4.3 Cables Laid in Concrete Trench

Cables shall be laid in 5 or 6 tiers in concrete trench as shown on layout drawings. Concrete cables trenches shall be filled with sand /stone dust in hazardous area, switchyard and in transformer bay to avoid accumulation of hazardous gases and oil. RCC covers of trenches shall be effectively sealed to avoid ingress of chemical and oil in process area. Removal of concrete covers where required for the purpose of cable laying and reinstating them in their proper position after cables are laid shall be done by electrical contractor.

Minimum depth of RCC cable trench shall be 500mm for all voltage grades with 300mm clearance between the bottoms of the trench cover and top of the cable. The depth and the width of the trench shall vary depending upon the number of layers of cables and bending radius required for cables as per EIL installation Standards

All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water.

4.4 Above Ground Cables

4.4.1 Cables installed above grade shall be run in cable trays, clamped on walls, ceiling or structures and shall be run parallel or at right angles to beams, walls or columns. Cable routing shall be planned to be away from heat sources such as hot piping, gas, water, oil drainage piping, air-conditioning duct etc. Each cable tray shall contain only one layer of cables as far as possible for power cables. However control cables may be laid in multiple layers in the cable trays. For power & control cables at least 20% space shall be kept as spare in cable trays after completion of cable laying for future use.

4.4.2 Individual/group of cables which run along steel/concrete structures shall be taken through 60/100/150 mm slotted channel tray or channel ISMC-75/100. Cables shall be supported so as to prevent sagging. In general, distance between supports shall be approximately 300 mm for cables upto 25 mm diameter and maximum 450 mm for cables larger than 25 mm dia. to prevent the sagging of cables.

4.4.3 Cable laid on supporting angle in cable trenches, structures, columns and vertical run of cable trays shall be suitably clamped by means of GI saddles / clamps, whereas cables in horizontal run of cable trays shall be tied by means of nylon cords. Distance between supporting angles shall not exceed 600 mm.

4.4.4 All cable trays (other than galvanized/FRP trays) and supporting steel structures shall be painted before laying of cables. The under surfaces shall be properly degreased, derusted, descaled and cleaned. The painting shall be done with one coat of redoxide zinc chromate primer. Final painting shall be done with two coats of approved bituminous aluminium paint unless otherwise specified.

4.4.5 Where cables rise from trench to motor, lighting panel, control station, junction box etc., they shall be taken in GI pipe for mechanical protection upto a minimum of 300 mm above grade for outdoor area. Cable ends shall be carefully pulled through conduit to prevent damage to cable.

4.4.6 All GI Pipes shall be laid as per layout drawings and site conditions. Before fabrication of various profiles of pipes by hydraulically operated bending machine (which is to be arranged by the contractor) all the burrs from the pipes shall be removed. GI Pipes having bends shall be buried in soil / concrete in such a way that the bend shall be totally concealed. For G.I. pipes buried in soil, bitumen coating shall be applied on the buried lengths. Installation of G.I. pipes

shall be undertaken well before paving is completed and necessary co ordination with paving agency shall be the responsibility of Electrical Contractor.

Following guide shall be used for sizing of GI. pipe.

a) 1 cable in a pipe - 53% of pipe cross-sectional area occupied by cables.

b) 2 cables in a pipe - 31% of pipe cross-sectional area occupied by cables.

c) 3 and above cables in a pipe - 40% of pipe cross-sectional area occupied by cables.

4.4.7 After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound/bitumen/suitable sealing compound. Alternatively rubber bushes shall be employed for the purpose of sealing.

4.4.8 Fire proofing of end of power cables at least 1 meter at each end as per OISD norms for the refinery and Petroleum industry, shall be carried out as per the recommendation of the paint supplier .Rates for the fire proofing of cables shall be included in the cable installation and no separate payment shall be made for the painting.

5.0 TERMINATIONS

5.1 All cables up to 1100V grade and higher levels shall be terminated at the equipment by means of compression type cable glands suitable for the cable size. They shall have a screwed nipple with electrical threads and check nut. The cables shall be identified close to their termination points at both the ends of cable(cable numbers shall be punched on stainless steel straps 2mm thick and securely fastened to the cable, wrapped around it) and also along the route at regular intervals, by cable tag numbers.

All cable entries for outdoor termination shall be through bottom/side. Outdoor cable termination through top of equipment shall not be permitted.

5.2 Power cables cores wherever colour coding is not available shall be identified with red, yellow and blue PVC tapes. Where copper to aluminium connections are made, necessary bimetallic washers shall be used.

5.3 In case of control cables, all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules suitable for core size. Wire numbers shall be as per schematic/ wiring/inter-connection diagram. All unused spare cores of control cables shall be neatly bunched and ferruled with cable tag at both ends, for future use.

5.4 Contractor shall drill holes for fixing glands wherever necessary. Gland plate shall be of non-magnetic material/ aluminium sheet in case of single core cables. All unused cable entries on equipment/panels shall be plugged/sealed.

5.5 The cable shall be terminated at electrical equipment/switchboards through glands of proper size. The individual cores shall then be dressed and taken along the cables ways or shall be fixed to the panels with polyethylene straps. The cable glanding shall be done as per manufacturer's instructions. Cable armour shall not be exposed after termination is complete.

In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom close fit holes shall be drilled in the gland plate for all the cables in one line, then gland plate shall be split in two parts along the centre line of holes. After fixing bottom plate, uncovered cable holes/gaps shall be sealed with cold setting compound.

5.6 Crimping of lugs to cable leads shall be done by hand crimping / hydraulically operated tool as per requirement. Insulation of the leads shall be removed before crimping. Conductor surface shall be cleaned and shall not be left open. Suitable conducting jelly shall be applied on the conductor lead. Lugs shall enclose all strands of cable core. Cutting of strands shall not be allowed.

5.7 The contractor shall bring to the notice of Engineer-in-charge any mismatch in cable glands, lugs provided with the equipment vis-à-vis to the cable size indicated in cable schedule for taking corrective action.

5.8 The cable joints shall be avoided as far as possible . In case a joint is unavoidable, the following shall be insured:

- The number of joints shall be restricted to minimum as far as possible.
- The location of joints shall be identified with permanent markers.
- No joints shall be allowed in hazardous areas without the approval of Engineer-in-charge.

The jointing and termination of medium voltage power cables shall be carried out by trained personnel only. Jointing and termination of high voltage and EHV cables shall be done by skilled and experienced jointer duly approved by Engineer-in-charge. Only type tested jointing and termination kits of approved make shall be used.

5.9 No unauthorized repairs, modifications shall be carried out on the hazardous area equipment terminal boxes and junction boxes. Damaged enclosures of hazardous area equipment shall be brought to the notice of Engineer-in-charge by contractor. After termination is complete, all the bolts, nuts, hard wares of terminal box shall be properly placed in its position and tightened.

5.10 All cables glands installed outdoor shall be provided with suitable sized shrouds and rates for the same shall be included in the scope of the termination of the cable glands. No separate payment is envisaged for the same.

6.0 TESTING AND COMMISSIONING

6.1 Field testing and commissioning of electrical installation shall be carried out as per EIL specification.

6.2 Before energising, the insulation resistance of every circuit shall be measured from phase to phase, phase to neutral and from phase/neutral to earth.

6.3 Where splices or terminations are required in circuits rated above 650 volts, insulation resistance of each length of cable shall be measured before splicing and or / terminating. After completion of splices and /or terminations, measurements shall be repeated.

6.4 The insulation resistance of directly buried cables shall be measured before cable trenches are backfilled. Measurements shall be repeated after back filling.

For cables upto 1.1 KV grade 1000 V Megger and for H.V. Cables 2.5 KV / 5 KV Megger shall be used.

6.5 D.C. High Voltage test shall be conducted on cables given below after installation.

a) All 1100 volts grade power cables in which straight through joints have been made.
b) All cables above 1100 V grade.
c) The DC High Voltage test shall be performed as detailed below in the presence of the Engineer-in-charge or his authorized representative only.

Cables shall be installed in final position with the entire straight through joints complete. During the high voltage test, all other electrical equipment related to the cable installation, such as switches, instrument transformers, bus bars, etc., must be earthed and adequate clearance shall be maintained from the other equipment and framework to prevent flash over.
In each test, the metallic sheath/screen/armour shall be connected to earth.

6.6 All checks and tests shall be made as per EIL standard test Performa available with site engineer.

All test readings shall be recorded and submitted to EIL in triplicate sets.

6.7 Cable schedule, cable layout drawings, Interconnection drawings shall be revised and marked by contractor for 'AS BUILT STATUS' and two sets of copies along with CD shall be submitted to EIL.

प्रकाश व्यवस्था के उत्थापन के लिए विनिर्देश

SPECIFICATION FOR LIGHTING INSTALLATION

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	31 12 2019	REVISED AND ISSUED AS SPECIFICATION	DK/RM	RS	SA	RKT
5	10 03 15	REVISED AND ISSUED AS SPECIFICATION	AKG	SA	BRB	SC
4	15 01 14	REVISED AND ISSUED AS SPECIFICATION	FA	SA	UAP	SC
3	25 04 08	REVISED AND ISSUED AS SPECIFICATION	RKS	SSM	JMS	VC
2	28 02.03	REVISED and ISSUED AS SPECIFICATION	HKM	RSG	VPS	SKG
1	01 09 97	REVISED and ISSUED AS STANDARD SPECIFICATION	RR	VPS	SG	AS
0	31 03 82	ISSUED AS STANDARD SPECIFICATION	RR	VPS	--	--

Abbreviations:

AC	:	Alternating Current
BIS	:	Bureau of Indian Standards
CCoE	:	Chief Controller of Explosives
CD	:	Compact Disc
CEA	:	Central Electricity Authority
CFL	:	Compact Fluorescent Lamps
CIMFR	:	Central Institute of Mining and Fuel Research
DC	:	Direct Current
DG	:	Diesel Generator
DGMS	:	Director General Mines and Safety
ELCB	:	Earth Leakage Circuit Breaker
FFL	:	Finished Floor Level
FRP	:	Fibre Reinforced Plastic
GI	:	Galvanised Iron
HPMV	:	High Pressure Mercury Vapour
HPSV	:	High Pressure Sodium Vapour
HRC	:	High Rupturing Capacity
IP	:	Ingress Protection
IS	:	Indian Standards
JB	:	Junction Box
LED	:	Light Emitting Diode
MCB	:	Miniature Circuit Breaker
MCCB	:	Moulded Case Circuit Breaker
MDB	:	Main Distribution Board
MS	:	Mild Steel
PE	:	Polyethelene
PVC	:	Polyvinyl Chloride
TPN	:	Three Phase and Neutral
SS	:	Stainless Steel

Electrical Standards Committee

Convenor: **Ms. Sumita Anand**

Members: Mr. Parag Gupta
Mr. M.K.Sahu
Ms. ANP Singh
Mr. Harish Kumar
Ms. Shalini Verma
Mr. Raman Sood
Ms. Shirali Aggarwal
Mr. Rajesh Sinha (Inspection)
Ms. N.P. Guha (Projects)

CONTENTS

1.0 SCOPE

This specification defines the requirements for the supply of equipment, materials, installation, testing and commissioning of the lighting system (lighting fixtures, lighting power distribution, telephone wiring etc.).

2.0 CODES AND STANDARDS

2.1 The work shall be carried out in the best workman like manner in conformity with this specification, EIL installation standards, layout drawings, the latest edition of relevant specifications, codes of practice of Bureau of Indian Standards and OISD standards listed below :

SP:30 (BIS)	Special Publication - National Electrical Code.
IS:5	Colours for ready mixed paints and enamels.
IS:3854	Switch for domestic & similar purpose
IS/IEC 60947	L.V. Switch gear and control gear
IS: 1293	Plugs & socket outlets of rated voltage upto and including 250V & rated current upto 16A.
IS:9537	Conduits for electrical installations
IS 694	Polyvinyl Chloride insulated unsheathed & sheathed cables/cords upto & including 450/750V
OISD RP- 147	Inspection and safe practice during electrical installation
OISD 173	Fire prevention and protection system for electrical installation

2.2 In addition to the above it shall be ensured that the installation conforms to the requirements of the following as applicable:

a. CEA Regulations
b. Regulations laid down by CEA/Electrical Inspectorate.
c. Regulations laid down by CCoE/DGMS (as applicable).
d. The petroleum rules (Ministry of Industry Government of India).
e. Any other regulations laid down by central/state/local authorities and Insurance agencies.

3.0 EQUIPMENT SPECIFICATIONS

All materials, fittings and appliances to be supplied by the contractor shall be new, unused and of the best quality and shall conform to the specifications given hereunder. These shall be manufactured in accordance with the latest revision of the specifications of Bureau of Indian Standards/International standards. In the absence of any specifications for a particular item, contractor shall bring material samples along with proven track record to site and get the same approved by Engineer-in-Charge/Owner before installation.

3.1 Lighting and Power Panels

3.1.1 Lighting and Power panels (general purpose panels for safe area) shall be made of 1.6mm thick sheet steel or polycarbonate material as specified and shall be dust and vermin proof. All metal surfaces shall be cleaned free of rust, given a coat of red-oxide primer and finished with two coats of epoxy based paint of shade 632 of IS 5. Panels shall be indoor/outdoor type as specified. Indoor type panels shall have IP42 degree of protection and shall be suitable for surface or flush mounting on wall surface as specified. Lighting and power panels located outdoor shall be IP55 weather protected and shall also preferably have integral canopy for

additional weather protection. The canopy shall be made of 2mm thick galvanized sheet steel, FRP, SS (1mm) where these are separate from the equipment.

3.1.2 Lighting and Power panels shall have TPN incoming feeder and single phase outgoing feeders. Lighting circuit feeders shall be rated for 10 amps and power circuit feeders shall have current rating of 16Amps.In power panels for window Air conditioning units, power circuit feeder shall be rated for 20 amps. Panels shall be equipped with phase and neutral bus bars of required current carrying capacity. The outgoing feeders shall be provided with single pole miniature circuit breakers (MCBs) for safe areas and double pole MCBs for hazardous areas. The incomer shall be with MCB and ELCB unit unless otherwise specified. In case of panel for Green Buildings incomer shall also be provided with Energy Meter as per GRIHA requirements. Accordingly, CTs shall be provided in all the three phases for current measurement and voltage shall be tapped directly from phases through control fuses. Miniature circuit breakers shall be mounted in such a way that the operating levers project outside the front Bakelite cover plates for ease of operation. A hinged door to cover the operating knobs shall be provided. In addition, a circuit diagram indicating incomer details and outgoing details viz. Circuit number, circuit rating, and load connected and details of the load shall be pasted inside the panel. Also a laminated copy of the diagram shall be provided inside the panel in a suitably designed pocket. Two external earthing studs for connection to the plant earthing grid shall be provided on the panel. Further, the panel shall be provided with an earth bus bar with terminal studs for connection to the third core of each outgoing circuit. Each circuit phase and neutral shall be given ferrule numbers. Complete wiring inside the panel, shall be neatly bunched with PVC tape and button. Sufficient terminals shall be provided in the terminal block so as to ensure that not more than one wire (core) is connected to a terminal. The panel shall have knock out holes or removable gland plate for the entry of incoming and outgoing conduits or cables. The panels shall be complete with requisite number of cable glands as specified.

3.1.3 The Main distribution board (MDB) where used, shall be made of 2mm thick sheet steel panel, dust and vermin proof similar in construction to Lighting and Power panels but with TPN MCCB or switch fuse incoming and TPN outgoings (MCB with ELCB units and MCB without ELCB unit as applicable) of required numbers as specified.

