor shall refer to Specifications provided in this document for relating to formation levels, sub-bases, concrete footings, foundations and all associated works.

The specifications are to be read along with necessary specifications from other consultants.

Vendors' shop drawings shall be submitted for all such items where the Contractor will procure and install items from/by a reputed vendor. Execution of all such items shall be done after such drawings are approved by the Employer/ Employer's representative.

Contractor shall prepare and issue all required working drawings and get them approved by Employer/ Employer's representative with required number of revisions till the details provided do not satisfy the Employer/ Employer's representative.

The scope includes maintenance of all above for 5 Years from the date of end Defects Liability Period (DLP). DLP shall be of one year after completion of Landscape Execution. The Contractor will maintain the entire landscape development area free of cost for a period of one year after completion of all above works as certified by the Employer/ Employer's Representative's in consultation with the Landscape Architect

11.7. SPECIAL CONDITION

The Contractor will have to provide the following items at no extra cost to Employer:

- a. The Contractor will supply and install 3.0 metres high barricades for safeguarding landscape development area and works, as indicated in the drawing. He may also install the barricades in the landscape development area according to his own understanding if he feels that any part of the landscape area is bound to be damaged for any reason, after taking prior permission from the Employer/ Employer's Representative.
- b. The Contractor will supply, install and maintain at his own cost, the most modern, automated watering system for the landscape, which will take care of the requirement for particular plants, save water and does not waste water, including any requirements specified by the Landscape Architect appointed by contractor. He will give full details of the layout, size of the pipe, size of the sprinklers, bubblers, etc and their warranty period. All equipment must conform to international standards and / or Indian Standards if available. The design of the irrigation system has to be approved by Employer/ Employer's representative.
- c. All equipment required for development shall be made available by Contractor, and its maintenance shall be his responsibility. This includes Tagara, Phawdas, Hose Pipes, Ground Roller, Manual and/or Electric lawn Mowers, Sprinklers, etc.
- d. Contractor will ensure that all plants remain free of diseases, pests, etc during development and maintenance periods. The contractor shall, without any additional charge renew any dead or defective plant material and shall fully maintain including watering, de-weeding etc. of the whole landscape as mentioned above.
- e. The Contractor shall maintain Nursery at his own cost at designated locations as shown in the drawing or at a suitable location within the plot as directed by Employer/ Employer's Representative. The Nursery will be fenced with gates for

protection from cattle. The area of Nursery will be approximately 5000sqm. The item would include construction and maintenance of Green Houses if required.

- f. Contractor shall follow pre construction and during construction soil erosion control measures as per the NBC Part 10, section 1, Chapter 4 – Protection of Landscape during Construction.
- g. The contractor in co-ordination with the Employer as applicable shall ensure conservation and storage of top soil: Topsoil shall be stripped to a depth of 200 mm from areas proposed to be occupied by buildings, roads, paved areas and external services. It shall be stockpiled to a height of 400 mm in designated areas and shall be re-applied to site during plantation of the proposed vegetation. Topsoil shall be separated from sub-soil debris and stones larger than 50 mm diameter. The stored topsoil may be used as finished grade for planting areas. It is the landscape contractor's responsibility to conserve top soil that is not disturbed by the civil contractor.
- h. The Contractor shall:
 - I. Furnish the source of top soil to Employer/ Employer's Representative.
 - II. Study the soil report provided with the tender document, providing soil details such as pH, alkalinity, total soluble salts, porosity, sodium content and organic matter. Ref. Soil Test Report
 - III. Use the restored soil at site for landscape purpose, manure mixture, Neemcake, weedicide shall be added if required.
 - IV. Not consider any external soil source unless the existing soil conserved from site is lacking in quality and/or quantity.

Soil Analysis for Top Soil fertility determination

To determine the fertility of top soil for conservation, soil investigation shall be carried out by an NABL accredited laboratory.

Adequate number of test samples of soil from a depth of 10-200mm below ground level shall be collected from at least 5 representative locations from site, preserved and transported (as per standard procedures specified by the laboratory) carefully to the laboratory for carrying out necessary tests.

All relevant Indian Standards for sampling and conducting laboratory tests shall be followed.

This soil samples shall be analyzed to determine soil type, texture, total organic content, pH, extractable nutrients such as nitrogen, phosphorus, potassium, salinity, cation exchange capacity, % base saturation and extractable heavy metals.

The soil analysis report from the laboratory shall also include a statement on the fertility and suitability of the soil for plant growth based on the analysis, in addition to the test results.

Top Soil conservation

Topsoil shall be removed for conservation to a depth of 200 mm (not more than 400 mm) and shall be separated from subsoil debris and stones larger than 50 mm diameter.

It shall be stockpiled to a height of 400 mm in designated areas. The stockpiled topsoil shall be protected from erosion during storage by installing earthen berms/solid walls, temporary seeding (using native grass), covering with mulch or plastic, etc.

The topsoil shall be protected with sand bags/solid walled enclosures (2 feet high) on all sides for containment.

Appropriate drainage channels shall be dug around the storage area to prevent flooding of the top soil storage area.

The top soil shall be reapplied to site during plantation of the proposed vegetation as finished grade for planting areas.

Seeding will take place immediately after respreading topsoil and decompacting, unless timing is inappropriate (for e.g., not in mid-summer).

- i. The contractor to identify erosion prone areas on site and protect them from construction activities throughout the construction period. Prevent / mitigate the disturbances caused to site due to construction activity.
- j. The contractor shall execute a sedimentation and erosion control plan that conforms to the best management practices highlighted in the National Building Codes of India (NBC) Part 10, section 1, Chapter 4 – Protection of Landscape during Construction. This standard describes two types of measures that can be used to control sedimentation and erosion. Stabilization measures include temporary seeding, permanent seeding and mulching. Structural control measures include earth dikes, silt fence, sediment trap, and sediment basin. All of these measures are intended to stabilize the soil to prevent erosion.
- k. The erosion and sedimentation control plan must be approved by Employer/ Employer's Representative and the erosion sedimentation control plan must be maintained throughout the execution period.
- l. The contractor shall execute measures of protection and preservation of existing landscape on site during entire construction time.
- m. Design, execute and maintain a temporary storm water management layout for the duration of construction activity. The storm water management layout should conform to National Building Codes of India (NBC) Part 10, section 1, chapter 4 – Protection of Landscape during Construction.
- n. Contractor should take measures to prevent entry of any soluble/ insoluble construction waste to enter the water table/ water ways/ ravines on site.

11.8. GENERAL SPECIFICATIONS

11.8.1 Holding Nursery

- i. A piece of land has been secured within the site for use as a holding nursery as indicated on the Contract Drawing. (Ref. Dwg. No)

- ii. As a holding nursery the Contractor shall provide all necessary plant and equipment to store his plant material, machinery and equipment for the duration of the contract, including the two-year maintenance period.
- iii. The Contractor shall be required to install and establish all equipment that may be required to run a major landscape contract and ensure plant materials remains in a healthy and fit condition. The list of requirements includes, but is not limited to:
 - Provision of a 3,000 high tensioned chain link fence (with at least 2 no. lockable gates) around the extent of the holding nursery)
 - Grading and laying of crusher together with associated storm water drainage to take vehicular loading
 - Provision of all site utilities including water, telephone, electricity
 - Provision of any shade structures that may be required to maintain the plants in a healthy condition prior to planting out
 - Provision of any irrigation systems, pumps, sprinklers that may be required to maintain the plants in a healthy condition prior to planting out
 - Provision of a site office to include at least one conference/meeting room capable of comfortably accommodating 15 persons
- iv. The Contractor may wish to use the holding nursery for the purpose of propagation of plant stock for the contract. This is not a mandatory requirement since it is assumed that plant stock will need to be outsourced in order to meet the programme target dates. The decision to use the holding nursery as a propagation area rests entirely with the Contractor having taken into account the programme constraints, the nature of the site location (relatively remote) and his own commercial considerations.