3.1.4 All MCBs shall be of M9 category as per IS 8828 and sensitivity of ELCBs shall be 100 mA-300 mA unless otherwise specified.

3.1.5 Wherever the size of incoming cable to lighting, power panels/MDB is more than 35 sq.mm a suitable cable adapter box shall be provided and attached to the panel. The incoming cable leads shall be connected to terminal block (bolted type terminals) of required size. This terminal block shall be connected to TPN incomer unit through separate PVC insulated copper conductor wires/bus bars. Sufficient space shall be provided (minimum 300mm) between gland plate and the bottom of terminal block for easy termination.

3.2 Lighting Fixtures

The types, makes and catalogue numbers of various types of lighting fixtures shall be as given in Fixture schedule, job data sheet. HPMV/HPSV/fluoroscent lighting fixtures shall be complete with ballast, starters and capacitor, as required. Control gears for these fixtures shall be integral or non-integral as specified in lighting layout drawings. LED lighting fixtures shall be complete with its driver. All lighting fixtures should have sufficient number of cable entry for loop in & loop out and also should have sufficient terminals & size for connection of cable/wire. All lighting fixtures to be installed in battery room should be flame proof type, suitable to IIC gas group and should have anticorrosive feature. Unless otherwise specified, all fixtures shall be supplied complete with lamps. Ballast for fixture shall be copper wound or electronic type. The fixtures shall be of high power factor type i.e. at least 0.9 or more.

3.3 Switches

Switches, manufactured in accordance with IS: 3854 shall be used for non hazardous areas. Switches in areas where concealed wiring has been adopted, shall be flush mounting Modular type unless otherwise specified. For surface conduit wiring, Modular type switches in surface mounted box shall be provided. Industrial Type switches (Weather protected) shall be used for outdoor areas. Industrial Type switches (Flame proof/Weather proof) shall be provided for tall structures, columns, vessels, walkways etc as shown in lighting layout drawings.

3.4 Receptacles

Three pin type 5A/15A receptacles manufactured in accordance with IS: 1293 shall be used for non hazardous areas. The receptacles and the controlling ON/OFF switch shall be mounted in the same enclosure box but these shall be in separate units to facilitate replacement by parts. Flush mounting type receptacles shall be used in areas where concealed wiring has been adopted and surface type shall be used in other areas. For exhaust fans and wall mounted air circulators, socket and switch enclosures shall be separate. In buildings such as sub-station, DG. Shed, Workshop, maintenance shop etc. industrial type metal clad socket outlets and plugs shall be provided. These sockets shall be supplied complete with plugs. Modular type receptacles along with required boxes shall be provided for indoor application in case shown in the layout.

3 phase, 5 pin, 40A, 415V sockets shall be provided for tower air conditioners in control rooms. The receptacles and the controlling ON/OFF switch shall be mounted in the same enclosure box but these shall be in separate units to facilitate replacement by parts.

3.5 Outlet Boxes

The outlet boxes used as point outlets shall be prefabricated GI sheet steel of 18 gauge thickness and of adequate depth. Outlet boxes custom fabricated for sockets, switches, fixtures and fan regulators etc. shall be made of MS sheet having minimum thickness of 1.6mm.Outlet boxes shall be galvanized/ nickel plated after fabrication. These shall be complete with terminal block suitable for connection of wires up to 4 sq. mm Front cover plate shall be of 3mm thick Bakelite / PE sheet. The colour shall suit the shade of the walls or shall be white if the shade of the walls is not finalised. The sheet shall extend at least 2 cm on all sides of outlet box. Cover plate shall be fixed by cadmium plated brass screws and cup washers. Outlet boxes shall be provided with adequate number of knock outs on all the sides for ease of wiring either with conduits or without conduits.

3.6 Conduit and Accessories

Conduits for Electrical installations shall conform to IS: 9537. The type of conduit (steel / GI/ PVC) shall be as specified on drawing. Black enameled steel or GI conduit shall be of 1.6mm thick and the minimum wall thickness of PVC conduit shall be 1.6mm. Generally PVC conduits shall be used in concealed wiring and for surface wiring GI conduit (in plant buildings) and black enameled steel conduit (in non plant buildings) shall be used.

3.7 Lighting Poles

Lighting poles shall be fabricated as per EIL installation standards enclosed with the specification from ERW steel tubular pipes of specified section, with joints, swaged together when hot and beveled on outside edges or hexagonal shape. Poles shall be coated with bituminous preservative solution on the ground portion of the outside surface. Remainder of the outside surface shall be given one coat of redoxide primer and finished with two coats of aluminium paint. The pole shall have a marshalling box near the bottom to contain HRC

fuses, a neutral link, an earth stud and terminal block. FRP/GRP type lighting poles shall be provided in case shown in the layout.

3.8 Lighting Mast

3.8.1 Lighting masts (Lattice tower) where used, shall be fabricated as per EIL Standard Drawing enclosed with the tender/specification. They shall be complete with 2 nos. MS flats provided at the base plate for connection to the plant earthing grid. A ladder, platform, handrail, a weather protected TPN switch (at 1500mm from ground level) and a weather protected distribution board fabricated out of sheet steel shall be provided at the top of mast. The TPN Switch and the distribution board shall also have a canopy for additional weather protection. The TPN switch shall be suitable for looping one more lighting mast from the same incoming power supply. The distribution board shall have TPN bus bars of 30 Amps. rating and 12 Nos. outgoing circuits each with a 6A single pole MCB. The distribution board shall have cable entries from bottom. Necessary space provision and suitable mounting arrangement shall be made on top of the tower for mounting of ballast (choke) and condensers for all the circuits and the lighting fixtures. The masts shall be given one coat of red oxide primer and two coats of aluminium paint. Distribution board shall be fabricated out of 2mm thick sheet steel and shall be painted with two coats of enamel over a base coat of red oxide.

3.8.2 Unless otherwise specified the flood lighting high masts shall be telescopic type conforming to EIL specification and data sheet.

3.9 Wires

Wires shall be PVC insulated and shall be of 660 Volts grade as per IS694. Conductor shall be of stranded copper and size shall be minimum 1.5 Sq. mm for lighting, 2.5 Sq. mm for 15A power socket circuits and 4 sq. mm for split A/C power socket circuits. Red/Yellow/blue wires for phases, black wire for neutral and green wire for earth shall be used (size of earth wire shall be same as for phase and neutral size). Wire size for air conditioning circuit feeders shall be as indicated in the panel schedule.

3.10 Ceiling fan/Exhaust fan

Ceiling fans shall be of 1200mm sweep with BEE (Bureau of energy efficiency) rating of minimum 3 star, unless otherwise specified with double ball bearing and regulator. The suspension down rod shall be sturdy mild steel rod of adequate diameter and of minimum length of 300mm with shackles suspension arrangement as per IS. For exhaust fans, the sweep dia. and air CFM shall be as specified in job specification. Exhaust fans for battery room shall be flame proof type, suitable to IIC gas group and with anticorrosive blades suitable for use in acidic fumes. Exhaust fans shall be with BEE rating of minimum 3 star.

3.11 Decorative switches and sockets

Decorative lighting switches and sockets where specified, shall be modular in design. All these items shall fit into the same frame with overall standard dimensions. Frames shall be suitable for surface and flush mounting in brick / concrete wall. The frames shall be suitable for conduit entry from all the sides. Switches and sockets shall match colors of the frame and cover plates to obtain a combination which shall match décor of the interiors of Control Room, Administrative buildings, offices rooms etc.

4.0 LIGHTING INSTALLATION

4.1 General

4.1.1 The lighting fixtures in the plant shall be fed from lighting panel. All outdoor lighting shall be group controlled manually or through synchronous timer or photocell. Lighting wiring between panel and lighting fixtures shall be done with PVC insulated 3-core (phase, neutral and earth) copper conductor armoured cable for hazardous areas. Wiring in the building shall be done by means of 3-core copper, conductor PVC insulated, un-armoured cables, or PVC insulated copper conductor wires in conduit/Metsec channel as specified. All joints of conductors in Switch boards/JBs Fittings shall be made only by means of approved mechanical connectors (nylon/PVC connectors). Bare twisted joints shall not be permitted any where in the wiring system.

4.1.2 The lighting layouts furnished by owner will indicate approximate locations of lighting fixtures. The electrical contractor shall determine, with approval of Engineer-in-Charge, the exact locations of each fixture in order to avoid interference with piping or other mechanical equipment and also with a view to obtain as much uniform illumination as practicable, and to avoid objectionable shadows. Conduits shall be laid out by the contractor to suit field conditions and as per directions of the Engineer-in-Charge.

4.1.3 On walkways, platforms and other outdoor area, lighting fixtures shall be located nearer to landing of stairs or ladders, gauges, flow meters, panel boards and other equipment to provide proper illumination.

4.1.4 The minimum height of any lighting fixture shall be preferably not less than 2.5 meters above the floor level.

4.1.5 All outdoor cable terminations to outdoor junction boxes, panels, socket outlets etc. shall be through bottom or from side. Top entries for cables shall be avoided to avoid water entry. All cable glands for outdoor terminations shall be double compression type and the gland shall be covered with PVC or rubber boot shroud. All unused cable entries shall be plugged with suitable blanking plugs.

4.1.6 Mounting height of equipment shall be as under:-

Top of Switch Box	:	1200 mm from FFL (Finished floor level)
Top of Lighting/Power Panel	:	1800mm from FFL
5/15 Amp. receptacle	:	300mm from FFL unless otherwise specified (1200 mm for process areas and industrial sheds)
Lighting fixture	:	As indicated in layout drawing
Exhaust fan	:	In the cutout provided / as indicated in Layout drawings.

4.1.7 Fixtures shall be firmly supported from the structures. Support clamps etc. may be bolted or welded to the existing steel work or metal inserts. In case of concrete structures, where metal inserts are not available, fixtures shall be suspended from concrete surfaces with the help of anchor fasteners. In such cases special care shall be taken to see that anchoring is firm. In places where ceiling fans are provided, lighting fixtures shall be suspended below the level of fan to avoid shadow effect.

4.1.8 The lighting fixtures on various circuits shall be suitably interlaced so that failure of any one circuit does not result in complete darkness.

4.1.9 Circuit cables in a group shall be cleated to structure by using galvanised strip clamps or cable run in cable trays wherever trays are available. Spacers and cleats shall be of required size to

accommodate the cables. All hardware shall be galvanised or zinc passivated. Underground lighting cables (in paved areas) shall be taken in suitable GI sleeves buried at a minimum depth of 300mm from FFL. GI pipe sleeves shall be extended to 300mm above FFL. Exact termination/layout of GI pipes (for protection of cables) shall be decided at site as per site convenience in consultation with Engineer-in-charge.

4.1.10 Wiring for all outlet sockets shall be done with 3 cores of equal sizes for phase, neutral and earth. The terminals of switch sockets shall be suitable to receive the size of wire specified.

4.1.11 All lighting fixtures shall be provided with terminal block with required terminals suitable for connection of wire up to 2.5 sq. mm copper conductor.

4.1.12 The cable shall be straightened after unwinding it from the drum. All cables are clamped/laid in straight run without any sag and kink.

4.1.13 For location where fan points are shown, fan hooks with junction box shall be provided during concreting.

Where fan hooks and JBs. are provided separately JB shall be located within a distance of 300mm from hook for mounting of ceiling rose.

4.1.14 Industrial type plug sockets with 20A MCB or rating as per job specification shall be provided at a height close to window/split AC units so that plugging of power cable coming from AC units can be easily achieved without adding any extensions to it, however, its switch should be installed at a height of 1200 mm from FFL.

Socket outlets and plugs for installation in Sub-station building, DG shed, workshop, and maintenance shop etc. shall be of industrial metal clad type.

4.1.15 Wiring for exhaust fans shall be terminated in receptacles as specified in layout drawing and the connection from receptacle to the exhaust fan shall be by means of a flexible cord equivalent in size to the main run of wires. Switch for exhaust fan shall be located in a separate switch board along with other switches.

4.1.16 Identification of indoor receptacles shall be done through stickers/paint.

4.1.17 Wherever in process units fire proofing of structural columns has to be done, it would be the responsibility of lighting installation agency to weld adequate size of angles to such structures before its fireproofing which length should be such that it is projected at least 65 mm outside from the finished surface of fireproofing. These welded angles shall be utilized latter to install lighting cable trays, bracket & clamps of lighting fixtures, frame of lighting/power panels, welding/ conveyance receptacles, control gears & other electrical equipments as required. It should be the responsibility of lighting installation agency to coordinate with other agencies which are involved in fireproofing works to complete the all structural/welding works before completion of fire proofing works.

4.2 Conduit System

4.2.1 Surface or concealed conduit system of wiring shall be adopted, as specified in the drawings. Required number of pull boxes shall be used at intervals to facilitate easy drawing of wires. Separate conduit shall be run for lighting and power circuits. Further, conduits for Normal lighting/Emergency lighting/DC critical lighting shall be separate. Conduit layout shall be decided at site as per site conditions. Drop conduits for switch boards shall be decided by contractor as per wall locations shown in Architectural drawings. All exposed run of conduits on surface, shall be vertical or horizontal.

4.2.2 Only threaded type conduit fittings shall be used for metallic conduit system. Pin grip type or clamp type fittings are not acceptable. Conduit ends shall be free from sharp edges or burrs. The ends of all conduits shall be reamed and neatly bushed.

Conduit shall be of minimum 25mm dia. Maximum number of wires permissible in a conduit shall be seven/nine for wire size of 2.5 sqmm/1.5 sq.mm. respectively.

4.2.3 The exposed outer surface of the conduit pipes, including all accessories forming part of the conduit system, shall be adequately protected against rusting. In all cases, bare threaded portion of conduit pipe shall not be exposed unless such bare threaded portion is treated with anti corrosive preservative or covered with approved plastic compound.

4.2.4 Conduit connection to outlet boxes shall be by means of screwed hubs or check nuts on either side. Where concealed wiring is done, junction boxes shall be used so as to rest on shuttering properly. Conduits shall be laid above reinforcement. All conduit connections shall be properly screwed and Junction box covers shall be properly fitted so as to avoid entry of concrete slurry.

4.2.5 Conduit pipes shall be fixed by 1.6mm thick GI saddles on 3mm thick GI. saddle bars of required width in an approved manner at intervals of not more than 50cms for straight run. At places near junction boxes, bends, or similar fittings, saddle and bars shall be provided on either side.

4.2.6 Where concealed wiring is to be adopted, conduits shall be laid in time before concreting of the slab. Pull wire (GI or steel) shall be provided inside conduit for the ease of wire pulling. The contractor shall coordinate his work with other agencies involved in the civil works in such a way, that the work of the other agencies is not hampered or delayed. Vertical conduit runs shall be made in wall before plastering is done so as to avoid chasing. Where chases are made for conduit run contractor shall fill these chases or any other openings made by them after completing the work and patch the surface. During installation, care shall be taken to see that proper covers are provided to prevent rusting of conduits. Locations of all point outlets, junction boxes shall be marked with brick powder or sand so that these are easily identified after shuttering removal. As built conduit layout drawing shall be submitted by contractor after completion of the work.

4.2.7 All junction boxes, bends and other accessories shall be of the same material as that of conduit and shall have the same protective coatings.

4.2.8 After erection, the entire conduit system shall be tested, for mechanical and electrical continuity and shall be permanently connected to earth by means of approved type of earthing clamps.

4.3 Hazardous Area Installation

4.3.1 Wiring in hazardous area shall be done by using minimum 2.5mm^2 copper conductor armoured cable.3rd core of the cable shall be used as earth conductor for earthing of lighting fixture. Circuit wiring feeding hazardous areas shall be controlled by two pole switches/MCBs (for phase as well as neutral isolation).Switches for lighting panels installed in hazardous area shall have a pole to break the neutral in addition to poles for phases.

4.3.2 Correct type of lighting equipment (fixtures and JBs) with regard to hazardous protection as specified in the drawing shall be installed for the areas classified as Zone 1, Zone 2 etc.

4.3.3 The terminations in the junction boxes and the lighting fittings shall be done avoiding possibility of loose connections due to vibrations. After the terminations are made the cover of the junction boxes and the lighting fittings shall be closed properly with all bolts and hard wares in correct position, retaining its explosion and weather protections. In fixtures having

double cable entries, both the entries shall be used for looping in and looping out connection, thus minimising the use of a separate junction box. Wherever separate control gear boxes (CG box) are provided looping in and looping out connections shall be through CG box, thus avoiding the use of an additional junction box. All unused cable entries shall be sealed with suitable plugs.

4.3.4 Circuit cables shall be firmly cleated in a group along columns/ beam/ladders/side channels/platform using 1.6mm thick GI saddles on 25x3 mm GI saddle bar at intervals of 400mm to 500mm for straight run and on either side close to bending and at both termination ends as per the directions of Engineer-in-charge. Where required 3 or more of cables shall be taken in perforated150mm wide slotted channel cable tray after getting the approval of Engineer-in-charge. Minimum straight run shall be 3000mm.Cables shall not be routed along hand rails.

Where fire proofing column/structures are encountered, all cabling shall be taken in GI pipes of required size and both ends shall be sealed, well before fire proofing is done. Similarly equipment such as lighting fixture, control gear box, lighting/ power panels, field call stations, junction boxes etc. shall be installed on suitable steel mounting frame/distance bracket, thereby avoiding direct contact with the concrete used for fire proofing.

4.3.5 Cable glands for terminating cable on flameproof equipment shall be of double compression FLP type. Any material/equipment specified to be supplied by contractor for installation in hazardous areas, shall be tested by CIMFR and duly approved by CCoE or DGMS or any other applicable statutory authority. All indigenous FLP equipment shall also have valid BIS license as required by statutory authorities.

4.4 Building Lighting

4.4.1 The type of wiring system shall comprise surface/concealed conduit system or cable wiring as specified on layout drawings.

4.4.2 Mounting details of fixtures shall be indicated on the drawings. If specified on the drawings, a group of fluorescent lighting fixtures which are to be mounted end to end shall be fixed to mild steel cold rolled sections of 50mm x 50mm and of 1.2mm thick (Metsec channel). The entire assembly shall be fixed to the ceiling with necessary number of supports which may be by means of steel conduit or chromium plated chain link as required. The `Metsec' Channel shall run continuous in suitable sections from one end to other end of wall. The complete channel shall be spray painted, with approved colour as per the directions of Engineer-in-Charge. All wires inside channel shall be neatly bunched by nylon tape and buttons.

4.4.3 Wiring in areas above false ceiling shall be done in Surface Conduit (25mm dia GI conduit) suitably clamped to the true ceiling. Vertical drops from true ceiling for panels, switches, receptacles etc. shall be taken in 25mm dia PVC conduit concealed in walls upto switchboards/panels. Lighting fixtures shall be supported from true ceiling. Exact location of fixtures shall be finalised in co-ordination with air-conditioning duct diffuser layout, panel's layout and false ceiling grid layout. To facilitate easy maintenance `Looping back system` of wiring shall be followed throughout. Accordingly supply tapping's and other interconnections including for earthing are made only at fixture connector blocks or at switch boards. Required number of junction boxes shall be used at intervals for wire pulling and inspection.

4.4.4 All wires in conduit shall be colour coded as specified. Each circuit shall have independent phase neutral and earth wire. However when group of circuits are run in a single conduit the earth wire can be common.

4.4.5 Building conduit lighting system of wiring where measurement is done on point wiring basis generally consists of two parts. The first part is the circuit wiring which includes the work necessary from lighting panel up to switch box and from switch box to another switch box.

The second part is the point wiring which shall include the work necessary from tapping point in the switch box upto various fixtures or fan outlets/ceiling roses.

4.4.6 Switches for light fixtures/exhaust fans in battery room shall be provided outside the Battery room.

4.4.7 Lighting layouts for non-plant buildings (such as ware house, cement godown, gate house, workshop, service building, rest room, etc.) shall be prepared by installation contractor as defined in the scope of work.

The following basic data/document for preparation of layouts will be provided to the contractor.

i) Architectural drawings
ii) Illumination level required
iii) Type of lighting fixture
iv) Type of wiring (concealed/surface conduit/cable wiring etc.)

Based on the above input, contractor shall prepare and submit lighting layout drawings, panel schedules, conduit layout drawings for concealed wiring, design calculations wherever required, for review by purchaser before erection work is started. The lighting layout drawing shall show the location, type and mounting details of lighting fixtures, receptacles, junction boxes, layout of circuit indicating number of wires etc. The number of points in a circuit shall not exceed ten and the load in each circuit shall be less than 1000 Watts.

The panel schedule shall include rating of incoming and outgoing feeders, number of outlets, load for each outgoing circuit, etc.

All drawings shall be prepared preferably in A0 and A1 size. Panel schedules shall be in A4 size drawings. Final submission of drawings shall be in soft copies (CD form) and in bound volumes.

4.5 Street Lighting

4.5.1 Street lighting poles to be located on road side shall be installed at a minimum distance of 300mm from the edge of the walkway of the road (road berm). Size of wires from marshalling box upto fixture shall be 1.5mm²/2.5mm², copper conductor PVC insulated.

4.5.2 Each pole shall be earthed at two points by connecting to the plant earth grid as shown on Installation standards.

4.5.3 Street lighting fixture shall be mounted on steel tubular poles as per standard drawings. The foundation for the street lighting poles will be made by electrical contractor. Street lighting poles shall be supplied with a base plate.

4.5.4 The poles shall be numbered as per the drawings/ directions of Engineer Incharge.

4.6 Mast Lighting

4.6.1 The lattice structure masts shall be installed on concrete foundations with the base plate bolted on to the anchor bolts. The lattice structure shall be painted with a coat of primer and two coats of aluminium paint, the second coat to be given just before handing over to the owner. The masts shall be numbered as per drawings. The masts shall be connected to the plant earth grid at two points

4.6.2 The main feeder upto the distribution board of lighting mast shall be through PVC insulated armoured cable of size as specified in the respective drawing. Wiring from Distribution Board to each flood-light fixture shall be by means of a 3-core 2.5sqmm, copper conductor PVC

insulated armoured cable. All the cables shall be neatly clamped to the structure at intervals not exceeding 25 cms.

4.6.3 Exact orientation of flood lighting fixtures shall be decided at site to achieve optimum utility of these fixtures.

4.7 Telephone Wiring

Conduits for telephone wiring in buildings shall be of 1.6mm thickness. 25mm dia black enameled steel conduit/PVC as per IS 9537, installed on wall surface or concealed or as specified in job specification.

Conduit installation system shall comply with the requirements given in clause 4.2 `conduit system'. Required number of pull boxes shall be provided at interval for easy drawing of wires. The telephone wiring shall be done with 0.63mm dia annealed copper conductor PVC insulated 660V grade, twin flat wire, unless otherwise specified in job specification. One telephone socket outlet shall be provided for connection to telephone instrument.

5.0 TESTING AND COMMISSIONING

5.1 Lighting installation shall be tested and commissioned by installation contractor as per EIL specifications. Precommissioning checks and tests shall include but not be limited to the following:

(i) The insulation resistance of each circuit without the lamps (load) being in place shall be measured and it should not be less than 500,000 ohms. (Between phases, phases to neutral, phase/neutral to Earth).

(ii) Current and voltage of all the phases shall be measured at the lighting panel bus bars with all the circuits switched on with lamps. If required load shall be balanced on the three phases.

(iii) The earth continuity for all socket outlets shall be checked. A fixed relative position of the phase and neutral connections inside the socket shall be established for all sockets.

(iv) After inserting all the lamps and switching on all the circuits, minimum and maximum illumination level shall be measured in the area and recorded.

(v) It shall be ensured that switch provided for ON/OFF control of point (light/fan/socket) is only on LIVE side.

(vi) Operation of ELCB's shall be checked.

Contractor shall duly fill in all the above test results and submit the test reports to Engineer-in-Charge in triplicate.

5.2 All lighting layout drawings shall be marked by contractor for 'AS BUILT STATUS' and two sets of hard copies plus 1 set of soft copy in CD, shall be submitted to EIL.

अर्थिंग डालने के लिए विनिर्देश

SPECIFICATION FOR EARTHING INSTALLATION

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	26 02 19	REVISED AND ISSUED AS SPECIFICATION	DC	RS	BRB	RKT
4	26 03 14	REVISED AND ISSUED AS SPECIFICATION	FA	SA	BRB	SC
3	25 04 08	REVISED AND ISSUED AS SPECIFICATION	RKS	SSM	JMS	VC
2	28 02 03	REVISED & ISSUED AS SPECIFICATION	HKM	RSG	VPS	SKG
1	16 07 97	REVISED & ISSUED AS STANDARD SPECIFICATION	RR	VPS	SG	AS

Abbreviations:

BIS	:	Bureau of Indian Standards
CD	:	Compact Disc
CEA	:	Central Electricity Authority
DGMS	:	Director General Mines and Safety
GI	:	Galvanized Iron
IEC	:	International Electrotechnical Commission
IS	:	Indian Standard
MS	:	Mild Steel
OISD	:	Oil Industry Safety Directorate
PESO	:	Petroleum and Explosive safety organization.
UPS	:	Uninterrupted Power Supply

Electrical Standards Committee

Convenor: Mr. BR Bhogal

Members: Ms. S. Anand
Mr. Parag Gupta
Mr. M.K. Sahu
Mr. Saeed Akhtar (Inspection)
Ms. N.P. Guha (Projects)
Ms. NS Bhattacharya

CONTENTS

1.0 SCOPE

This specification defines the requirements for the supply of earthing and lightning protection materials and installation of the earthing and lightning protection systems.

2.0 CODES AND STANDARDS

2.1 The work shall be carried out in the best workman like manner in conformity with this specification, EIL Installation Standards, layout drawings, the latest edition of relevant specifications, codes of practice of Bureau of Indian Standards and OISD Standards listed below :

SP:30 (BIS)	Special Publication-National Electrical Code
IS/IEC:62305	Protection against lightning.
IS:3043	Code of practice for earthing
IS:7689	Guide for control of undesirable static electricity.
OISD 110	Recommended practices on static electricity
OISD 147	Inspection and safe practice during electrical installation.
OISD GDN 180	Lightning protection.

2.2 In addition to the above, it shall be ensured that the installation conforms to the requirements of the following as applicable:

a. CEA Regulations

b. Regulations laid down by CEA/Electrical Inspectorate.

c. Regulations laid down by PESO/DGMS (as applicable).

d. The petroleum rules (Ministry of Industry, Government of India).

e. Any other regulations laid down by central/state/local authorities and Insurance agencies.

3.0 MATERIAL SPECIFICATIONS

3.1 All materials and hardware to be supplied by the contractor shall be new, unused and of best quality and shall conform to the specifications given here under and to latest specifications of Bureau of Indian Standards. Contractor shall bring material samples to site and get it approved by Engineer-in-charge before installation.

3.2 The main earth grid conductor shall be hot dip galvanised M.S. flat unless otherwise specified. Sizes for main conductors shall be as indicated on the earthing layout drawing .Amount of galvanizing shall be 610gm per sq.metre. Earth electrodes and Earth plate shall be as per EIL Installation Standards.

4.0 EARTHING NETWORK

4.1 This consists of main earth conductor (grid conductor) forming a closed ring network with required number of earth electrodes connected to it to provide a common earth for electrical devices and metallic structures. From each earth electrode two distinct connections shall be made to the main earth conductor. The earth plates shall be used for taking multiple earth connections to two or more equipments.

4.2 The earth conductor shall be laid along cable trays/cable trench/pipe racks/ buried in pavement/ below finished grade level as indicated on the earthing layout drawing. Where lined cable trenches are available, the earth conductor shall be preferably laid in the trenches and shall be firmly cleated to the sidewall of concrete trenches using GI clamps at interval of 400 mm to 500 mm and near to the termination end. The earthing conductor shall run along one of the cable trays along the overhead cable route. The earthing conductor shall be suitably cleated and electrically bonded to all the other cable trays on the same cable route at a regular interval of 25 to 30 meter through copper flexible (insulated) . The earthing for equipment shall be tapped from the main earth conductor and not from cable tray support structure. Earth conductor when laid underground shall be at a depth of 500mm below finished grade level.

4.3 Joints and tapping's in the main earth loop shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below grade shall be welded and shall be suitably protected by giving two coats of bitumen and covering with Hessian tape. Earth strip laid above ground shall be welded across straight through joints and joints shall be suitably protected by giving two coats of bitumen to avoid oxidation and insulation film formation of the strip surface. When two earth strips are to be jointed by means of welding, lap welding with an overlapping of strip equivalent to double the width of the strip and all four sides(three on the Top and one bottom) shall be continuously welded. All joints at tappings above ground shall be by means of connector/lugs. A minimum of two bolts of adequate size shall be used for this purpose. Earthing strip joints at earth plate and equipment shall be through GI bolts, nut etc.

5.0 INSTALLATION OF EARTH ELECTRODE

5.1 Earth Electrode shall be installed as shown on installation standard and layout drawings. The location shown on the layout drawings are indicative.

The exact location of earth electrodes in the field shall be determined by contractor in consultation with the Engineer-in-charge, depending on the soil strata and resistivity. Earth electrodes shall be located avoiding interferences with road, building foundation, column, pipelines etc. The civil area drawings shall be referred for this. The distance between two electrodes shall not be less than twice the depth of electrode. However in the areas where there is physical limitation to meet the above separation distance between two electrode, the mutual spacing can be reduced to a value not less than the driven depth of each earth electrode.

5.2 Electrodes shall preferably be located in a moist soil which has a fine texture, grain size and distribution. Wherever practicable the soil shall be dug up, all lumps broken and stones removed from the immediate vicinity of the electrodes and soil packed by watering and ramming as tight as possible.

5.3 The electrodes shall have a clean surface, not covered by paint, enamel, grease or other materials of poor conductivity.

5.4 All earth electrodes shall be tested for earth resistance by means of standard earth test meter. The tests shall take place in dry months, preferably after a protracted dry spell.

5.5 The disconnect facility shall be provided for the individual earth electrode to check its earth resistance periodically.

5.6 Location of earth electrodes shall be marked by permanent markers for easy identification. All earth Electrodes shall be serial numbered and also marked on 'As Built' drawing for future reference.

5.7 Individual earth electrodes shall be provided for each lightning arrestor, each dropper of building earthing protection system and flood light mast.

5.8 Earthing system provided for concrete paved area by other agency where applicable; shall be connected to the plant earthing system below ground by minimum two earth connections.

5.9 Top of earth pit shall be flushed with finished floor level in paved areas. In unpaved areas, top of earth pit shall be projected 100 mm above finished ground level.