11.8.2 Provision of Site Utilities

- i. The Contractor is to allow for the provision at his own cost of all site utilities for the duration of the contract including but not limited to water, electricity and telephone.

11.8.3 Landscape Development Technique

- i. The contractor will not be allowed to use different techniques or quality criteria or materials unless his alternative system has been confirmed in writing by the Employer/Employers representative.
- ii. No cost increases for alternative specifications will be entertained unless formally submitted in writing as an improvement in the quality of a product and accepted in writing, following Employer/Employer's Representative approval, by the Employer/Employers representative.

11.8.4 Quality of Workmanship and Materials

- i. All materials and workmanship shall be of the high standards and quality demanded by this specification. Sub-standard work and materials identified by the Employer/Employer's representative will be rejected and will be required to be rebuilt or replaced at the Contractor's costs.

- ii. All plant material shall be of the genus, species and variety specified and substitutions will not be permitted unless authorized in writing by the Employer/Employer's representative. The sizes and plant description set out in the section headed Plant Material.
- iii. All trees and shrubs supplied for the contract shall be free of pest, disease, discolouration and damage. Plants shall be well branched with vigorous shoots. The root system of each plant shall contain a good proportion of fibrous roots.
- iv. All materials are to be approved by the Employer/Employer's representative prior to use on site. Materials shall be obtained from approved sources/manufacturers and/or suppliers. All guarantees and warranties shall be copied and submitted to the Employer/Employer's representative prior to requests for approval.
- v. Where particular products are specified, the Main contractor's specialists subcontractors if he wishes to use similar products from other manufacturers must seek prior confirmation from the Employer/Employer's representative.

11.8.5 Site Responsibilities

- i. From the commencement of the works until the Certificate of virtual Completion has been issued by the Employer/Employer's representative, the Main contractors specialists subcontractors shall, in respect of all areas of soft landscape works, adjacent areas and parts of the site used by him, be responsible as follows:
 - For adequate protection to grassed areas, planted areas and trees and for making good Softscape works on removal of any protective measures at completion.
 - For any damage to existing works and features and any necessary rectification work required to obtain approval from Employer/Employer's Representative.
 - For keeping all paved surfaces used by him in a clean and tidy condition.
 - For periodic removal of all surplus excavations and waste matter produced by his operations to a Local Authority registered tip off site, to be found by the Main contractors specialists subcontractors.
 - For keeping all Softscape areas in a weed-free and tidy condition and adequately watered.
- ii. The Main contractor's specialist subcontractors shall make appropriate allowance for these requirements in his rates.
- iii. The Main contractor's specialist subcontractors shall, within 24 hours of notification and as directed by the Employer/Employer's representative, undertake at his own expense any remedial works arising from the stated requirements.
- iv. Tree conservation:
 - All trees to be conserved shall be protected with a 3-4 foot high enclosure constructed using brick/fencing (with an access gate for tree maintenance) at a distance indicated in the table below depending on the diameter of the tree trunk.

TRUNK DIAMETER	DISTANCE FROM TRUNK ON
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(measured at 4.5 feet above natural grade)	ALL SIDES
Up to 6 inches	Past dripline
6-9 inches	5 feet
10-14 inches	10 feet
15-19 inches	12 feet
over 19 inches	15 feet

- This tree enclosure shall be erected before demolition, grading, or construction begins and remain until final inspection of the project. A ‘Warning’ sign of size 8.5“x 11” shall be prominently displayed on each protective enclosure to state the following:
- The following activities are prohibited within and in the vicinity of the tree protection zone throughout the entire duration of the construction project:
- Cutting of tree roots by utility trenching, foundation digging, placement of curbs and trenches, or other miscellaneous excavations
- soil disturbance or grade change
- drainage changes
- storage of material, topsoil, vehicles, or equipment
- Activity including but not limited to compaction, grading, construction etc.
- dumping of any material including but not limited to paint, petroleum products, concrete, mortar, dirty water, waste
- use of the tree trunks as a backstop, support or anchorage as
- a temporary power pole, signpost or other similar function
- The following activities are permitted or required within the Tree Protective Zone with approval from Landscape Architect:
- Mulching with wood chips (unpainted/untreated) or approved material to a four to six inch depth, leaving the trunk clear of mulch to prevent inadvertent soil compaction and moisture loss.
- Irrigation, Aeration, fertilization indicated by Landscape Architect for the healthy growth/maintenance of the tree
- if tree is adjacent to or in the immediate proximity to a grade slope of 8% or more, erosion control measures shall be installed outside the Tree Protection Zone to prevent siltation and/or erosion within the zone

11.8.6 Plant Protection

- i. All plant material is to be carefully protected and if necessary wrapped in the nursery during lifting, awaiting transportation, during transportation, unloading and during storage on site.

- ii. Any evidence of unsatisfactory protection to roots, stems, branches and leaves will result in plants being rejected.
- iii. Unprotected plants must not be transported during very hot weather, and all plants must be kept moist during transportation and storage. No plant material shall be left on site unplanted for more than two days.

11.8.7 Work by Machine or Hand

- i. All operations herein described shall be carried out by suitable approved machines or by hand.
- ii. Any work around the base of existing trees, in confined spaces or which is impractical to carry out by machine for any reason shall be executed by hand and the contractor shall include for this in his rates.

11.8.8 Notice of Intentions

- i. The contractor shall give forty-eight hours written notice to the Employer/Employer's representative of his intention to commence any of the following operations:
 - Setting out,
 - Planting,
 - Topsoiling,
 - Turfing,
 - Sprigging,
 - Maintenance visits

11.8.9 Heavy Machinery

- i. Heavy machinery, which would excessively consolidate the sub-soil, shall not be used during any operations nor shall heavy machinery be taken over areas prepared for planting or grassing.

11.8.10 Substitutions

- i. If the Main contractor's specialist subcontractor is unable to supply a particular species of plant he is to notify the Employer/Employer's representative in advance of his intention to make a substitution. No substitution will be allowed without prior written agreement of the Employer/Employer's representative.
- ii. Notices of substitutions are to be made sufficiently far in advance of installation to ensure that the substituted material conforms to specifications. Substitutions requested by the Main contractor's specialist subcontractor after work has started on site will not be entertained.

11.8.11 Setting Out

- i. The Contractor shall be responsible for accurately setting out all the works prior to the commencement of the works and shall rectify errors in setting out at his own expense.

- ii. Any discrepancy in site area between that shown on the drawings by Landscape Architect appointed by contractor and the actual area on the ground shall be notified to the Employer/ Employer's representative.
- iii. The Contractor shall supply all necessary materials, equipment and labour to enable the Landscape Architect to check the setting out, levels and dimensions on the site along with the Employer/ Employer's representative.

11.8.12 Tools and Equipment

- i. The Contractor shall use proper tools and equipment for the carrying out of the works and is to ensure that the work force is fully and properly equipped with the correct equipment and experience for the job at hand.

11.8.13 Failures of Plants (Pre-practical completion)

- i. Any trees, shrubs, grass or other plants (other than those found to be missing or not in accordance with the Contract Documents as a result of theft or malicious damage and which shall be replaced), which are dead, dying, missing or found not to have been in accordance with the Contract Documents at practical completion of the Works shall be replaced by the Contractor entirely at his own cost unless the Contract Administrator shall otherwise instruct.
- ii. The Contract Administrator shall certify the dates when in his opinion the Contractor's obligations under this clause have been discharged.