6.0 CONNECTION

The earth system connections shall generally cover the following:

- Equipment earthing for personnel safety
- System neutral earthing
- Static and lightning protection

6.1 The following shall be earthed.

- System neutral
- Current and potential transformer secondary neutral
- Metallic non-current carrying parts of all electrical apparatus such as transformers, switchboards, bus ducts, motors, neutral earthing resistors, capacitors, UPS, battery charger panels, welding receptacles, power sockets, lighting/power panels, control stations, lighting fixtures etc.
- Steel structures/columns, rail loading platforms etc.
- Cable trays and racks, lighting mast and poles
- Storage tanks, spheres, vessels, columns and all other process equipment.
- Fence and Gate for electrical equipment (e.g. transformer yard etc.)
- Cable shields and armour
- Flexible earth provision for Wagon, Truck
- Shield wire
- Ladder, staircase as per layout drawing/job specification.

Conductor size for branch connection to various equipment shall be as per EIL Installation Standards unless otherwise stated on earthing layout drawings.

6.2 All process pipelines shall be bonded and earthed at the entry and exist points of unit battery limit of hazardous area.

6.3 Steel pipe racks in the process units and offsite area shall be earthed at every 24 meters.

6.4 Equipment/street light pole etc. located remote from main earth network may be earthed by means of individual earth electrode and earth conductor unless otherwise stated in job specifications/earthing layout drawing.

6.5 Lightning protection shall be provided for the equipment, structures and buildings as shown on layout drawing. Self conducting structures shall not require separate aerial rod and down conductors. These shall however be connected to the earthing system at two or more points as shown on layout drawing. Each down conductor shall be provided with an earth electrode with test pit and all earth electrodes shall be interconnected through underground strip. Lightning protection system may be bonded to electrical safety earthing system, inside ground. Lightning down conductor shall be brought to earth electrode in shortest straight path as feasible to minimise surge impedance.

6.6 The main earthing network shall be used for earthing of equipment to protect against static electricity.

6.7 All medium and high voltage equipment (above 250V) shall be earthed by two separate and distinct connections with earth.

6.8 Plant instrument system clean earthing, UPS system clean/safety earth, Data concentrator panel, HMI etc shall be separate from the electrical earthing system, if mentioned in job specification/ layout drawings.

6.9 All paint, scale and enamel shall be removed from the contact surface before the earthing connections are made.

6.10 All earthing connections for equipment earthing shall be preferably from the earth plate mounted above ground wherever provided

Equipment foundation bolts shall not be used for earthing connection.

6.11 Earth connections shall be made through compression type cable lugs/by welded lugs.

6.12 All hardware used for earthing installation shall be hot dip galvanised or zinc passivated. Spring washers shall be used for all earthing connections and all connections adequately locked against loosening.

6.13 Lighting fixtures and receptacles shall be earthed through the extra core provided in the lighting circuit/cable for this purpose.

6.14 The reinforcements of sub-station building coulumns/beams and the sub-station floor slab shall be connected to main earth grid.

7.0 TESTING AND COMMISSIONING

7.1 Field inspection, testing and commissioning of electrical installation shall be done as per EIL standard specification.Earthing systems/connections shall be tested as follows:

7.2 Resistance of individual earth electrodes shall be measured after disconnecting it from the grid by using standard earth test meggar.

7.3 Earthing resistance of the grid shall be measured after connecting all the earth electrodes to the grid. The resistance value of an earth grid to the general mass of earth shall be as follows:

- For the electrical system and equipment, a value that ensures the operation of the protection device in the electrical circuit but not in excess of 4 ohm. However for generating stations and large sub-systems, the value shall not be more than 1 ohm.
- For lightning protection, the value of 5ohms as earth resistance shall be desirable, but in no case it shall be more than 10 ohms.

7.4 The resistance to earth shall be measured typically at the following points:

a) At each electrical system earth or system neutral earth.

b) At each earth provided for structure lightning protections.

c) At one point on earthing system used to earth electrical equipment enclosures.

d) At one point on earthing system used to earth wiring system, enclosures, such as metal conduits and cable sheaths or armour.

e) At one point on fence enclosing electrical equipment.

7.5 All earthing layout drawings shall be marked by contractor for 'AS BUILT STATUS' and two sets of hard copies plus 1 set of soft copy, shall be submitted to EIL. For projects, where layout drawings have been prepared based on 3D modeling, contractor shall carryout necessary changes for 'AS BUILT STATUS' in the 3D model.

विद्युत संस्थापनों के साइट निरिक्षण, परिक्षण व कमीशनिंग के लिए विनिर्देश

SPECIFICATION FOR FIELD INSPECTION, TESTING AND COMMISSIONING OF ELECTRICAL INSTALLATIONS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
4	13 08 19	REVISED & ISSUED AS STANDARD SPECIFICATION	RM	RS	SA	RKT
3	10 6 14	REAFFIRMED & ISSUED AS STANDARD SPECIFICATION	AKG	SA	BRB	SC
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1	14 07 03	REVISED & ISSUED AS STANDARD SPECIFICATION	HKM	RSG	VPS	SKG
0	02 08 01	ISSUED AS STANDARD SPECIFICATION	UAP	RR	VPS	MI

Abbreviations:

AC	:	Alternating Current
AFC	:	Approved for Construction
BIS	:	Bureau of Indian Standards
CCOE	:	Chief Controller of Explosives
CEA	:	Central Electricity Authority
DC	:	Direct Current
DCS	:	Distributed Control System
DGMS	:	Director General for Mines and Safety
ECS	:	Electrical Control Station
GI	:	Galvanized Iron
HV	:	High Voltage
IS	:	Indian Standard
MV	:	Medium Voltage
OISD	:	Oil Industry Safety Directorate
PESO	:	Petroleum and Explosives Safety Organization

Electrical Standards Committee

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Ms. ANP Singh
Mr. Harish Kumar
Ms. Shalini Verma
Mr. Raman Sood
Ms. Shirali Aggarwal
Ms. N.P. Guha (Projects)
Mr. Rajesh Sinha (Inspection)

CONTENTS

1.0 SCOPE

This specification covers the requirements for the field inspection, testing and commissioning of Electrical Equipment and Installation, forming part of electrical power distribution and utilisation system.

2.0 CODES AND STANDARDS

2.1 The field inspection, testing and commissioning of electrical equipment shall be carried out in line with this specification and the latest edition of following Indian Standards and OISD standards.

SP-30(BIS)	National Electrical Code.
IS 1255	Code of practice for installation and maintenance of power cables up to & including 33 kV rating.
IS-7816	Guide for testing Insulation resistance of rotating machines.
IS 10810(Part 43)	Method of Test for cables; Part 43 Insulation resistance.
IS 10810(Part 45)	Method of Test for cables; Part 45 High voltage test.
IS 12729	HV Switchgears
OISD 137	Inspection of Electrical Equipment.
OISD 147	Inspection and safe practice during electrical installation.

2.2 In addition to the above it shall be ensured that the installation conforms to the requirements of the following as applicable:

a. CEA Regulations
b. Regulations laid down by CEA / Electrical Inspectorate.
c. Regulations laid down by Tariff Advisory Committee/Loss prevention council.
d. Regulations laid down by PESO/DGMS (as applicable).
e. The petroleum rules (Ministry of Industry, Government of India).
f. Any other regulations laid down by central / state / local authorities / insurance agencies

3.0 FIELD INSPECTION, TESTING AND COMMISSIONING

3.1 Contractor shall carry out complete field inspection, testing and commissioning of electrical equipment as per Inspection & Test plans.

3.2 Before the completed installation or an addition to the existing installation is put into service, inspection / pre-commissioning checks and tests shall be carried out by contractor. In the event of defects being found out, the same shall be rectified and the installation retested as applicable.

3.3 The pre-commissioning inspection among other requirements shall include visual inspection, checking the workmanship of the installation, the rating of equipment, safety clearances, sizes of cables installed, conformance to the AFC document, soundness of switchgear bus connections, wiring properly dressed and labeled, sealing of unused cable entries, checking of all safety interlocks, control/interface functions as per requirement etc.

3.4 Visual inspection for soundness of bus bar connections of busducts, terminal connections of equipment/motor shall be carried out. It shall be ensured that no foreign materials are present inside busduct and equipment terminal boxes. After the visual inspection, all the covers of terminal boxes, inspection chambers shall be refitted with gaskets, bolts & nuts as per equipment manufacturer's instructions.

3.5 Pre-commissioning tests shall include but not be limited to the following:

- Continuity test for each winding and power and control circuits.
- Insulation test for each winding and power and control circuit
- High voltage test for cables
- Dielectric strength test on transformer oil.
- Checking the correctness of wiring schemes, control circuit interlocks for intended functioning.
- Verification of phase sequence.
- Testing of all types of relays/releases for required operation.
- Testing of measuring instruments for proper functioning.
- Earth continuity test for all circuits.
- Checking of safety features for correctness of operation, etc.
- Checking of all wired interface contacts (analogue, digital input/output contacts) for DCS and ECS interface, at panel and equipment terminal chambers as applicable.

  (Electrical contractor shall co-ordinate with other agencies involved for the above and provide support services for checking interfaces of electrical equipment and the intended functioning)

- Earth resistance measurement for each earth electrode, and the earthing system as a whole.
- Lighting installation shall be tested for correct illumination levels, with fittings installed. Fittings shall be operated only with specified type of a lamp or tube.

3.6 After the above tests and inspection are completed, control circuits shall be tested for correct operation under all operating combinations and proved correct before applying power to main circuit.

3.7 Plant Communication, Fire alarm detection and telephone system shall be checked for correct operation and intended function.

3.8 A close visual inspection of electrical equipment in hazardous areas shall be made to ensure that equipment is suitable for the classified zone and gas group and correctly installed, with all covers, bolts, nuts and hardwares intact and there is no physical damage mark seen on the enclosure

3.9 Site Acceptance Test procedure for specific equipment shall be furnished by the respective equipment vendor in line with testing requirements as per relevant standard, this specification & relevant equipment specifications. The Site Acceptance Test Procedure/ Site Testing Procedure shall be duly reviewed by the site Engineer-in-Charge. The contractor shall provide necessary assistance to the equipment vendor to perform Site acceptance testing to enable the equipment vendor to perform the same.

3.10 All pre-commissioning checks and tests shall be carried out as per the directions of Engineer-in-charge. In addition to the equipment manufacturer's instructions, pre-commissioning check requirements shall also be complied. All tests shall be carried out by contractor in the presence of EIL/Owner's representatives

3.11 The contractor shall bring to site all required tools, tackles, and testing instruments for carrying out field testing. Contractor shall use only calibrated measuring and test instruments and shall maintain valid calibration records.

3.12 The **Insulation Resistance** test values for various electrical equipment shall be as below:

3.12.1 **Cables**

The insulation resistance test values for cables shall be as per following table:

Rated voltage of the Cable	**DC Test Voltage in Volts**	**Minimum Insulation resistance in Mega ohms**
Lighting and power circuit wiring	250	1
650/1100V grade cables	1,000	10
1,900/3,300V grade cables	1,000	200
3,800/6,600V grade cables	1,000	200
6,350/11,000V grade cables	5,000	200
8,700/15,000V grade cables	5,000	200
12,700/22,000V grade cables	5,000	200
19,000/33000V grade cables	5,000	200
38000/66000V (72500V) grade cables	5,000	500

3.12.2 **HV, MV and Miscellaneous Switchboards**

The insulation resistance test values for the switchboards shall be as per following table:

Rated voltage of the Switchboard	**DC Test Voltage in Volts**	**Minimum Insulation resistance in Mega ohms**
33,000V	5,000	200
11,000V	5,000	200
6,600V	1,000	200
3,300V	1,000	200
415V	1,000	100
240V	500	10
110V	500	10

3.12.3 **Generators and Motors**

3.12.4 The insulation resistance test values for Generators and Motors shall be as per following table:

Rated voltage of the Generators and Motors	**DC Test Voltage in Volts**	**Minimum Insulation resistance in Mega ohms at 40 °C**
11,000V	5,000	120
6,600V	1,000	80
3,300V	1,000	50
415V	1,000	15
240V	500	12

3.12.5 **Transformers**

The insulation resistance test values for the Transformers shall be as per following table:

Rated voltage of the Transformers	**DC Test Voltage in Volts**	**Minimum Insulation resistance in Mega ohms at 40 °C**
Up to 600V	1,000	100
601 to 5000V	2,500	1,000
5001 to 15,000V	5,000	5,000
15001 to 35,000V	5,000	10,000
35001 to 66,000V	5,000	10,000
66001 to 132,000V	5,000	10,000

3.12.6 It shall be ensured that during insulation tests, electronic devices and components that are liable to get damaged on applied test voltage shall be disconnected from circuit. The instructions of equipment/panel manufacturer shall be followed strictly in this regard.

3.13 High-voltage Testing

3.13.1 DC high voltage test shall be conducted as per following table on all HV feeder cables and also on 1100 V grade cables where straight through joints have been made. This table shall be used as a reference and the DC high voltage test shall be conducted considering equivalent IS/ IEC voltage grades upto 66kV

Rated Voltage of Cable (kV)	**TEST VOLTAGE (kV) BETWEEN**		**Duration (Minutes)**
U_o / U*	**Any Conductor and Metallic Sheath/ Screen/Armour**	**Conductor to Conductor (For Unscreened Cables)**	
0.65/1.1	3	3	5
1.9/3.3	5	9	5
3.3/3.3	9	9	5
3.8/6.6	10.5	18	5
6.6/6.6	18	18	5
6.35/11	18	30	5
11/11	30	30	5
12.7/22	37.5	-	5
19/33	60	-	5

*U_o : Phase Voltage

U : Line Voltage

The cable cores must be discharged on completion of DC high voltage test and cable shall be kept earthed until it is put into service.

DC test voltage for old cables shall be 1.5 times rated voltage or less depending on the age of cables, repair work or nature of jointing work carried out, etc. In any case, the test voltage shall not be less than the rated voltage.

3.13.2 AC high voltage test shall be conducted as per following table on all HV Switchboards.

Rated Voltage (rms Value in kV)	Rated 1 Min. Power Frequency Withstand Voltage (rms Value in kV)		Duration in Minutes
U	To Earth, Between Poles and Across Open Switching Device	Across the Isolating Distance	
3.6	10	12	1
7.2	20	23	1
12	28	32	1
24	50	60	1
36	70	80	1
72.5	140	160	1

The withstand voltage values across the isolating distances are valid only for switching devices, where the clearance between open contacts is designed to meet the safety requirements specified for disconnectors.

3.13.3 DC Voltage test of the cable over-sheath shall be conducted as per IEC 60840 & IEC 60229:- A D.C. voltage of 4kV per millimetre of specified thickness of extruded over-sheath shall be applied with a maximum of 10kV D.C. between the underlying metallic layers and the outer electrode, for a period of 1 min. All metallic layers under over-sheath shall be connected together.

This test requires that the over-sheath has an outer "electrode" which may be moist backfill or a conductive layer.

No breakdown of the over-sheath shall occur during the test

3.13.4 AC voltage test of the cable insulation shall be conducted as per IEC 60840, rated voltage may be applied for 24 hours.

3.14 All protective relays including thermal overload relays shall be tested by secondary injection current. Primary injection tests shall be carried out for differential protection, restricted earth fault protection at full/reduced current to ensure correctness of complete wiring.

3.15 Before energizing any equipment, 'COMMISSIONING CLEARANCE FORM' as per standard format shall be duly filled in by contractor and submitted to EIL/owner.

3.16 It shall be ensured that the electrical inspectorate approval is available before energizing the equipment

4.0 RECORDS

Contractor shall keep up-to-date records of all activities carried out and test results. Field inspection / test reports shall be submitted to EIL / Owner by the contractor in bound volumes (triplicate copies).

पैकेज उपस्कर के विद्युत उपकरणों हेतु विनिर्देश

SPECIFICATION FOR ELECTRICS OF PACKAGE EQUIPMENT

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	28.03.23	Revised and issued as standard specification	AP/GK	RS	MKS	SM
5	21.03.18	Revised and issued as standard specification	NV/GK	VKJ	BRB	RN
4	21.11.13	Revised and issued as standard specification	VB	VKJ	UAPJMS	SC
3	25.04.08	Revised and issued as standard specification	RS	IKG	JMS	VC
2	28.03.03	Revised and issued as standard specification	LS	AAN	VPS	SKG

Abbreviations:

AC	:	Alternating current
ASB	:	Auxiliary Service Board
BASEEFA	:	British Approval Service for Electrical Equipment's in Flammable Atmosphere
BIS	:	Bureau of Indian Standard
CEA	:	Central Electricity Authority
CIMFR	:	Central Institute of Mines and Fuel Research
CRCA	:	Cold Rolled Cold Annealed
CT	:	Current Transformer
DC	:	Direct current
DCDB	:	Direct Current Distribution Board
DGMS	:	Directorate General of Mines Safety
EIL	:	Engineers India Limited
ELCB	:	Earth Leakage Circuit Breaker
FM	:	Factory Mutual
GI	:	Galvanised Iron
HRC	:	High Rupturing Capacity
IE	:	Indian Electricity
IEC	:	International Electrotechnical Commission
IEEE	:	Institute of Electrical & Electronics Engineer
IP	:	Ingress Protection
KW	:	Kilo Watt
LCIE	:	Laboratoire Central des Industries Electriques
LDB	:	Lighting Distribution Board
LED	:	Light Emitting Diode
MCB	:	Miniature Circuit Breaker
MCC	:	Motor Control Centre
MCCB	:	Moulded Case Circuit Breaker
MDB	:	Main Distribution Board
MS	:	Mild Steel
MV	:	Medium Voltage
NEC	:	National Electric Code
NEMA	:	National Electrical Manufacturers Association
PCC	:	Power Control Centre
PMCC	:	Power- Cum- Motor Control Centre
PTB	:	Physikalisch- Technische Bundesanstalt
PVC	:	Poly Vinyl Chloride
SWG	:	Standard Wire Gauge
UL	:	Underwriter's Laboratories
V	:	Volt
VDE	:	Verband Deutscher Elektrotechniker

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Mr. Bishan Dass
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Ms. Shirali Aggarwal
Mr. Ayush Mathur (Projects)
Mr. Rajest Sinha (Inspection)

CONTENTS

1.0 SCOPE

1.1 This specification defines the requirements for design, engineering, shop-supervision, testing, supply, installation, testing and commissioning of electrical equipment and facilities for package equipment as covered in the job Specifications and data sheets.

1.2 For the purpose of this specification, the term `package equipment' or `package' denotes the complete integrated equipment to be supplied by the vendor comprising of all main and auxiliary equipment and associated local panel(s). The package equipment may be mounted on a common skid and/or installed on a common platform/area in the field, as specified elsewhere. Unless otherwise specified, the local panel shall include the power distribution to various loads along with the necessary controls, interlocks, indications and alarms. The local panel may either be mounted on the equipment skid/platform or separately but not very far from the main equipment.

1.3 It is not intended to cover all aspects of design but to indicate the basic requirements only. Vendor shall ensure that the design and installation on the skid is carried out as per good engineering practice, relevant codes and shall meet the requirements of safety, reliability, ease of maintenance and operation, aesthetics, scope of future expansion and maximum interchangeability of the equipment. Vendor shall acquaint himself with EIL standards, specifications, inspection test plans and field testing procedures as deemed necessary for proper execution of work.

1.4 Compliance with this specification and /or review of any of the vendor documents shall not relieve the vendor of his responsibility and his contractual obligations with regard to the completeness and satisfactory operation of the package.

2.0 STATUTORY REQUIREMNTS

2.1 All electrical equipment and the complete package shall meet the requirements of this specification and enclosed data sheets, in addition to the relevant Publications and Codes of Practice of Bureau of Indian Standards, EIL Standards, statutory regulations and good engineering practices. Complete system must also conform to the latest revisions of the following:

a) CEA Regulations
b) Fire Insurance Regulations
c) Petroleum Rules and any other regulations laid down by Chief Controller of Explosives
d) The Factory Act and regulations laid down by Factory Inspectorate
e) Regulations laid down by local statutory authorities and Electrical Inspectorate

2.2 In case of imported equipments, standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.

2.3 Vendor shall provide all assistance required for obtaining approvals from statutory authorities for materials, plant design/ drawings and complete installation.

2.4 Where Indian Standards do not exist, the relevant IEC/ BS/ VDE/ IEEE/ NEMA standards shall apply. Any other international standard may also be followed provided it is equivalent to or more stringent than the standards specified above.

2.5 In case of any contradiction between various referred standard / specification /datasheet and statutory regulations, most stringent requirement shall prevail. However owner's /EIL's decision in this regard will be final and binding.

3.0 GENERAL REQUIREMENTS

3.1 The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.

3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment at least for 10 years from the date of supply.

3.3 Vendor shall give a notice of at least one year to the end user of equipment and EIL before phasing out the product/ spares to enable the end user for placement of order for spares and services.

4.0 SITE CONDITIONS

The equipment shall be suitable for continuous operation under the site conditions specified elsewhere. If not specifically mentioned, a design ambient temperature of maximum 40^0C and an altitude not exceeding 1000 meters above mean sea level shall be considered for design purpose.

5.0 AREA CLASSIFICATION AND EQUIPMENT SELECTION

5.1 In case of storage, handling or processing of flammable materials within the battery limits of the package, area classification shall be carried out in line with IS: 5572, Indian Petroleum Rules, OISD standard-113 and DGMS guidelines where applicable. Where specified, the vendor shall furnish an `Area Classification Drawing' indicating the zones of hazardous area and the applicable gas groups and temperature class (T rating). A list of flammable materials handled along with their properties like flash point, ignition temperature, explosive limits etc. shall also be furnished.

5.2 All the electrical equipment installed in hazardous areas shall be selected as per IS-16724:2018 / IEC-60079-14, where applicable, and shall meet the requirements of relevant IS, IEC or NEC Standards and statutory regulations. However, electrical equipment for Zone-2 areas as a minimum shall be Ex 'e'/ Ex 'n' type as specified in data sheet, subject to the same being acceptable to the concerned statutory authorities. Increased safety (Type Ex 'e') equipment shall not be used in zone-1 areas. Ordinary industrial electrical equipment (even though permitted for use in Div.2 area as per NEC, USA) shall not be used in Zone-2 areas.

5.3 Electrical equipments for hazardous areas shall be certified by CIMFR/ ERTL/ Karandikar Lab or equivalent recognised independent test house of country of origin such as BASEEFA / ATEX/ LCIE / PTB / UL / FM. All equipment (indigenous and imported) shall also have valid statutory approvals i.e. PESO as applicable for use in the specified hazardous area. All indigenous flameproof equipments shall have valid BIS license and marking as required by statutory authorities

5.4 Electrical equipment for hazardous areas shall, generally, be suitable for gas groups IIA and IIB and temperature Class -T3 as applicable to the selected type of explosion protection. In case of hydrogen or hydrogen-hydrocarbon mixtures having more than 30% hydrogen, the gas group to be considered, shall be IIC.

5.5 All electric motors for agitators/mixers and metering pumps handling flammable materials and oil sump pumps, shall be flameproof (Type Ex-de), irrespective of the area being classified as Zone-2 or Zone-1.

5.6 In case the package equipment is to be located in a classified hazardous area, the same shall be indicated in the data sheet. In such a case, the offered equipment/package shall conform to

whichever are the more stringent requirements, i.e. either due to materials being handled in the package or hazardous location in which package is installed.

6.0 EQUIPMENT SPECIFICATIONS

6.1 General Requirements

6.1.1 Specifications of all equipments/items, shall be furnished by the vendor for owner's review. However, certain minimum requirements for the major equipment are highlighted in this section.

6.1.2 All equipments and components shall be new and supplied by approved reputed manufacturers. Equipment requiring specialised maintenance or operation shall be avoided as far as possible and prototype equipment shall not be accepted. All equipments shall be complete with all necessary weather and anticorrosion protection including tropicalization to prevent damage due to climate, saline atmosphere, dust and corrosive vapours.

6.1.3 All equipment / material shall be protected for inland / marine transport, carriage at site and outdoor storage during transit and at site. Vendor shall be responsible for any damage to the equipment during transit. All packages shall be clearly, legibly and durably marked with uniform block letters giving the relevant equipment/ material details. Each package shall contain a packing list in a waterproof envelope.

6.1.4 All electrical components and equipment shall be sized to suit the maximum load under the most severe operating conditions. Rated voltage and frequency for the equipment shall be as indicated in enclosed data sheet.

6.1.5 All spares required for testing and commissioning the package shall be included by vendor in his scope of supply along with any special tools and tackles required for operation and maintenance.

6.2 Medium Voltage Motors

All medium voltage induction motors shall meet the requirements of the enclosed data sheet and EIL standard specification.

6.3 Power Distribution Board/Local Panel for Safe Area

6.3.1 This shall meet the requirements of data sheets and the following specific requirements.

6.3.2 Unless otherwise specified, the Power Distribution Board (PDB) may be incorporated as part of the Local Panel. The PDB shall include necessary power distribution equipment as applicable for the package equipment in addition to the associated controls, interlocks, indications and alarms. All motor starters shall be Direct-on-line type unless specified otherwise.

6.3.3 The panel shall be free standing, metal enclosed, dust and vermin proof type having minimum IP-42 degree of protection as per IS:13947 (Part-1). Panels for outdoor locations shall be weatherproof and supplied with a sheet steel kiosk or have internal and external doors with a rain shelter. The panel shall be designed to ensure maximum safety during operation, inspection, connection of cables and maintenance with energised busbars and without any special precautions. Ample space shall be provided inside the panel for any future addition of components in the panel. Power and control equipment shall be segregated inside the panel as far as practicable. The maximum height of the operating handle/switches shall not exceed 1800mm and the minimum height shall not be below 300mm.

6.3.4 The panel shall have an integral base frame and shall be sheet steel clad, fabricated out of 14 SWG CRCA sheet steel except that doors and covers may be of 16 SWG thickness. Necessary stiffeners shall be provided on doors / covers to prevent buckling. Large size doors and covers or those on which substantial relays/meters are mounted shall be fabricated out of 14 SWG CRCA sheet steel. All doors shall be hinged type, and all covers, doors, openings and gland plates shall be provided with neoprene gaskets. All hardware shall be corrosion resistant. All bolts, nuts and washers shall be secured against loosening and shall be made of galvanized, zinc passivated or cadmium plated high quality steel. Unless otherwise specified, the panel shall be suitable for bottom cable entry. The gland plate and cable glands shall be provided with the panel.

6.3.5 For the Flameproof Power Distribution Board / Local Panels, to be installed in a hazardous area, vendor to refer EIL standard specification 6-51-0007 attached elsewhere (if applicable).

6.3.6 Outgoing motor feeders shall be provided with switch, fuse, thermal overload relay with single phasing preventor or Motor Protection Relay and contactors for operation / safety isolation. All switches shall be load-break, heavy duty, air-break type with the operating handle mounted on the compartment door. Load break switch or MCCB shall be provided as main incoming switch complete with necessary mechanical interlocks, door interlock and defeat mechanism. Motor duty switches of AC-23 duty are also acceptable for outgoing motor feeders.

6.3.7 All fuses shall be non-deteriorating HRC cartridge, pressure fitted, link type. The contactors shall be air-break having AC-3 duty rating. Power contactors shall be rated for 100% of the maximum continuous current (e.g. rated current of motor) with a minimum rating of 16 Amperes with AC-3 duty. Contactor coils shall be suitable for 240V AC control supply.

6.3.8 Thermal overload relays shall be three element, positive acting, ambient temperature compensated type with adjustable setting range and built-in protection feature against single phasing which can operate even with 50% rated current. The relays shall be manual reset type with the reset push button provided on the cubicle door.

6.3.9 All indicating instruments shall be moving iron, flush mounting type of 72mm x 72mm square pattern of at least 1.5 accuracy class. LEDs provided for indication shall be cluster type with adequate brightness and minimum 2Nos LEDs chips per light. LEDs shall be connected in parallel and each LED chip having diameter not less than 3mm.

6.3.10 All control/selector switches shall be rotary back connected type having a cam-operated contact mechanism with knob type handle. Ammeter selector switches shall have contacts with make before break feature and additional locking facility shall be provided where required.

6.3.11 All motor feeders shall be provided with a STOP (red) push button and necessary START (green) push button and control/interlock switches. STOP push buttons shall have stay put feature and additional locking facility shall be provided where required.

6.3.12 Current transformer fed ammeter shall be provided for all motors, which may have variable loading or are required for process control. Feeders of 30 Amperes rating and above shall be provided with a CT and ammeter as a standard. The current transformers shall have an accuracy class 1.0 and instrument security factor not greater than 5.

6.3.13 All auxiliary devices for control, indication, measurement and alarm such as push buttons, control and selector switches, indicating lamps, metering instruments, annunciators etc. shall be mounted on the front door of the panel. Components requiring frequent inspection shall be easily accessible.

6.3.14 Control supply for the equipment shall normally be derived from an adequately sized transformer in the panel connected across two phases.

6.3.15 Adequate number of potential-free contacts shall be provided in the control panel for any remote control monitoring of the package equipment.

6.3.16 The panel shall be provided with an anti-condensation heater controlled through a switch fuse /MCB and an adjustable thermostat.

6.3.17 Inside the panel, the wiring for power, control and signaling circuits shall be done with BIS approved flame retardant PVC insulated copper conductors having 660/1100V grade insulation. Power wiring shall be sized for the nominal rating of associated switch/contactor. Minimum size of control wires shall be 1.5mm² copper for control circuits having fuse rating 10 amperes or lesser. For control circuits with higher fuse rating, minimum 2.5mm² copper conductor shall be used. Wiring for AC and DC circuits shall have different colour coding. Clamp type terminals shall be acceptable for direct termination of wires upto 10mm² size. For conductors larger than 10 mm², bolted type terminals with crimping lugs shall be provided. Each wire shall be terminated at a separate terminal. A minimum of 10% spare terminals shall be provided on each terminal block. All incoming and outgoing wires from the panel shall terminate on a suitable terminal strip/block. No such wire shall terminate/emanate directly from a panel component. However, in case power supply connections are to be looped, the loop wires are to be crimped together before fixing on terminal strip, such that loop continuity is not lost in case wire is removed from terminal strip.

6.3.18 An adequately sized earth bus shall be provided in the panel for connection to the main earth grid. All non-current carrying metallic parts of the mounted equipment shall be earthed. Doors and movable parts shall be earthed using flexible copper connections. The earth bus shall be provided with alternate bands of yellow and green. All earth connection wires shall be suitably colour coded.

6.3.19 Engraved nameplates shall be provided for all auxiliary devices mounted on the front of the panel. Nameplate or polyester adhesive stickers shall be provided for each equipment inside the panel.

6.3.20 All metal parts shall be thoroughly cleaned degreased and made free from rust. After application of the primer, the panel shall be spray painted with two coats of final paint. Colour shade of the final paint shall be RAL 7032 for indoor Electrical Equipment and RAL 7031 for Outdoor Electrical equipment, unless otherwise specified. Powder coating of panel shall also be acceptable.