11.8.14 Plants Defects Liability and Post Practical Completion Care by Contractor

- i. Any grass which is found to be defective within 24 months, any shrubs, ordinary nursery stock trees or other plants found to be defective within 24 months and any semi-mature, advanced or extra large nursery stock trees found to be defective within 24 months of the date of virtual completion due to materials or workmanship not in accordance with the Contract Documents shall be replaced by the Contractor entirely at his own cost unless the Contract Administrator shall otherwise instruct.
- ii. The Contract Administrator shall certify the dates when in his opinion the Contractor's obligations under this clause have been discharged.
- iii. Malicious Damage or Theft (Before Practical Completion): All loss or damage arising from any theft or malicious damage prior to practical completion shall be made good by the Contractor at his own expense.

11.8.15 Submittals

- i. The Contractor shall submit for review drawings by Landscape Architect appointed by contractor completely dimensioned, indicating any pattern layouts, special installation procedure, cutting, fitting, sinking and adjacent equipment materials for coordination.
- ii. The Contractor shall submit samples of all materials and samples of workmanship for approval by Employer/Employer's representative.

- iii. The Contractor shall be responsible for producing and submitting for comment and approval to the Employer/Employer's representative the shop drawings and samples of all elements indicated in this section. All should be based on the drawings provided by Landscape Architect appointed by contractor. All submissions should be reviewed, approved and endorsed by the Contractor.

11.8.16 Handling, Storage And Delivery

i. The Contractor shall:

- Coordinate delivery with suppliers, to minimize handling.
- Handle and store equipment and materials in such a manner that no damage will be done to the materials or the work of other trades.
- Store packaged materials, undamaged in their original wrappings, or containers with manufacturer's labels and seals intact.
- Stack equipment and materials on wooden platforms at least 150mm clear of the ground and protect with weatherproof covers.
- Damaged equipment, material or works will be rejected by the Employer/Employer's representative whether built-in or not.
- For equipment, materials and work, covering shall be of suitable material containing nothing that may injure or stain the materials.

11.8.17 Protection of Work

- i. The Contractor shall protect all equipment, materials and completed work from damage until final completion of the work.
- ii. The Contractor shall remove and replace damaged work at no extra cost.

11.8.18 Reference Standards

- i. The Contractor shall comply with all relevant Indian Standards, ASTM, British Standard Code of Practice, Draft BS or DIN Standard applicable to elements indicated in this section, the recommendations and requirements of such documents shall be considered a minimum standard of such work described and must be complied with.
- ii. Nothing shall relieve the Contractor of his responsibility for providing a higher standard than the relevant Code or Standard where it is required to comply with other sections of the Specification.

11.9. PLANT MATERIALS AND PLANTING OPERATIONS

The following plant descriptions cover the different categories of plant material to be used on the site.

These descriptions and their accompanying drawings requirements must be studied carefully and adhered to.

Plants that do not reach the specified dimension or quality, characteristics in this section or in the sizes and descriptions set out in the Bill of Quantities will be rejected and will have to be replaced at the Contractor's cost.

Trees and palms and large feature plants that are growing in open ground are to be prepared for transplanting at least 2 months before moving, either to containers in the nursery or direct to the site.

Preparation of in-ground trees and palms shall be by root pruning to the stated rootball dimensions.

Trenching around the outer edge of the rootball using pruning and a sharp spade shall be done in four separate stages trenching in quarters, with one quarter of the tree roots being cut and backfilled each week, the next quarter the following week, with all of the ball being cut in one month.

If roots over 25mm are encountered these are to be cleanly cut with large secateurs or pruning saw.

The trench which shall be at least 200mm wide shall be dug to the full specified depth of the rootball and undercut at the end of the root-pruning exercise to sever base roots.

The whole trench shall by this time be backfilled with sand. The tree is then to be allowed to settle for one month before final wrapping with protection and lifting. The rootball is to be well watered during this period.

For trees and palms that are to be containerised or root wrapped, the lifting and placing in containers or being wrapped is to be done immediately after the root trenching operation is complete.

Plants to be transported or moved are to be thoroughly wrapped and protected prior to transporting.

Rootballs are to be wrapped and tied with Gunny sack or hessian sacking if not containerised.

Exposed trunks are to be wrapped in rice straw including the lower parts of the branch system.

The upper branch system, especially if well furnished with leaves and twigs during transportation is to be completely wrapped in Lightweight netting or cloth tied and palms are to be laid at an angle to prevent damage from overhead structures and from buffeting and shall be covered by canvas as protection from wind.

Damaged trees will automatically be rejected on arrival at site.

All trees and palms are to be purchased, stored and grown on in suitable nursery conditions within one month of the contract and made ready for direction by the Landscape Architect appointed by Contractor.

Failure to procure within this time and to reveal the source of supply and location will result in the Employer/Employer's representative sourcing the plant materials for the Contractor, and the cost of this sourcing operation will be deducted from the Contractor's payments.

All dimensions shown with tolerances (that is 120 - 150mm) refer to maximum and minimum dimensions that will be accepted. Measurement of all plants of one species shall, as a minimum, average between the upper and lower figures (that is in the above case 135mm).

All trees and palms specified for containerising or root wrapping after root pruning operations are to be well furnished with leaves over the crown of the tree. Thinning of leaves to reduce transpiration to give a 50% cover is permissible providing due notification is given that thinning is required to ensure that the trees can be inspected before thinning work is done. Bare crowned trees will not be permitted.

Leave cover: Any trees or palms which shed their leaves within 2 weeks of transplanting are to be replaced by the Contractor at no extra charge.

11.9.1 Trees

a. Instant Trees

These are semi-mature trees especially prepared in advance for transplanting.

Root pruning to cleanly cut roots to the diameter of the rootball shall be carried out 3 months in advance of transplanting.

Trees shall be 300 - 450mm (12" - 18") circumference of stem when measured 1.0m (3') from ground level and shall have a clear stem of minimum 1.8 metres.

The head shall be well balanced and contain at least four main branches 500-1000mm long giving an overall height of 3 - 4m after pruning.

All saw cuts are to be painted with an approved insecticide/fungicide solution.

b. Extra Heavy Standard Trees (EHS)

These are large size nursery grown trees pruned during growth to produce a tight well rounded head and a straight stem clear of leaves or twigs.

Trees shall be 140 - 180mm circumference of stem when measured 1m above ground level and shall have a clear straight stem of minimum 2m.

The head shall be well balanced and rounded and contain at least four main branches, and a well developed secondary branch system giving an overall height of 4.5 - 4.8m at the time of planting.

Trees shall have a defined central leader. Pruning at the time of removal from the nursery will not be permitted.

In dry weather conditions trees are to be sprayed with approved Anti-transpirant.

Rootball dimensions: diameter 750mm x 600 deep minimum. Branching/leaf spread shall be of 2.2 - 2.4m diameter.

c. Heavy Standard Trees

These are large size nursery grown trees pruned during growth to produce a tight well rounded head, and a straight stem clear of leaves or twigs.

Trees shall be 120 - 150mm (5" - 6") circumference of stem when measured 1.0m (3') from ground level and shall have a clear straight stem of minimum 1.8 metres.

The head shall be well balanced and rounded and contain at least four main branches with a well developed secondary branch system and a central leader, giving an overall height of 3.5 - 4.0m (10' - 13') at the time of planting.

Pruning at the time of removal from the nursery will not be permitted.

In dry weather conditions, trees are to be sprayed with approved Anti-transpirant.

Rootball dimensions: diameter 600mm (2') x 450mm (1'6") deep minimum.
Branching/leaf spread to be of 1.8 - 2.0m diameter.

d. Standard Trees

These are medium size nursery grown trees pruned during growth to produce a tight well rounded head, and a straight stem clear of leaves or twigs.