6.3.21 At least one outgoing feeder of each rating and type shall be provided as spare in the PDB.

7.0 CABLING SYSTEM

7.1 Unless otherwise specified, a single point power supply shall be provided by the owner through an aluminium/copper conductor, XLPE insulated, armoured cable terminated at the Power Distribution Board/Local Panel. The vendor shall provide all power and control cabling between the PDB/ Local panel and the package equipments.

7.2 Power and control cables for 415V system shall be of 1100V grade Fire retardant low smoke type XLPE insulation with copper conductors up to 16mm² and aluminum conductors beyond 16mm², PVC inner sheath, armouring and overall PVC sheath as per IS: 7098 (Part-I). The conductor size shall be minimum 2.5mm² copper. All power and control cables shall have extruded inner and outer sheaths. Outer sheath of cables shall be black in colour and the minimum value of oxygen index shall be 29 at 27± 2 °C. In addition, suitable chemicals shall be added into the PVC compound of the outer sheath to protect the cable against rodent and

termite attack. Adequate derating factors shall be used for sizing the cables. At least one spare core shall be provided in all control cables. All cable / wire shall be BIS approved.

7.3 All cabling on the equipment skid/platform shall be in GI cable trays/conduits. All cable trays and accessories shall be prefabricated and hot dip galvanised. The minimum amount of galvanising shall be 610g/m². All cables shall be identified close to their termination point by cable number punched on 2mm thick aluminium straps securely fastened to each cable. In case of control cables, all cores shall be identified at both ends by their terminal numbers using PVC ferrules as per interconnection diagrams. All equipments shall be supplied with double compression type nickel plated–brass cable glands and tinned copper lugs.

7.4 In case, PDB/Local Panel installed away from the equipment skid/platform, necessary cable trenches/trays between panel and equipment shall be in owner's scope, unless otherwise specified.

8.0 EARTHING SYSTEM

8.1 Earthing system design and installation shall generally be as per IS: 3043. One or more number of G.I. earth plates shall be provided for the package equipment depending upon its size. All metallic non-current carrying parts of electrical apparatus, current and potential transformer secondaries, structural steel, vessels etc. shall be connected by at least two distinct separate earth conductors to an earth plate. All earth plates shall be bonded together and shall have the provision for interconnection to owner's main earth grid at two points. Earth plates shall be of 360x80x10mm size and shall be provided with adequate number of tapped holes. Earth continuity bonding shall be provided across all pipe flange joints.

8.2 All hardware used for earthing installation shall be hot dip galvanised or zinc passivated. The amount of galvanizing shall be min. 610 g/m². Specially provided bolts, lugs and spring washers shall be used for all earthing connections of equipment.

8.3 Unless specified otherwise in data sheet, equipment earthing shall be as per standard equipment earthing schedule.

8.4 Earthing connections to equipment shall be made by means of bolts, lugs and spring washers provided specifically for this purpose.

9.0 LIGHTING SYSTEM

9.1 General lighting for area in which package is to be installed shall be provided by purchaser, unless specified otherwise in data sheet.

9.2 Any other lighting requirements such as Local panel lighting shall be provided by vendor and shall be with LED fixtures. Power for such local lighting shall be obtained from a suitable feeder in PDB/Local Panel. All lighting circuits shall have provision for isolation in both phases and neutral for packages to be installed in hazardous areas.

10.0 INSPECTION, TESTING AND COMMISSIONING

10.1 All equipment shall be tested and inspected at vendor's works before dispatch to ensure compliance with the relevant specifications and agreed quality assurance/ testing plan. The owner or his authorized representative may visit the works during manufacture of various electrical equipment / materials to assess the progress of work as well as to ascertain that only quality raw materials are used for the same. He shall be given full assistance to carry out the inspection. Purchaser's representative shall be given minimum two weeks' advance notice for witnessing the final testing. The minimum testing / inspection requirements for all components /equipments shall conform to the requirements stipulated in applicable codes and

standards. Test certificates including test records and performance curves etc. shall be furnished by the vendor.

10.2 Vendor shall submit the field testing procedures for purchaser's approval. Field tests as per the approved procedures shall be performed on the electrical system/ equipment before its being put into service. All test equipment required for this purpose shall be arranged by the vendor, in case testing and commissioning at site is included in his scope, and test reports shall be approved by the site-in-charge before acceptance of the complete package.

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DESIGN PHILOSOPHY FOR ELECTRICAL FACILITIES

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
7	15 10 19	REVISED AND ISSUED AS STANDARD SPECIFICATION	DA/JLC	PG	SA	RKT
6	27 08 14	REVISED AND ISSUED AS STANDARD SPECIFICATION	RS	PG	BRB	SC
5	15 04 09	REVISED AND ISSUED AS STANDARD SPECIFICATION	AM	UAP	JMS	ND
4	31 03 04	REVISED AND ISSUED AS STANDARD SPECIFICATION	AKG	AAN	VPS	SKG
3	01 12 99	REVISED AND ISSUED AS STANDARD SPECIFICATION	UAP	AAN	VPS	AS

Abbreviations:

A	:	Amperes	LAN	:	Local Area Network
AC	:	Alternating Current	LCIE	:	Laboratoire Central des Industries Electriques
ACB	:	Air Circuit Breaker	LDB	:	Lighting Distribution Board
ACDB	:	AC Distribution Board	LDP	:	Local Distribution Panel
AN	:	Air Natural	LED	:	Light Emitting Diode
APFC	:	Automatic Power Factor Correction	LV	:	Low Voltage (Up to 250V)
API	:	American Petroleum Institute	MCB	:	Miniature Circuit Breaker
ASB	:	Auxiliary Service Board	MCC	:	Motor Control Centre
ATEX	:	ATmospheres EXplosibles	MCCB	:	Moulded Case Circuit Breaker
BASEEFA	:	British Approval Service for Electrical Equipment in Flammable Atmospheres	MCP	:	Manual Call Point
BIS	:	Bureau of Indian Standards	MPPT	:	Maximum Power Point Tracker
CEA	:	Central Electricity Authority	MOV	:	Motor Operated Valve
CIMFR	:	Central Institute of Mining and Fuel Research	MV	:	Medium Voltage (Above 250V and up to 650V)
CPRI	:	Central Power Research Institute	MVA	:	Mega Volt Ampere
CT	:	Current Transformer	NEC	:	National Electric Code
DB	:	Distribution Board	NFPA	:	National Fire Protection Association
DC	:	Direct Current	NGR	:	Neutral Grounding Resistor
DCDB	:	DC Distribution Board	NGT	:	Neutral Grounding Transformer
DCS	:	Distributed Control System	NIFPS	:	Nitrogen Injection Fire Protection System
DG	:	Diesel Generator	ODC	:	Over Dimension Consignment
DGCA	:	Director General Civil Aviation	OFC	:	Optical Fibre Cable
DGMS	:	Director General Mines Safety	OISD	:	Oil Industries Safety Directorate
DOL	:	Direct On Line	OLTC	:	On Load Tap Changer
ECS	:	Electrical Control System	ONAF	:	Oil Natural Air Forced
EHV	:	Extra High Voltage (Above 33 kV)	ONAN	:	Oil Natural Air Natural
ELCB	:	Earth leakage Circuit Breaker	PCC	:	Power Control Centre
ELR	:	Earth Leakage Relay	PCU	:	Power Conditioning Unit
EOT	:	Electrically Overhead Travelling	PDB	:	Power Distribution Board
EPABX	:	Electronic Private Automatic Branch Exchange	PESO	:	Petroleum and Explosives Safety Organisation
ERTL	:	Electronic Regional Test Laboratories	PMCC	:	Power Cum Motor Control Centre
FA	:	Fire Alarm	PTB	:	Physikalisch-Technische Bundesanstalt
FM	:	Factory Mutual	PV	:	Photo Voltaic
FRLS	:	Flame Retardant Low Smoke	PVC	:	Polyvinyl Chloride
GI	:	Galvanised Iron	RCC	:	Reinforced Cemented Concrete
GIS	:	Gas Insulated Switchgear	RTCC	:	Remote Tap Changing Controller
HDPE	:	High Density Poly Ethylene	RTD	:	Resistance Temperature Detector
HMI	:	Human Machine Interface	RTU	:	Remote Terminal Unit
HV	:	High Voltage (Above 650V and up to 33 kV)	RVT	:	Residual Voltage Transformer
HVAC	:	Heating Ventilation and Air Conditioning	SPV	:	Solar Rooftop Photo Voltaic
IAC	:	Internal Arc Classification	SVL	:	Surge Voltage Limiter
IEC	:	International Electro-Technical Commission	TRV	:	Transient Recovery Voltage
IEEE	:	Institute of Electrical and Electronics Engineers	UL	:	Underwriter's Laboratory
IES	:	Illumination Engineering Society	UPS	:	Uninterrupted Power Supply
IS	:	Indian Standards	V	:	Voltage
kV	:	Kilo Volt	VFD	:	Variable Frequency Drive
kVA	:	Kilo Volt Ampere	VRLA	:	Valve Regulated Lead Acid
kVAR	:	Kilo Volt Ampere Reactive	VT	:	Voltage Transformer
kW	:	Kilo Watt	XLPE	:	Cross Linked Poly Ethylene
kWH	:	Kilo Watt Hour	X/R	:	Impedance/ Resistance

Electrical Standards Committee

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Ms. ANP Singh
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Mr. Raman Sood
Ms. Shirali Aggarwal
Ms. N.P. Guha (Projects)
Mr. Rajesh Sinha (Inspection)

CONTENTS

1.0 SCOPE

This specification along with the applicable project design data sheet shall form the basis for developing detailed design and engineering for electrical facilities including electrical power system, Electrical equipment, Electrical control system, Plant communication system, Fire detection & alarm system and electrical installation etc.

2.0 CODES AND STANDARDS

The main codes and standards, considered as minimum requirements, as applicable, are as mentioned below. Latest version of these shall be followed:-

IS-732	:	Code of practice for electrical wiring installations
IS-1646	:	Fire safety of buildings (General): Electrical Installations – Code of Practice
IS-2189	:	Selection, Installation and Maintenance of automatic fire detection and alarm system – Code of Practice
IS-3034	:	Fire safety of industrial buildings: Electrical generating and distributing stations – Code of Practice
IS-3043	:	Code of practice for Earthing
IS-3646	:	Code of practice for Interior Illumination
IS-3716	:	Application guide for Insulation Coordination
IS-4051	:	Code of practice for installation and maintenance of electrical equipment in mines
IS-5216	:	Recommendation on safety procedures and practices in electrical work
IS-5572	:	Classification of hazardous areas (other than mines) having flammable gases and vapours for electrical installations
IS-6665	:	Code of practice for Industrial Lighting
IS-7689	:	Guide for Control of undesirable static electricity
IS-7752	:	Guide for improvement of power factor in consumer installations
IS-8478	:	Application guide for on load tap changers
IS-9676	:	Reference ambient temperature for electrical equipment
IS-10028	:	Code of practice for selection, installation and maintenance of transformer
IS-10118	:	Code of practice for selection, installation and maintenance for switchgear and control gear
IS-10561	:	Application guide for Power Transformer
IS-12360	:	Voltage bands for electrical installations including preferred voltages and frequencies
IS-13234	:	Guide for short circuit calculations in three phase AC systems
IS-16724/ IEC 60079-14	:	Explosive Atmospheres – Electrical installations design, selection and erection
SP-30	:	National Electrical Code (NEC) - BIS Publication
OISD-RP-110	:	Recommended practices on static electricity
OISD-STD-113	:	Classification of Area for electrical installation at Hydrocarbon processing and handling facilities
OISD-STD-137	:	Inspection of electrical equipments
OISD-RP-147	:	Inspection and safe practices during electrical installation
OISD-RP-149	:	Design aspects for safety in electrical systems

OISD-STD-173	:	Fire Protection System for Electrical Installations
OISD-GDN-180	:	Lightning Protection
IS/IEC 60079-0	:	Electrical apparatus for explosive gas atmospheres – General requirements.
IS/IEC 60079-1	:	Explosive Atmospheres: Equipment protection by flameproof enclosures "d"
IS/IEC 60079-2	:	Explosive protection by pressurized enclosures "p"
IS/IEC 60079-5	:	Explosive Atmospheres: Equipment protection by powder filling "q"
IS/IEC 60079-6	:	Explosive Atmospheres: Equipment protection by Oil immersion "o"
IS/IEC 60079-7	:	Explosive Atmospheres: Equipment protection by increased safety "e"
IS/IEC 60079-10-2	:	Explosive Atmospheres: Classification of areas: Combustible dust atmosphere.
IS/IEC 60079-11	:	Explosive Atmospheres: Equipment protection by intrinsic safety "i"
IS/IEC 60079-15	:	Electrical apparatus for explosive gas atmosphere – Construction, test and marking of type of protection ``n" electrical apparatus.
IS/IEC 60079-18	:	Explosive Atmospheres: Equipment protection by encapsulation "m".
IS/IEC 60079-20-1	:	Electrical apparatus for explosive gas atmosphere: Data for flammable gases and vapours relating to the use of electrical apparatus.
IS/IEC 60079-31	:	Explosive Atmospheres: Equipment dust ignition protection by enclosure "t".
IS/IEC 62305-1	:	Protection against lightning: General Principles
IS/IEC 62305-2	:	Protection against lightning: Risk Management
IS/IEC 62305-3	:	Protection against lightning: Physical damage to structures and life hazard
IS/IEC 62305-4	:	Protection against lightning: Electrical and electronics systems within structure
API-RP-545	:	Recommended Practice for Lightning Protection of Aboveground Storage Tanks for Flammable or Combustible Liquids

3.0 STATUTORY REQUIREMENTS

The latest version of the following statutory regulations shall be followed for design of electrical system, as applicable for the particular project/ industry.

- Indian Electricity Act.
- Central Electricity Authority Regulations.
- The Factory Act.
- The Petroleum Rules.
- The Mines Act.
- Requirements of other statutory bodies as applicable, e.g. CEA/ State Electrical Inspectorate, PESO, DGMS.
- Oil Industry Safety Directorate.

4.0 SYSTEM DESIGN PHILOSOPHY

4.1 General

The electrical system shall be designed to provide:

- Safety to personnel and equipment both during operation and maintenance.

- Reliability of Service.
- Minimal fire risk.
- Ease of maintenance and convenience of operation.
- Automatic protection of all electrical equipment through selective relaying system.
- Electrical supply to equipment and machinery within the design operating limits.
- Adequate provision for future extension and modification.
- Suitability for applicable environmental factors.

4.2 Area Classification and Equipment Selection

4.2.1 All the areas within the battery limits shall be classified for the degree and the extent of hazard from flammable materials. Classification of hazardous areas shall be done in accordance with Petroleum Rules, DGMS regulations (where applicable), IS-5572 (for flammable gases & vapours), IS/IEC 60079 Part 10 Sec 2 (for explosive dust atmosphere), OISD standards and Process Licensors recommendations.

4.2.2 Following factors shall be considered for proper selection of electrical equipment for use in hazardous area:

- Area classification i.e. Zone.
- Gas classification i.e. Group - The characteristic of the minimum gas or vapour involved in relation to the ignition current or minimum ignition energy & minimum safe gap data.
- Dust classification i.e. Group - The characteristic of the dust involved.
- Temperature classification - The ignition temperature of the gas, vapour or dust involved or the lowest value of the ignition temperature if more than one combustible material is present.
- Environmental conditions in which apparatus is to be installed - The selected electrical apparatus shall be adequately protected against corrosive and solvent agencies, water ingress, thermal and mechanical stresses as determined by the environmental conditions.