Trees shall be 100 - 120mm circumference stem when measured 0.9m from ground level and shall have a clear straight stem of minimum 1.5m.

The head shall be well balanced and rounded and contain at least four main branches with a well developed secondary branch system and a defined central leader that has not been pruned, giving an overall height of 2.5 - 3.0m at the time of planting.

Pruning at the time of removal from the nursery will not be permitted.

In dry weather conditions, trees are to be sprayed with approved Anti-transpirant.

Rootball dimensions: diameter 500mm (1.6") x 300mm (1') deep minimum.
Branching/leaf spread shall be of 1.5 - 1.8m diameter.

e. Standard Feathered Whips

These are medium sized nursery grown trees having a single straight stem and unbroken leader giving an overall height of 2.5 - 3m.

The stem shall be fully furnished with evenly spread and balanced lateral branches down to ground level and shall be 80 - 100 mm circumference of stem when measured 1m from ground level.

The tree shall have a strongly developed fibrous root system and shall be container grown. Leaves or branches shall not be cut off before planting.

Rootball dimensions 450 x 300mm minimum. Branching/leaf spread shall be of 1.5 - 1.8m diameter.

f. Ships/Saplings

These are young tree grown from seed or cuttings which are trimmed or pruned, furnished with branches down to ground level.

Trees shall have a single straight stem and unbroken leader between 900 - 1500mm overall height.

Stem thickness will vary between species, but a strong stem which does not bend over is required.

The tree shall have a strongly developed fibrous root system and shall be container grown. Leaves shall not be cut before planting.

Container dimensions: 250mm diameter x 250mm deep minimum.

11.9.2 Palms

All palms shall be single stem. Single Stem Palms shall have clear straight trunks of heights as stated in the Bill of Quantities as measured from the root collar to the base of the lowest leaf sheath. The stem girth shall be of dimension normally found for palms for the stem height and species specified.

Acceptable tolerances to variations in stem height shall be +200mm or -200mm from the height specified in the Bills of Quantities.

The heads of palms shall be well balanced with at least 7 leaves and a healthy growing apical shoot all free from pest and disease.

a. Rootball dimensions shall be in proportion to stem heights as follows:

Stem height	Rootball diameter	Depth
1m	400mm	400mm
2m	750mm	600mm
3m	900mm	600mm
4m	1200mm	750mm

1.1. Shrubs, Herbaceous Plants and Ground Covers

a. Shrubs

These are woody perennials of generally multi stemmed and bushy habit ranging from 3 - 4.5m down to 500mm height.

Shrubs shall have no less than three main stems and shall be well balanced and bushy, with strongly developed fibrous root systems, and shall be pruned in advance as required to achieve the specified height tolerances.

Branches shall break from the base of the plant just above the root collar, and shall be well furnished with leaves right down to ground level.

All plants are to be container grown in containers of suitable dimensions for the species.

b. Herbaceous Plants

These are non-woody perennials usually of a clump forming habit.

Plants shall have a well developed main stem or stems with good symmetry, a healthy root system, free from pest or disease.

Clumps of herbaceous plants shall include rhizomes, corns, tubers or roots and soil undisturbed by lifting with evidence of growing shoots emerging above soil level.

All herbaceous plants are to be grown in containers unless specified as being produced by alternative method.

c. Groundcover plants

These are low growing, 500mm or less, or prostrate shrubs or herbaceous plants whose habit is to totally cover the soil.

All groundcover species shall be evenly balanced to allow equal growth in all directions.

Plants shall have fully developed roots and leaves.

Rooted cuttings will not be accepted. All plants to be container grown.

Rooted shoots of certain spreading ground cover plants shall be used only where specified, planted as 'sprigs' as opposed to established plants in soil.

Plants shall be rooted shoots and shall have at least one and evidence of vigorous root growth.

Recent cuttings with no root development shall not be acceptable.

d. Climbers

Climbers are plants whose growth habit is to climb upwards by means of twinning stems, tendrils or clinging roots.

Plants shall be grown to reach the recommended size using stocks no less than one year old, and no more than five years old at the time of the start of the contract.

Plants shall have at least two leader shoots up to the recommended height and a vigorous root system.

All plants to be container grown.

11.9.3 Hedging Plants

Hedging Plants shall be shrubs such as Lawsonia, Ixoras, etc as per design requirements of Landscape Architect appointed by contractor as suited to regular clipping, previously prepared to establish a uniform height and complete foliage cover to the stem from ground level upwards.

Plants shall be a minimum overall height of 500mm with a minimum of 4 branches arising from ground level and a strongly developed fibrous root system.

Branches shall be well clothed in leaves down to ground level.

All plants to be container grown in suitably sized containers.

Hedging plants shall be prepared by root and branch pruning to achieve the 'box' shape shown, at least 3 months before transplanting.

11.9.4 Container Grown Plants

Container grown plants shall mean trees and shrubs which have been grown in containers sufficiently large to hold the developing root system from seed or cutting and shall be filled with suitable nutrient rich, free draining compost as per design requirements of Landscape Architect appointed by contractor.

Container grown stock shall be well watered prior to dispatch from the nursery and shall remain in the container until planted on site, whereupon the container shall be carefully removed to avoid soil disturbance.

Empty containers are to be removed from site.

11.9.5 Cultivation of Plant Beds

Cultivation of the completed soil mix beds shall take place only when the seeding or planting operations can begin immediately after cultivation. No cultivation shall be undertaken in weather or ground conditions in which operations may destroy soil structure or where soil mix has not been approved by the Landscape Architect.

Cultivation shall be by approved mechanical or manual means to a depth of 250mm for Ground Cover and 450mm for Shrubs to provide an even, weed free texture.

After cultivation, stone picking from the surface of soil areas shall be carried out such that all stones and lumps exceeding 50mm in diameter are collected. All stones, weeds and rubbish brought up shall be removed from the site to a tip to be found by the Contractor.

Ground cover, rooted shoot and herbaceous beds are to have 25mm solid conditioner spread over the entire area and well forked in to the top 250mm of soil during cultivation. This operation is separate from the mulching specified.

11.10. PLANTING TECHNIQUES AND ACCESSORIES

All plants shall be planted to accommodate the spreading root system of the plant to the same soil depth as in the nursery and shall be well watered before removing them from containers. Plants are to be positioned upright and the soil firmed around the roots.

Planting shall be carried out in accordance with the schedule of plants and drawings supplied by Landscape Architect appointed by contractor. The number of each species and variety shall be evenly distributed over the area as indicated on the drawings by Landscape Architect appointed by contractor.

For large areas the outer rows are to be set out first to ensure the correct shape to the bed is established. The remaining plants are then to be evenly distributed to cover the planting area. The Landscape Architect is to be notified in advance if there are too many or too few plants to fill the area required and an assessment of setting out adjustments will be directed accordingly.

Setting out of plants is to be completed and approved by Landscape Architect appointed by contractor before planting into the soil bed can commence.

11.10.1 Small Shrubs, Herbaceous, Ground Cover and Root Planting in Beds

Small shrubs, ground cover and herbaceous plants shall be planted in pockets formed by a trowel or spade.

The pocket shall be deep enough and wide enough to accommodate the root of the plant.

The sides and base of the pocket shall be loosened and the plant roots lightly loosened from the rootball.

The plant shall be placed upright in the pocket and firmed into the ground by backfilling and treading or hand pressure.

The topsoil in areas to receive rooted shoots shall be brought to a fine layer 75mm deep by approved mechanical means or hand raking.

Approved slow release fertiliser shall be applied evenly over the area at a rate of 40gms per square metre and shall be lightly raked into the surface.

Rooted shoots shall be firmly bedded into the soil at 75mm centres with each shoot spread on the topsoil surface, separated from adjacent shoots.

The area shall be top-dressed with finely sifted topsoil/compost mix as approved by the Landscape Architect appointed by Contractor to lightly cover the rooted shoots after laying.

The ground shall then be firmed by lightly treading or hand pressure around the roots, taking care not to damage the shoots, to ensure good contact with the soil.

Watering shall take place immediately after planting, using a fine spray.

The firmed up area is to be tightly cultivated after completion of this operation to leave an even layer before mulching.

11.10.2 Shrub Pits

Shrub pits for large and medium shrubs, feature plants and climbers shall be excavated to 150mm wider on either side than the root spread, and to a depth of 150mm deeper than the root depth and shall not be less than 300mm x 300mm x 450mm deep.

The bottom 150mm of the pit is to be forked loose prior to backfilling.

Backfill material shall be topsoil Mix A for backfilling purposes. (Ref. Section 11.4.3 Soil Mixes)

The Contractor shall note that for planting into turf areas, where topsoil has not been spread topsoil mix will be required for backfilling purposes.

Climber pits shall be 150 - 200mm away from the supporting structure with the roots spread away from the wall or adjacent supporting structure.

The climbing plants shall be trained through the wire mesh with leading shoots directed upwards and tied.

Pits for shrubs and feature plants in planters shall be excavated to 150mm wider on either side than the root spread and to a total depth of the rootball.

The bottom of the pit shall be lightly formed, prior to planting taking care not to damage the terrain layer below.

After planting shrubs the area is to be watered immediately to bed the shrubs in.

Once the water has percolated away and left the surface relatively dry the soil area is to be lightly forked to loosen the surface and leave an even soil layer.

11.10.3 Tree Pits

Tree pits shall be excavated to the dimensions and the location shown on the drawing by Landscape Architect appointed by Contractor.

Tree pits shall be dug a minimum of 3 weeks period prior to back filling.

The bottom of the pit shall be forked to loosen the soil. In case the soil is clayey, a layer of broken bricks and stones shall be spread on the bottom of the hole and this layer shall be covered with dried leaves or straw.

No tree pit shall be less than 300mm wider on either side than the root spread, and to a depth of 150mm deeper than the root depth, and shall not be less than 1m x 1m x 1m.

The trees shall be planted to the same depth in the nursery or as in their containers.

In case the site is infested with white ants the sides of the pits shall be brushed with a mixture of BHC (10% concentration) and water in a proportion of 200 gms of BHC mixed in 5 litres of water. BHC is the common name for the insecticide.

11.10.4 Backfilling of Pits (trees, shrubs and climbers)

Before backfilling, imported topsoil and sand is to be thoroughly mixed with soil conditioner and organic fertiliser as specified for Topsoil Mix A. (Ref. Section 11.4.3 Soil Mixes)

The tree pit shall be backfilled with the Soil Mix A to a depth which will allow soil, after settlement to match surrounding ground level.

The filled pit shall be watered and allowed to settle. After settlement soil levels shall be topped up as required.

The centre of the backfilled tree pit shall be excavated large enough to allow placing of the rootball, and to allow even compaction all round during backfilling.

After careful removal of the container or wrapping, the rootball of trees shall be placed carefully in the pit, and soil replaced gradually into the pit.

The soil is to be consolidated during backfilling in layers to ensure that the plant is firmly held in the ground and that voids are not left around the roots.

Care shall be taken during planting to avoid damage to the root system, branches or leaves.

After careful removal of the container or wrapping, the rootball of the roots of shrubs and climbers shall be placed carefully and the soil replaced gradually in the pit.

The soil is to be consolidated during backfilling in layers to ensure that the plant is firmly held in the ground and that voids are not left around the roots.

Care should be taken during planting to avoid damage to the root system, branches or leaves.

11.10.5 Staking and Supports

Stakes shall always be used when planting instant trees, standards and single stem palms and for tall shrubs when directed by the Landscape Architect appointed by Contractor.

Stakes shall be in sawn timber of an approved type and be carried out according to the size of plant to be supported. The types of approved staking methods are:

a. Tripod or Quadropod staking for large trees or palms (extra heavy standard and above)

Three or four stakes each 50 x 50mm section shall be positioned equidistantly around the tree and firmly driven into the ground at angles of between 30 - 40 degrees.

The inner ends of the stakes shall extend beyond the tree stem by not more than 150mm and shall not be higher than 300mm below the lowest branch.

The tree stem shall be wrapped in hessian or gunny sacking at the point where the tree stakes are to be fastened in order to prevent bark damage.

The stakes shall be neatly and firmly fastened to the tree stem using rubber hose or cord; String are not be used.

The stakes are to be adjusted and the position of the protective wrapping is to be altered up or down every month.

The hessian wrapping is to be sprayed with an approved horticultural pesticide.

b. Multiple guying - for large trees or palms (heavy standard and above)

A minimum of three wire guys are to be used per tree.

Each guy wire is to be fastened by a loop around the lowest branches of the tree at the junction with the main trunk or branches of the tree at the junction with the main trunk or stem.

Loops are to have protective rubber or plastic hose to prevent chafing and are to be fastened back to the guy wire by means of U-clamps or bolts.

Guy wires are to be fastened at ground level to short stakes firmly driven at an angle into the ground.

Stakes shall be minimum length of 600mm and are to be driven deep enough to resist movement.

A notch is to be made near the top of each stake for the fastening of the guy wire.

Stakes shall be positioned equidistantly and equally around the tree and shall be at least 300mm beyond the extent to the tree pit.

Distance away from the tree shall be gauged on site to provide firm and secure guying.

Each guy wire is to have one turnbuckle located near the fastening to the stake.

Guy wires are to be kept in a proper tension and adjusted to maintain the tree in a vertical position without guy wires being rigid.

c. Double Staking - for trees and palms (heavy standard and smaller)

Two stakes each 50mm x 50mm cross section shall be driven into the ground in a vertical position on either side of and outside the rootball of the tree so as to form a straight line outside the rootball of the tree so as to form a straight line with the stem at the centre.

Stakes shall be driven in to penetrate the bottom of the tree pit and be deep enough to resist lateral movement when tested.

Stakes shall not extend beyond the lowest branch of the tree and if necessary are to be sawn off at the top.

Fastening or securing of the tree may be carried out by using either:

i. Cross bar

A wooden cross bar of same section as the stakes is fastened in a horizontal position to the outside of the stakes by nails or tying securely at a level below the lowest branch.

The tree is fastened to the cross bar with a single adjustable tie of an approved rubberised or plastic type with a spacer and shall be fastened to prevent any chafing or abrasion of the bark.

No nails or fixings are to be driven into the tree trunk.

ii. Wire/Hose loops

Two separate wire or rope loops are made about the stem just below the lowest branch with each being fastened back to one of the vertical stakes.

Each loop is to have a protective outer covering or sheath of rubber hose to prevent chafing or abrasion of the bark.

The wire or rope is to be fastened to the stakes in a manner that allows adjustment of the tension to be made easily.

Tension on each wire is to be equal to maintain the tree in a vertical position.

Where directed by the Landscape Architect appointed by Contractor the tree may be secured with a second set of loops at a lower level.

d. Single Staking - for trees and palms of sapling size only

A single stake of cross section 50mm x 50mm is driven vertically into the ground 150mm - 250mm away from the tree.

The stake is driven down beyond the base of the tree pit and shall be firm when tested.

The top of the stake shall be 100mm below the lowest branch.

Two ties of an approved rubberised or plastic type are to be used.

The top tie is to be located 100mm below the top of the stake; the lower tie 300mm from the base.

Ties are to have spacers to maintain the 150mm - 250mm distance between the stake and the tree.