4.2.3 All electrical equipment installed in hazardous areas shall be selected as per IS 16724/IEC 60079-14 and OISD-RP-149 as applicable and shall meet the requirements of relevant IS & Statutory regulations. Ordinary industrial electrical equipment (even though permitted for use in Div.2 area as per NFPA-70) shall not be used in Zone-2 areas. Type of hazardous area protection to be used for individual equipment shall be as specified in the project design data sheet.

4.2.4 Electrical equipment for hazardous areas shall be certified by CIMFR/ ERTL/ Karandikar Lab or equivalent recognised independent test house such as BASEEFA / ATEX/ LCIE / PTB / UL / FM. All equipment (indigenous and imported) shall also have valid statutory approvals i.e. PESO/ DGMS as applicable for use in the specified hazardous area. All indigenous flameproof equipments shall have valid BIS license and marking as required by statutory authorities.

4.3 Power System Design

4.3.1 The distribution system shall be designed in accordance with project specification/ design data taking into account all possible factors affecting the choice of the system to be adopted such as required continuity of power supply, flexibility of operation, operational costs, space availability and reliability of supply from available power sources, total load and the concentration of individual loads.

4.3.2 In general the design intent shall also be for reduction in energy consumption through the selection and utilization of efficient electrical equipment i.e. energy efficient motors, transformers, lighting equipment and other equipment notified from time to time.

4.3.3 Power system studies shall be performed using standard software in support of design, as required.

4.3.4 Special attention is drawn to chapter IX of CEA regulations, which includes requirements for design of electrical system as applicable to Mines and oil fields installation.

4.4 Capacity of Electrical System

4.4.1 All the components of the electrical system shall be sized to suit the maximum load, under the most severe operating conditions. The amount of electrical power consumed by each process unit shall be calculated for its operation at the design capacity. System design shall permit direct on line starting of all motors unless specified otherwise.

4.4.2 For Electrical load analysis, loads shall be classified as continuous loads, intermittent loads and standby loads based on their operation. Following factors shall be applied to calculate the total operating load, unless otherwise specified:

100% (Continuous Loads) + 30% (Intermittent Loads)[1] + 10% (Standby Loads)[2,3,4]

Notes:
1. 30% of intermittent loads such as EOT cranes, MOVs, etc. or the largest intermittent load whichever is higher.
2. 10% for only those Standby Loads which are required in emergencies only, such as fire-water pumps or those of normally not running electrically driven units in stand-by mode for normally running turbine driven loads.
3. Driven equipment 'Standby' in 'Normal-Standby' combination shall not be considered as a standby load.
4. 10% of standby loads or the largest standby load whichever is higher.

4.5 System Voltages

System voltages shall be as defined in project design data sheet.

4.6 Voltage Drops

4.6.1 The maximum voltage drops in various sections of the electrical system under steady state conditions at full load shall be within the limits stated in the following table:

Sl. No.	System Element	Maximum Permissible Voltage Drop
a)	Cable between transformer secondary and Switchboards	0.5%
b)	Cable between PCC/PMCC and MCC or auxiliary switchboard i) MCC /Auxiliary Switchboard near PCC/PMCC ii) MCC/Auxiliary Switchboard situated remote from PCC/PMCC	 0.5% (Note-3b) 2 to 2.5% (Note-3a)
c)	Cables between HV Switchboard and HV Motor	3% (Note-4)
d)	Cable between PCC/PMCC and motor	5.5% (Note-4)
e)	Cable between MCC (situated near PCC / PMCC) and motors	4.5 to 5% (Note-4)
f)	Cable between MCC (situated remote from PCC / PMCC) and motors	3% (Note-4)

g)	Cable between Auxiliary Switchboard / LDB and Lighting Panel/ Power panel	1 to 1.5% (Note- 2)
h)	Circuit between lighting panels and lighting points	4% (Note- 2)
i)	DC Supply Circuit (Electrical Controls)	5%
j)	DCDB to Control Room	2% (Note -1)
k)	UPS outgoing circuit	5% (Note - 1)

Note-1

Minimum voltage available across any instrument in the field/ control room/ Satellite rack room shall be as per instrumentation design basis. Distribution system for instrumentation supplies shall be designed accordingly. In case of any conflict between electrical project design data sheet and instrumentation design basis, the latter shall govern regarding instrumentation power supplies.

Note-2

In case of difficulty in achieving specified voltage drops in cables up to lighting panel, total 5.5% drop from Auxiliary switchboard/ LDB up to lighting points may be permitted.

Note-3

a) Higher voltage drop may be permitted between PCC / PMCC and remote mounted MCC/ASB, if overall voltage drop up to motor (from PCC / PMCC) is limited within 5.5%.

b) For large substations 1% drop may be permitted.

Note-4

For VFD fed motors, the maximum permissible voltage drop, as specified, shall be considered between VFD Panel and Motor.

4.6.2 The maximum voltage drop at various buses during start-up of large motor and/or motor reacceleration conditions shall be within the limits stated below:

S. No	System Element	Operating Condition	Max. Permissible Voltage Drop
a)	At the busbars of the worst affected Switchboard	Start -up of the large HV motor with other loads on the bus or reacceleration of a group of HV motors (Simultaneous start-up or group reacceleration of HV motors is not envisaged)	15 %
b)	At the busbars of the worst affected MV Switchboard (PCC/PMCC/MCC)	Start up of large MV motor with other loads on the bus or reacceleration of a group of MV motors (Simultaneous start-up or group reacceleration of MV motors is not envisaged)	10 %
c)	Cables between HV Switchboard and motor	Motor start-up or reacceleration	5 % (Note-a)

d)	Cables between MV switchboard (PCC/PMCC/MCC) and motor	Motor start-up or reacceleration	15 % (Note-a)

Notes:

a) Higher voltage drop in motor cables may be permitted, in case the conditions given in Note b), c) and d) are complied.

b) The voltage available at the motor terminals during start-up must be sufficient to ensure positive starting or reacceleration of the motor (even with the motor fully loaded, if required), without causing any damage to the motor.

c) For medium voltage motors, the voltage available at the motor terminals must not be less than 75% of the rated value during start-up or reacceleration.

d) For high voltage motors, the voltage available at the motor terminals must not be less than 80% of the rated value during start-up or reacceleration.

4.7 System Earthing

4.7.1 System earthing for incoming supply and primary/secondary EHV/ HV/MV distribution systems shall be as per project design data. The system earthing point shall always be at the power source.

4.7.2 Neutral earthing system shall be solidly earthed for voltage system up to 650 V and above 11000 V (except in case of Mines and Oil fields installations where it shall be in line with Chapter IX of CEA regulations and statutory requirements).

4.7.3 For voltages between 3300 V to 11000 V, the neutral earthing system shall be resistance earthed. NGR rating shall be selected such that earth fault current is limited to not less than system charging current and shall be sufficient for selective & reliable operation of earth fault protection relay. The HV system earth fault current shall be limited to either 100% of highest CT rating of motor feeders or 50% of highest CT rating of Delta-Star transformer feeders or 10% to 20% of incomer CT rating whichever is higher. In general, a value of 600A for earth fault current may be considered for HV system unless specified otherwise.

4.7.4 For generators connected to switchboard via step up transformer, generator neutral shall be earthed through single phase transformer with secondary resistor. For generator directly connected to switchboard without generator transformer, generator shall be earthed via its own earthing resistor.

4.8 Short Circuit Capacities

Each short circuit interrupting device shall be designed to have rated short circuit breaking capacity and making capacity equal to or higher than the maximum value of short circuit current (rms) and peak value of short circuit current respectively, calculated at its location. The short circuit calculation shall also take into account increase in short circuit level due to direct or indirect connection of expected future load and future source, if specifically agreed upon. The related switchgears and bus-ducts shall withstand the above maximum available fault current for a minimum period of one second. The minimum size of conductor & metallic screen of high voltage cables and extra high voltage cables shall also be based on the short circuit withstand capacity for a minimum time period as dictated by the protection system and defined in project design data sheet.

4.9 Insulation System

The insulation of electrical facilities shall be designed considering the system voltage, the system neutral earthing and the over voltages resulting due to system fault, switching or lightning surges. Lightning arresters and surge absorbers shall be provided where necessary.

4.10 Protection and Metering Schemes

4.10.1 The protective system shall be selected and coordinated to ensure the following:

a) Protection of equipment against damage, which can occur due to internal or external short circuits or atmospheric discharges.
b) Uninterrupted operation of those parts of the system, which are not affected by the fault.
c) Personnel and plant safety.

4.10.2 Protection relays shall be provided as specified in project design data sheet.

4.10.3 Metering shall be provided to keep a record of power consumption and supervision of all concerned parameters like current, voltage, power, frequency, power factor etc. as specified in project design data sheet.

4.10.4 Wherever numerical relays are provided, metering shall be part of numerical relay, unless otherwise specified.

4.11 DC Power Supply

4.11.1 Independent DC power supply systems shall be provided for the following requirements, unless otherwise specified:

- Plant shutdown system including DC instrumentation control supply (if required, as per instrumentation design basis)
- Electrical switchgear controls
- Critical DC motors power supply (if required)
- Critical DC lighting system

4.11.2 Fire alarm system control panels and EPABX telephone exchange shall be provided with dedicated DC system as part of the equipment.

4.12 Emergency Power Supply

4.12.1 The emergency power supply system, wherever envisaged and required as per project design datasheet, shall feed the following:

- Electrical loads essential for the safe shutdown of the plant.
- Emergency lighting.
- Communication system.
- Fire detection and alarm systems.
- D.C. Supply systems.
- UPS Systems.
- Fire fighting equipment excluding main firewater pump.
- Loads critical for process, plant and personnel safety.

4.12.2 Emergency power supply could be from a different power source or Emergency Generator as per Project design data sheet. Rating specified for emergency generator shall be prime rating, unless otherwise specified. Where Emergency Generator is envisaged, emergency power supply shall be made available within a time period of 30 seconds from the instant of failure of normal supply.

4.12.3 The emergency generator shall generally not be required to run continuously in parallel with the normal power supply system. However, short time paralleling facility shall be provided for transferring load to normal power supply or other operational needs e.g. periodic testing etc. as required.

4.13 Uninterrupted Power Supply (UPS)

4.13.1 Uninterrupted power supply system shall be provided, as required for meeting critical loads that cannot withstand a momentary interruption in voltage (e.g. critical instrumentation, process control, HMI for substation automation system, ECS, Plant communication system, LAN system and other loads, as defined in project design data sheet).

4.14 Power Factor Improvement

Capacitor banks shall be provided, as specified in Project design data sheet, to improve the power factor to meet the minimum stipulated power factor by the power supply authorities. Automatic power factor correction shall be provided.

4.15 Plant Communication System

4.15.1 It shall consist of the following:

- Central exchange(s)/ Distributed intelligent nodes.
- Master control station(s) with inbuilt loudspeaker, microphone etc.
- Desk type call stations with inbuilt microphone, loudspeaker for installation in buildings.
- Wall/column mounting type call stations for hazardous/safe areas with external loudspeaker as per Operational requirements.
- Flashing beacon and acoustic hood for noisy areas.

4.15.2 Each exchange/ distributed intelligent node shall be designed to have at least 10% spare capacity.

4.15.3 Plant communication system shall have interface with fire alarm & detection system, EPABX telephone system, wherever specified.

4.16 Fire Detection and Alarm System

4.16.1 The Fire Detection and Alarm System shall be an independent system comprising of individual break glass type manual call points, automatic sensors e.g. smoke/heat detectors, multisensory detectors, linear beam detectors, hooters, exit signs, main panel, zonal panel, battery, battery charger and other hardware. Detail design, selection and installation of fire detection and alarm system including quantity and location of detections, MCP, etc. shall be as per IS 2189.

4.16.2 The system shall be designed to provide audio-visual indication at the main fire alarm panel to be located in fire station and zonal panels. Repeater panels shall be provided as specified in project design data sheet.

4.16.3 Electrical sirens shall be provided to cover entire plant area.

4.16.4 Each panel and each loop / Zone shall have at least 10% spare capacity.

4.16.5 The fire detection system shall be interfaced with fire suppression system, HVAC system, pressurization system and plant communication system, wherever specified.

4.16.6 Heat detectors to be installed in battery room shall be intrinsically safe, gas group IIC type. Zener barrier shall be provided to limit the ignition energy.

4.17 Electrical Surface Heating System

4.17.1 Electrical surface heating system shall be provided for temperature maintenance of process pipes and associated equipments, if required as per process design basis.

4.17.2 The electrical equipments i.e. heat tracers, thermostat/ RTD, LDP, PDB, Junction boxes, connectors, splice boxes, etc. shall be suitable for applicable area classification, though PDBs shall be preferably located in safe area.

4.17.3 In general, the system shall be suitable for maintaining the temperature, unless otherwise specified. In case process fluid heating is desired, time duration and other parameters shall be as per process design data.

4.17.4 Skin effect electrical heat tracing system shall be provided for pipelines, if specified in project design data sheet.

4.17.5 In general, double/ sandwich insulation technique shall not be utilized for electrical heat tracing.

4.18 Substation Automation System

4.18.1 Substation Automation system shall be provided, if specified in project data sheet. The Substation Automation system shall broadly comprise of numerical relays, data concentrator panels (as required), Ethernet switches, interconnecting cables, HMI, laptop, printers and their associated software for monitoring of the Electrical system.

4.18.2 The communication protocol shall ensure transfer of all information including time stamping data from relay to Data concentrator/ HMI. Generally IEC-61850 based communication shall be provided, unless otherwise specified.

4.19 Electrical Control System

4.19.1 Electrical control system shall be provided (as required) to monitor and control electric power generation and distribution network of the plant. ECS shall broadly include distributed RTUs, Interface panels, I/O panels, servers, HMI, printers, fiber optic data highway, network switches etc. Base functionalities and advanced functionalities as specified in project design datasheet shall be provided.

4.19.2 If specified, there shall be provision of redundant connectivity of ECS system with DCS for serial data transfer.

4.20 Rooftop Solar Photovoltaic Power System

4.20.1 The grid connected photovoltaic (PV) solar system for converting solar energy to generate electricity shall be provided on the building rooftop. The solar system shall be photovoltaic based in which arrays of photovoltaic (PV) modules shall be installed on building roof top under clear sky, shade free, tilted towards south at an optimum inclination.

4.20.2 The Grid connected Solar Rooftop Photo Voltaic (SPV) system shall consists of PV modules/ panels, Module Mounting Structure, Power conditioning Unit (PCU) having Maximum Power Point Tracker (MPPT), controls and protection, junction boxes, AC distribution board, data acquisition & monitoring system including weather monitoring instruments, cables, pipe conduits, earthing, lightning protection, overvoltage and surge protection, etc.

4.20.3 The system shall be without battery and shall be designed with necessary features to supplement grid power during day time.

4.20.4 Solar PV module array shall consist of high efficiency Solar Modules utilizing Crystalline Silicon solar PV cells

4.20.5 The power conditioning unit (PCU) shall be either located indoor or outdoor as specified in project design datasheet.

4.20.6 For specific applications, battery may be provided as part of solar photovoltaic (PV) system, if specified in project design data sheet.

5.0 EQUIPMENT DESIGN PHILOSOPHY

5.1 General

The equipment shall in general conform to EIL standard specifications. Equipments shall be selected and sized as per philosophy given below:

5.2 Transformers

5.2.1 All transformers except lighting transformers & isolation transformers shall generally be three phase, oil immersed, double wound type suitable for outdoor use, unless otherwise specified. Lighting transformers & isolation transformers shall be dry type, unless otherwise specified. Preferably transformers of variable frequency drive system and soft starter system shall be dry type located indoor adjacent to VFD/ soft starter panels.