Ties are to be fastened to avoid rubbing, chafing or abrasion of the bark.

e. Climber wires

Wires for training climbing plants against walls shall be approved lightweight PVC mesh, fixed at 600mm intervals to screw eyes supplied under the sub contract.

Maximum mesh coverage shall be 180mm high x 240mm wide.

The climbing plants shall be trained through the wire mesh with the shoots directed upwards and tied.

11.10.6 Turfing

a. Close Turfing

Close Turf shall be a live grass sod or mat at least 300mm square with a well developed root system growing in a minimum of 25mm soil bed, free from stones or extraneous roots, cut mechanically or by hand to give an extra thickness and texture.

A sample of one square metre of Turf shall be submitted to the Employer/Employer's representative for approval before Turf is brought in for use on site.

The source of the material shall be stated by the Contractor.

Turf shall be free from weeds, fungus, pest or disease and contamination or pollutants.

Turf sods shall be kept moist and in shade and shall be planted within 24 hours after lifting.

In exceptionally dry weather, the turf must be kept well watered at the nursery or turf farm in order to keep full green leave structure.

Dry, brown or wilting grass turf will be rejected and growth or recovery on site will not be permitted.

i. Close Turfing: Ground Preparation

Rake the topsoil mix area to a smooth and uniform grade free of any slight mounds or depressions to achieve a uniformly flat surface.

Re-grade any depressions or humps that may occur until a satisfactory grade is achieved.

The area to be turfed is to be brought to a fine tilth by approved mechanical means or by hand raking.

Any stones over 25mm in diameter shall be removed from the site of turfing.

Watering of the area shall be carried out to produce a moist condition of the soil and to consolidate the soil.

If consolidation occurs to produce any areas with topsoil depths less than 100mm these areas shall have extra topsoil spread to produce finished levels.

Fertiliser shall be applied to all areas to be turfed prior to turfing at the rate of 40gm per square meter, evenly spread over the whole area and lightly worked into the soil.

ii. Close Turfing: Operations

Close turf sods shall be laid onto the surface of the prepared ground with leaf turfs upwards, butt jointed as closely as possible to achieve a uniform cover.

The turf shall be laid off planks working over turves previously laid.

The whole area is then to be top dressed with finely sifted topsoil mix to give an evenly smooth surface. The finished close turfing shall be lightly compacted by treading or with a wooden beater to ensure even coverage and compaction.

Watering shall take place over the area that has been turfed immediately after planting. Watering shall be undertaken by use of a fine spray to avoid disturbance of soil particles.

Turfing shall be only accepted as complete after the growth of an even grass cover is evident. Any areas not covered by green healthy grass to the satisfaction of the Employer/Employer's representative within 28 days after turfing shall be re-laid as specified at the Contractor's own expense.

For the period of 28 days after turfing the vegetative cover shall:

- I. Evenly cover at least 90% of the areas with leaves and spreading shoots of specified grass variety
- II. be free of perennial weeds or disease
- III. be healthy and vigorous and showing a strongly developed root system

Should there be any settlement due to lack of even compaction this will be corrected by application of topdressing of finely sifted soil to maximum depth of 25mm.

If the depression is greater than 25mm the grass in the affected area shall be lifted, the depression filled with sifted topsoil, lightly compacted and the affected area re-turfed as specified. These operations shall be done as often as necessary to produce an even and smooth surface free from bumps and hollows.

All turfing operations shall be carried out from wooden planks or plywood boards, with the workers moving away from completed turfed areas, raking any compressed soil or footprints before laying of sods.

All access onto soil areas shall be on wooden boards or plywood sheets. Areas compacted by working are to be re-cultivated and re-laid.

iii. Maintenance of Close Turfing Before Completion

The following operations are to be carried out as often as required to achieve the specified quality of turf:

- I. Cutting before Completion shall be carried out as necessary to keep the grass to a maximum height of 30mm.
- II. Watering shall be carried out as often as necessary before Completion to allow a satisfactory green sward to develop over the whole close turfed area.

- III. One fertiliser application per month is to be carried out for before Completion.
- IV. Topdressing as specified as often as required to establish smooth even grades and levels free of hollows.
- V. If compaction or consolidation takes place or hard passing or baking of the soil occurs, the soil areas are to be well watered first and lightly loosened by mechanical means such as spiking, slitting or hollow tinning using approved equipment.
- VI. Completed close turfed areas are to be kept in a weed free insect free, fungus free and tidy condition until Completion (that is start of maintenance period).

iv. Sourcing of Turf Types

Close turfing materials are to be obtained from a bona-fide horticultural source or private landowner.

No turf is to be removed from unauthorised locations, roadside, riverbanks or private property without permission of the Employer.

The Contractor is to inform source of all turf delivered to the Employer/Employer's representative before any turf is laid at site.

b. Fine Turf

Fine Turf shall consist of fine bladed rhizomatous grass such as Bermuda grass or cultivar specified by Landscape Architects appointed by the Contractor.

Fine Turf shall be a live grass sod or mat at least 300mm square with a well developed root system growing in a minimum of 25mm soil bed, free from stones or extraneous roots, cut mechanically or by hand to give an even thickness and texture.

A sample of one square metre of Fine Turf or both types shall be submitted to the Employer/Employer's representative for approval before fine Turf is brought in for use on site.

The source of the material shall be stated by the Contractor.

Fine Turf shall be free from weeds, fungus, pest or disease and contaminants or pollutants.

Fine Turf sods shall be kept moist and in shade and shall be planted within 24 hours after lifting.

i. Fine Turfing Operations

Subsoil mix shall be hand raked to provide an even and fine tilth to an even and accurate level matching kerb edge levels.

Any lumps or stones over 25mm in diameter brought up in this operation shall be removed from site.

Soil areas shall be lightly sprinkled with water to moisten surface in dry weather before laying turf.

Pre-Turfing fertiliser shall be applied to all areas to be turfed prior to turfing at the rate of 40gm per square metre evenly spread over the whole area and lightly worked into the soil.

The turves shall be laid on the prepared soil bed and firmed into position in consecutive rows with broken joints, closely butted and to the correct levels.

The turf shall be laid off planks working over turves previously laid.

Where necessary, the turves shall be lightly and evenly firmed with wooden beaters, the bottom of the beaters being frequently scraped clean of accumulated soil and mud.

A dressing of finely sifted topsoil/sand/compost mix shall be applied and well brushed into the joints to give an overall even surface.

Watering shall take place over the area that has been turfed immediately after planting. Watering shall be undertaken by use of a fine spray to avoid disturbance of soil particles.

Fine turfing shall only be accepted as complete when new growth has caused turves to knit together and adhere by rooting to the soil bed.

Any areas not covered by green healthy grass to the satisfaction of the Landscape Architect within 28 days after fine turfing shall be re-laid as specified at the Contractor's own expense.

If shrinkage occurs or the joints open, finely sifted topsoil/ sand/ compost mix shall be brushed into the gaps and shall be watered in.

Any inequalities in finished levels owing to variation in turf thickness or uneven consolidation of soil shall be adjusted by lifting turves and by re-spreading fine soil mix to correct levels and relaying turves as specified.

The finished level of the Fine Turf shall be 25mm above adjoining paved surfaces or other hard edges after allowing for final settlement.

Turf edges and margins shall be laid with whole turves and uneven edges trimmed to give an even line.

ii. Maintenance of Fine Turfing before Completion

Watering shall be carried out as often as necessary before completion to allow a satisfactory green sward to develop over the whole fine turfed area.

Cutting before completion shall be carried out as necessary to keep the grass to a maximum height of 25mm.

One extra fertiliser application is to be allowed for before completion, to be used if directed by the Landscape Architect appointed by Contractor.

Completed fine turfed areas are to be kept in a weed free insect free, fungus free and tidy condition until completion (that is start of maintenance period).

Edge cutting shall be carried out as required along edges of paths, plant beds or other junctions with other materials. Only sharp edge cutting tools are to be used for this operation.

Over cutting or ragged edges will require the relaying of the turf edge strip as specified (that is 300mm wide).

iii. Specification for Sourcing of Turf Types

Fine Turf is to be specially prepared horticultural turf, re-lawn or turf-carpet, mechanically cut to specified tolerances.

c. Slope retention work with Coir Mat Turfing

i. Site Preparation

Sub-grade shall be excavated to proper lines and grades based on construction plans.

The sub-grade shall be fairly smooth and free of sharp objects and debris that may damage the Coir Mat.

The soils should be proof rolled prior to Coir Mat and backfill placement.

The soils should be compacted to 95 Percent of the relative density based on the Site Engineer's recommendations.

Above the compacted soil, Top soil mix 'A' to be laid upto 150 mm thick layer for planting turf.

Coir mat to be laid first and then planting operation should take place.

ii. Laying of Coir Mat

Coir Mat should be placed in correct orientation as shown on the construction plans and approved by the Engineer.

The Contractor should verify the orientation. The orientation of the Coir Mat should be such that it is rolled in the direction of the slope – not perpendicular to it.

The Coir Mat should be cut to length based on construction plans using an Engineer approved cutting tool.

Each sheet of Coir Mat should be pulled taut by hand to get rid of any wrinkles.

Adjacent sheets should be overlapped for minimum width of 0.30 M.

Each sheet may be secured in place using staples, pins, sandbags, backfill, or by other Engineer approved methods to help prevent disruption during the installation of adjacent sheets

iii. Turfing

Turfing should be done as per procedures mentioned above once Coir mat is installed.

11.10.7 Watering of all Plants

After planting all plants are to be thoroughly watered to soak the ground all around the rootball.

After watering and the water has percolated away leaving the surface relatively dry the soil is to be lightly cultivated to give an even soil tilth.

11.10.8 Mulching

After completion of planting and watering and light cultivation operations a 50mm deep layer of approved mulch shall be spread and forked in over all cultivated planting areas.

Around each tree and palm and around the base of each climber, additional mulch is to be applied to a 50mm depth to a diameter of 600mm.

Mulching is to be done within 2 days of completing planting and watering in.

11.10.9 Fertilising

After a period of settling in of at least one month, all pit planted materials shall be fertilised with an approved slow release fertiliser at the rate of:

Trees : 250gm per tree
Shrubs/climbers : 50gm per plant
Ground Cover/Herbaceous : 100gm per square meter spread
Rooted Shoots : around the base of the plants - 40gm per square meter
All fertilised areas are to be watered immediately after fertiliser application.

11.10.10 Disease Control

The Contractor shall take all necessary precautions to prevent or eradicate any outbreak of disease or insect attack.

11.10.11 Planting into Turf Areas

Where planting is to be carried out in areas of turf, the turf shall be carefully cut to the size of the tree or shrub pit, rolled and stored for re-use, being kept moist and in shade.

After planting is complete stored turf shall be re-laid around the base of the plant.

The Contractor shall replace at his own expense, any turf which is damaged during planting operations.

11.10.12 Protection of Planted Areas

The contractor shall be responsible for protecting all planted areas.

If it is necessary for the Contractor to erect protective fencing, the Contractor shall be responsible for keeping the fencing in position and in good repair until the end of the maintenance period.

Fencing proposals shall be submitted to the Employer/Employer's representative for approval.

Post and string fences shall not be acceptable.

11.10.13 Maintenance prior to Completion

After planting and prior to the onset of the maintenance period, the Contractor shall be responsible for carrying out all necessary measures to ensure that the plant material thrives and becomes established and that the landscape areas are kept in a clean and tidy condition.

The Contractor shall allow for carrying out the following maintenance operations when necessary prior to the onset maintenance period, all as specified in section 11.11 of this specification:

- Replacement of dead/missing plants
- Grass cutting around trees
- Watering
- Cultivation and loosening of soil
- Weeding
- Pruning and clipping
- Firming up and adjusting stakes and ties

- Eradication of pest or insect attack
- Topdressing and mulching
- Fertilising

The Contractor shall be responsible for replacing any plants which fail to survive as a result of inadequate maintenance operations, poor workmanship or poor quality of plant material prior to completion.

The Virtual Completion Certificate will not be issued until all plants scheduled on the Drawings and Schedule of Works are installed in a healthy condition in the manner specified.

11.11. MAINTENANCE WORKS

11.11.1 General

- i. The Contractor shall maintain the landscape for a two-year period after the date certified by the Landscape Architect that the work has been satisfactorily completed (issue of Certificate of Completion).
- ii. The extent of the landscape to be maintained by the Contractor shall be deemed to cover and include all soft landscape areas within the overall project boundaries as shown on the drawings including all existing soft landscape not affected by the contract works and retained intact or nearly so through the end of the contract period as well as all the landscape works covered in the contract scope of works. No additional maintenance charges will be allowed unless specifically agreed to by the Landscape Architect in writing.
- iii. The Contractor shall ensure that a senior qualified supervisor is made available for organising and running the maintenance programme. The Contractor shall also have available an experience foreman who can supervise the workers on a day-to-day basis. An adequate trained labour force of at least 3 workers must be available for routine work and they must be on site for at least half a working day, 5 days per week during the maintenance period. Additional grass cutting operators will be needed to ensure adequate cutting and cleaning.
- iv. The Contractor's Supervisor shall inspect the site once per week during the maintenance period and shall prepare a brief schedule of operations required for the coming week. The format for the schedule of operations will cover each distinct areas of the site such as frontage, rear, courtyard, roof, interior, etc. The schedule shall describe the operations the Contractor intends to carry out in the coming week to cover the items listed in the specification and to ensure that the current weather conditions and growing performances, insect attack, etc is taken into account.
- v. A copy of this schedule is to be submitted to the Landscape Architect and Employer every week so that a running record of proposed operations can be checked at the maintenance inspections each month. If in the opinion of the Landscape Architect the maintenance works have not been satisfactorily carried out according to site

conditions and the specifications, part of the monthly payment will be withheld until the works have been satisfactorily carried out.

- vi. The contractor shall carry out all necessary measures to ensure that all pot plants, trees and shrubs and other plants shall thrive and become established within this period. All landscape areas will be inspected monthly and lists of remedial works issued after each inspection. All items on the remedial lists are to be carried out by the time of the next inspection, ie within one month.
- vii. The Contractor shall keep the landscape areas clean and tidy at all times and dispose of all waste materials arising from the cleaning.

11.11.2 Maintenance of Planted Areas

- i. The Contractor shall water all trees, palms, shrubs, ground cover, rooted shoots, herbaceous plants and other planting areas as often as necessary to keep the ground moist all around and to the full depth of the roots of the plants to a minimum depth of saturation of:
 - 100mm for groundcover
 - 300mm for shrubs
 - 750mm for trees
- ii. Fresh water only shall be used for the Works. Water shall be supplied to the Contractor from agreed points on the site. However, it will be only to necessary for the Contractor to supply his own means of transport from the watering points to the plant beds.
- iii. An inspection of watering requirements is to be made by the Contractor at least two times a week in dry weather.
- iv. Water shall be supplied using an approved hose or sprinkler so as not to cause compaction or wash-outs of the soil or loosening of plants. The Contractor shall immediately make good any such damage, soil erosion or outwash and plants loosened by erosion are to be replanted or if damaged, replaced.
- v. All plant beds are to be kept in a weed free condition with a weeding operation once a month. All weeds, stones and rubbish collected from this operation shall be removed from the site to a tip to be found by the Contractor. Herbicides may not be used on this site unless a specific application in writing is made by the Contractor with full back up data on the performance of the chemicals and the particular need for the chemicals use. Approval will in all cases be subject to the Landscape Architect's decision.
- vi. After weeding, at least once per month the soil surface is to be lightly broken up between plants using a pronged fork upto maximum depth of 100mm. Contractor shall Take care not to disturb the root systems of plants. After forking the soil loose, the mulch and loosened soil are to be raked to give an even re-distribution of the mulching materials

- vii. Firming up and adjusting of stakes/ties shall be carried out monthly to ensure that the trees and shrubs are firmly held in the ground. If required guy ropes or tree pits shall be adjusted, tightened or loosened. If tree ties or ropes are rubbing the bark of the trees, the ties are to be taken off and retied. Any damaged branches are to be carefully pruned and the wounds sealed.
- viii. All protective fencing is to be maintained and kept in good condition and in position until the end of the maintenance period.
- ix. Trees shall be pruned if dead, rotten or crossed branches are present or to maintain a clear stem up to the specified height using the methods described below. Tree pruning is to be reviewed monthly.
- x. All shrubs and ground covers are to be reviewed monthly and pruned as and when required during the Maintenance Period to promote bushy growth and good flowering characteristics. The shrubs shall be checked and all dead wood, broken, damaged or crossed branches shall be cut back, depending on species. Pruning and removal of branches is to be carried out using sharp clean implements to give a clean sloping cut with one flat face. Ragged edges of bark or wood are to be trimmed with a sharp knife.
- xi. Pruning for all plants shall be carried out as follows:
- Pruning is to be done with the cut just above and sloping away from an outward facing health bud.
 - Removal of branches is to be done by cutting flush with the adjoining stem and in such a way that no part of the stem is damaged or torn.
 - Ragged edges of bark are to be trimmed with a sharp knife.
 - Any cuts or wounds over 25mm diameter are to be painted with an approved sealant after trimmed.
 - All pruning to be cleared up and removed from site after pruning.
- xii. All hedges, mat forming herbaceous plants and ground cover plants shall be clipped with shears as often as necessary (at least monthly) to maintain a tidy appearance. Tall hedges are to be cut to forms shown on the drawings. Fertiliser is to be applied to clipped areas around 1-2 weeks after clipping.
- xiii. Selective pruning of flowering plants shall be done where special flowering characteristics are required such as for Ixoras, Hibiscus, Allamanda where flowering takes places on twig ends. Heavy clipping must not be used for these species since this will remove future flower buds. Selective pruning by clipping non flowering twigs and leaving flowering twigs is necessary for these plants, and this operation must be done by experienced workers.
- xiv. The Contractor shall allow for monthly fertiliser operations during the Maintenance Period. An approved slow release fertiliser shall be applied to each plant at the rate of 50gm per shrub and 200gm per tree, one month after planting and thereafter monthly. After spreading the fertiliser around the base of the plant the granules shall be lightly forked into the soil, and the plant well watered. Herbaceous and ground cover areas

shall receive 25mm of approved soil conditioner, evenly spread and mixed with 50gm/m² of approved slow release fertiliser, evenly spread over entire area and lightly forked into the soil to break up the top layer, and the area well watered on a month by month basis.

- xv. The horticultural requirements of different plants or areas may involve variations to those techniques (such as the use of organic liquid fertilisers for sensitive plants) and variations in method will be authorised as required.
- xvi. Heavy feeding plants such as Canna, Heliconia and Lantana shall be dressed with a 25mm mulch of approved organic compost or similar approved compost every 2 months, lightly forked in around the base of the plants.
- xvii. Additional mulching layer, 25mm deep to be spread and forked in over all planted areas at 3 monthly intervals.
- xviii. The Contractor shall make regular weekly checks to ensure that the plant material is insect and pest and fungus free. No pesticides may be used unless approval from the Landscape Architect is given from the Contractor stating the chemical intended for use; concentration, spraying programme and including full technical details of the product.

11.11.3 Maintenance of Lawn Areas

- i. The Contractor shall mow all lawn areas using approved cutting equipment to maintain a close sward to a height of not less than 20mm and not more than 30mm for all grass types.
- ii. Mowing shall be carried out generally weekly, except in dry weather and grass shall not be allowed to flower between cuts.
- iii. Weekly inspections are to be made to ensure adequate planning of grass cuts to suit growth and weather conditions. All clippings to be gathered up and removed from site.
- iv. All grass areas are to be watered by means of sprinklers during dry weather as often as is required to keep the grass green and the soil moist.
- v. The Contractor shall provide hoses and sprinklers for use from water points provided. Weekly inspections are to be made to determine the need for water and, in dry weather watering must be done to moisten the soil to a depth of 100mm.
- vi. Fertiliser of NPK value 10-15-15 or similar approved be spread at a rate of 40gm/sq m over all grass areas at monthly intervals, using approved spreading equipment to give an overall even spread. Grass areas that have been fertilised shall be watered if no rain falls within 24 hours.
- vii. The Contractor shall apply top-dressing of not more than 15mm depth fine sand and granulated compost raked and spread evenly over the lawn areas. The next top-dressing shall be applied only after the grass has grown through to a mowable height.
- viii. There shall be at least two applications of topdressing during the maintenance period, to be directed by the Landscape Architect appointed by Contractor.

- ix.If depressions or bumps over 25mm deep or high in turf areas during the maintenance period these are to be levelled out by lifting the turf and raising the soil level with sand/compost mix or trimming to level grades, followed by re-turfing.
- x.Grass areas are to be kept free of weeds, annual grasses, fungus and insect attack and free of stones or other debris throughout the maintenance period as often as is required.
- xi.All chemicals used shall be to the approval of the Employer/Employer's representative. Assessment of these operations is to be prepared on the basis of the weekly maintenance inspection chart.
- xii.If compaction or consolidation takes place or hard passing or baking of the soil occurs, the soil areas are to be well watered first and lightly loosened by mechanical means such as spiking, slitting or hollow tinning using equipment approved by the Employer/Employer's representative.

11.11.4 Replacement Planting

- i.If during the course of the Maintenance Period trees or shrubs or other plants die because of a fault by the Contractor, the Contractor shall replace the plant at no cost to the Employer.
- ii.All questions related to responsibility for the replacement planting will be subject to site inspection and agreement of the appointment of responsibility.
- iii.This will be done very month at the monthly maintenance inspections.

11.11.5 Final Handover

- i.Two weeks before the end of the Maintenance Period a joint inspection shall be held with the Maintenance Agency, Contractor and the Employer/Employer's representative review the requirements for alteration or replacement in order to gain approval for Final Handover.
- ii.In order to ensure satisfactory handover procedures, the site meetings held each month between the Contractor and Employer/Employer's Representative will be used to inspect and approve the maintenance works which will be reviewed to ensure adequate work has been done.
- iii.At the time of the final inspection, all areas under this contract shall be free of weeds, neatly cultivated and raked, and all plant boxes in good order.
- iv.Grass shall be neatly cut and all clippings removed. No bare patches of earth shall be visible in turf or planting areas unless specified (that is rings around tree trunks).
- v.If, after this inspection, the Employer/Employer's representative is of the opinion that all work has been performed in accordance with the drawings and specifications, the Employer/Employer's representative will give written letter of acceptance and completion of the project.

vi.If, all or certain portions of the work are not acceptable under the terms and intent of the drawings and specifications, the formal maintenance period for all the work shall be extended at no cost to the Employer/Employer's representative until the defects in the work have been corrected and the work is accepted by the Employer/Employer's representative.