5.2.2 100% standby transformers (for power, distribution and lighting) shall be provided in all unit, offsite and utility substations, unless otherwise specified.

5.2.3 In general kVA rating & percentage impedance ratio of each transformer shall be selected to limit the rated current and short circuit current to values which are within the current rating and interrupting capacity of associated switchgear available.

The kVA rating for power, distribution and lighting transformers shall be decided on the following basis and shall be as far as possible a standard value.

a) In systems having redundancy for transformers, with transformers having natural cooling i.e. ONAN/AN, each transformer shall be rated equal to or greater than the 8 hour maximum demand of the load plus 10% margin for future load growth.

b) In systems having redundancy for transformers, with transformers having forced cooling i.e. ONAF, each transformer shall be rated equal to or greater than the 8 hour maximum demand of the load plus 10% margin for future load growth (within 110% of it's self cooled (ONAN) rating) and shall be fitted with automatic forced air cooling fans.

c) Where redundancy in number of transformers is not provided, rating shall be equal to or greater than 8 hour maximum demand plus 10% margin for future load growth. Fan

cooled rating, where provided, shall be reserved as spare capacity for further future load growth.

d) Where switchboard with three incomers and two bus coupler fed from three transformers is provided, transformer rating shall be finalized considering the load distribution pattern on the three buses of downstream switchboard during normal operations & also during outage of any one of the transformer. However in no case, transformer rating shall be less than 2/3rd of 8 hour maximum demand of the load plus 10% margin for future load growth.

5.2.4 Transformers connected directly to grid power supply shall be provided with OLTC to take care of variations in grid supply voltage.

5.2.5 For transformers having oil quantity equal to or above 2000 liters, Nitrogen Injection Fire Protection System (NIFPS) shall be provided, unless otherwise specified.

5.2.6 Distribution transformers shall be energy efficient type having energy efficiency level as specified in project design data sheet.

5.3 Switchgear

5.3.1 HV and EHV switchgears directly connected to grid/ power plant shall be provided with double bus arrangement, if justifiable in terms of operating flexibility, system extension and connection of differing priority loads to different buses.

5.3.2 Gas Insulated Switchgear (GIS) shall be provided for EHV system and HV system if specified in project design datasheet. In general, GIS may not be considered for voltages below 22 kV.

5.3.3 All switchgear and associated equipment fed from generators and transformers shall have rating at least equal to the rating of respective generators and transformers feeding it, under any circuit configuration. Generator incomer shall be rated w.r.t. maximum power output of the generator set over entire operating temperature range. Transformer incomer shall be rated at least equal to forced cooled rating of transformer or 110% of ONAN rating, whichever is higher.

5.3.4 Generator Circuit Breaker directly connected to generator shall be as per IEEE/IEC 62271-37-013.

5.3.5 Bus tie circuit breakers shall have rating higher of the following:

a) Largest incoming circuit breaker.

b) Maximum running load on either side of bus section.

The tie breaker rating shall not be less than the bus-bar current rating, unless otherwise specified.

5.3.6 HV and MV switchgears including components shall be natural air cooled type for achieving the required current rating inside the panel/cubicle at design ambient temperature. In case, natural cooled design is not available, forced cooling of components i.e. bus bars, circuit breaker etc. can be considered if specifically agreed upon.

5.3.7 All other switchgears not directly fed from generator and transformers shall have rating at least equal to the maximum demand under any circuit configuration plus a provision for 10% future load growth. Incomers of these switchgears shall be designed to cater to the complete load including 10% margin for future load growth.

5.3.8 Spare outgoing feeders shall be provided in all switchgear. At least one number of each type of outgoing feeder or 10% of each type of outgoing feeder, whichever is more, shall be provided as spare in the HV and MV switchboards, except for capacitor feeder in HV switchboard.

5.3.9 Circuit breakers/contactors controlling motor feeders shall have a rating of at least 125% of the maximum continuous rating of the connected motors.

5.3.10 Separate feeders shall be provided in the switchboard for each load/motor. However, as an exception maximum two numbers welding receptacles or flood light masts may be connected to one power feeder.

5.3.11 All circuit breakers shall be of single break type having one pole per phase. Circuit breakers for all MV switchboards incomers and bus couplers including generator incomer shall be with four poles.

5.3.12 Rated short circuit breaking capacities and making capacities for all breakers and MCCBs shall be equal to or higher than the maximum specified value of the short circuit current and peak specified value of short circuit current respectively at the point of installation. MCCBs with backup fuses shall not be acceptable.

5.3.13 Air circuit breakers (ACB) shall be provided in MV switchboards for all feeders rated above 400A and switch fuse/MCCB/ACB shall be considered for feeder rated up to 400A. However in the feeders feeding power to small rated MCCs/ASBs/LDBs, switch-fuse feeders shall not be used.

5.3.14 Circuit breakers/Switch fuse units for capacitors shall, have a current rating of at least 135% of the capacitor rated current. Circuit breakers capability to interrupt applicable capacitive current shall be specifically verified.

5.3.15 The switchboard components viz. circuit breakers, main horizontal and vertical bus-bars, bus-bar joints, bus-bar supports etc. shall be designed to withstand the maximum specified short circuit current for a minimum time of 1 second, unless otherwise specified. Further, the switchboard shall be rated for Internal Arc Classification (IAC) for the short circuit current and duration as specified.

5.3.16 In general, for motors rated above 5.5 kW, CT in Y phase shall be provided in the switchgear for ammeter on the local control station/local control panel. Project design data sheet shall be referred for exact motor kW rating above which CT & ammeter need to be provided.

5.3.17 The maximum rating of bus bars for MCCs/ASBs/LDBs shall be limited to 1250 A or 40% of the feeding switchgear incomer rating, whichever is lower. Heavy duty type load break switch/ACB/MCCB for MCCs/ASBs and ACB/MCCB for lighting transformer fed LDBs, rated for maximum specified short circuit current & duration shall be used for incomer and bus coupler as specified in project design data sheet and these shall have suitable interlocks.

5.3.18 Special attention is drawn to Chapter IX of CEA regulations, which includes requirement of additional protective elements in switchgear applicable to Mines and Oil fields installations.

5.4 Bus Duct

The rating of bus ducts connected to breakers shall have same continuous and short circuit rating as that of breakers. Similarly bus ducts connecting two bus sections shall have same continuous and short circuit rating as that of main bus bars.

5.5 Neutral Grounding Resistor

The NGRs shall be rated to withstand the fault current for 10 seconds.

5.6 Batteries

Batteries shall be of adequate capacity to meet the back-up requirements as envisaged in the duty cycle. While sizing the battery, temperature correction factor and ageing factor shall be considered in addition to the maintenance factor. Batteries shall be complete with battery racks and accessories.

5.7 DC Power Supply System

5.7.1 DC power supply system shall include battery bank, charger-cum-rectifier, DC distribution board and cell booster.

5.7.2 The battery charger/rectifier shall feed the load and keep the batteries under fully charged condition. Provision shall also be made for necessary boost charging/initial charging of battery.

5.7.3 The DC system shall have at least 10% spare capacity for future load growth.

5.7.4 Each battery charger and DCDB shall be sized to cater to selected battery capacity.

5.7.5 Each DCDB shall have at least 10% spare feeders with one no of each rating for future use.

5.7.6 Three pole power switch/ isolator outside battery room shall be provided for local isolation of battery during maintenance.

5.7.7 For dual redundant system, each system shall be provided in separate compartment with the common components mounted in another separate compartment, so that it is possible to do maintenance on one system while the other system is in operation.

5.8 Uninterrupted Power Supply System

5.8.1 UPS system shall include battery bank, rectifier transformer, rectifier-cum-charger, inverter, set of filter circuits, static switches, bypass transformer, facility for manual transfer between inverter supply & bypass line, facility for bypassing inverter & static switch for maintenance, AC Distribution board, cell booster and other associated accessories.

5.8.2 Each branch circuit of the UPS distribution system shall have a fused disconnect switch. The fuse shall be fast clearing semiconductor type and the fuse rating shall be co-coordinated with the rating of the UPS system. Normally the largest branch circuit rating shall not exceed 25% of the UPS system rating for feeders without isolation transformer and 10% of the UPS system rating for feeders with isolation transformer.

5.8.3 UPS system shall be sized to have at least 10% spare capacity for future load growth.

5.8.4 Each UPS ACDB shall have at least 10% spare feeders for future use by owner.

5.8.5 Power switch/ isolator outside battery room shall be provided for local isolation of battery during maintenance.

5.9 Motors

5.9.1 In general, three phase squirrel cage induction motors designed for direct on line starting shall be used. Motors shall be totally enclosed, fan cooled type and suitable for continuous use. Synchronous motors and motors with variable frequency operation shall be designed for special application.

5.9.2 All motors shall be continuous maximum rated with possible exception of crane and hoist motors, soot blowers, turbine/engine starting motors etc. which may be rated for the envisaged duty cycle.

5.9.3 DOL start high voltage motors shall be suitable for starting under specified load conditions with 80% of the rated voltage at the terminals and DOL start medium voltage motors shall be suitable for starting under specified load conditions with 75 % of the rated voltage at the terminals. If required, large rated motor starting shall be through soft starter/ dedicated transformer as per project design data sheet. Voltage available at the motor terminals which are started through dedicated transformer shall be decided considering the speed torque characteristics of the driven equipment and ensuring the voltage dip at the source bus does not exceed the permissible limits as per project design data sheet.

5.9.4 MV Motors shall be energy efficient type having energy efficiency level as specified in project design data sheet.

5.9.5 VFD fed motor shall be suitable for converter duty application.

5.10 HV Capacitor Banks

5.10.1 The capacitor banks shall be supplied with series reactor and RVT (residual voltage transformer). All the capacitor bank equipment except APFC panel shall be suitable for outdoor location unless otherwise specified.

5.10.2 The capacitor bank in conjunction with series reactor shall provide minimum net required kVAR at rated nominal voltage. The insulation system shall be designed to withstand continuous over voltage of 110%.

5.10.3 Capacitor bank rating shall be sized considering the power factor correction requirement. The maximum rating of capacitor bank unit shall be restricted by the available capacitive breaking capacity of feeding switchgear in APFC panel.

5.11 Emergency Generator

5.11.1 The emergency generator set shall be designed to start automatically on power failure and feed the selected loads. It shall be capable of taking care of the load variations including the starting of the largest rated motor with specified base load. However, DG sizing shall not include boost charging loads for UPS and DC system batteries but shall only include float charging and service loads.

5.11.2 The regulation of generator voltage shall be automatic and necessary instruments for metering viz., Ammeter, Voltmeter, frequency meter, kWH meter, power factor meter, hour run counter etc. shall be included in control panel. Warning of abnormal conditions shall be incorporated prior to automatic trip to prevent unnecessary shutdown.

5.11.3 The unit shall be complete with necessary engine starting equipment, associated control panel and shall be suitable for remote starting. Emergency Generator shall have auto-starting

arrangement but only with manual switching off feature. 'Fail to start' annunciation shall be provided, in case the engine fails to start.

5.11.4 The load shall be automatically switched on to the generator only after the requisite voltage build-up.

5.11.5 The Emergency generator set shall have at least 10% spare capacity for meeting future requirements.

5.11.6 Local line side circuit breaker shall be provided in DG control panel. Further isolation switch shall be provided for generator system neutral if specified in project specification.

5.12 Annunciation Panel

5.12.1 Audio-visual annunciation panels shall be provided, where specified in project design data sheet, to monitor the switchgear and other electrical equipments. In case hardwired panel is not envisaged, audio visual annunciations shall be provided as part of the HMI system.

5.12.2 Detailed annunciation schedule shall be based on but not limited to the following:

a) EHV & HV Switchgear
- Breaker-wise fault trip alarm
- Auto-changeover completed
- Auto-changeover failure
- Trip circuit status for each breaker
- Differential and restricted earth fault relay operation alarm
- Transformer trouble alarm
- DC supply failure alarm (Bus wise)
- PT secondary MCB trip alarm for all line and bus PTs
- Bus wire supervision alarm
- Alarms for SF6 gas system

b) MV Switchgear
- Incomer/ Bus coupler fault trip alarm
- Auto-changeover completed
- Auto-changeover failure
- Bus-wise group fault trip alarm for outgoing feeder breakers
- D.C. supply failure alarm (Bus-wise)
- PT secondary MCB trip alarm for all line and bus PTs

c) Operating status/fault conditions for UPS system.

d) Operating status/fault conditions for DC supply system.

e) Operating status/fault condition for DG sets.

f) Fault alarm for VFD panels

5.12.3 Annunciation panel shall be complete with acknowledge, test and reset pushbuttons. 10% spare windows for future use shall be provided in the panel. Generally, annunciation panel shall be fed from the UPS system/ DC system.

5.13 Cables and Wires

5.13.1 Unless otherwise specified, EHV cables shall be single core type, copper/ aluminum conductor, XLPE insulated, corrugated Aluminium sheathed, unarmored, FRLS, PVC outer sheathed with overall conductive graphite coating. The exact type & construction of EHV cables shall be as specified in project design data sheet.

5.13.2 HV cables shall be dry cured XLPE insulated, armoured, extruded FRLS PVC outer sheathed with aluminum/copper conductor, as per project design data sheet. All cables rated 3.3 kV and above shall be provided with both conductor screening and insulation screening.

5.13.3 MV power cables shall be PVC/ XLPE insulated, armored/ unarmored, extruded FRLS PVC outer sheathed with aluminum/copper conductor, as per project design data sheet.

5.13.4 The control cables shall be twisted pair, copper conductor, PVC/ XLPE insulated, armoured, extruded FRLS PVC outer sheathed and overall shielded.

5.13.5 The power cables shall be sized based on the maximum continuous load current, the voltage drop during running & start up, system voltage, system earthing and also short circuit withstand criteria if applicable. The derating due to design ambient air temperature, ground temperature, depth of laying, grouping & proximity of cables with each other, thermal resistivity of soil, laying conditions etc. shall be taken into account.

5.13.6 Cables connected in parallel shall be of the same type, size, cross-section and terminations.

5.13.7 All power and control cables shall be in continuous lengths without any splices or intermediate joints. The cables used for lighting and wires in conduits shall have appropriate junction boxes with adequately sized terminals. Unless otherwise agreed, cable joints in hazardous areas shall not be permitted.

5.13.8 All incoming cables to switchgear/UPS/DC system/DBs and other equipment shall be sized for maximum anticipated load including 10% future growth. Cable for capacitor banks shall be sized for 135 % of the rated capacitor current.

5.13.9 The incoming cable for heat tracing power distribution panel shall be with four cores, the neutral conductor being of same size as the phase conductors.

5.13.10 All control cables shall have minimum 10% spare pairs/ cores.

5.13.11 Optical fiber cable (OFC) for data highway of Fire Alarm system, Plant communication system & Electrical control system (ECS) and for feeder differential relay etc. shall be laid in heavy duty flame retardant HDPE duct. The HDPE duct for each service shall be unique color coded as per project design data sheet for ease of identification of service.

5.14 Control Station

5.14.1 Each motor shall be provided with a control station/control panel in the field, unless otherwise agreed upon. Additional emergency stop push button station for air cooler motors, cooling tower motors and other motors located at higher elevations shall be provided at grade level. Further, emergency stop control station for transformers in transformer bay and at intermediate levels for conveyers shall also be provided. If specified, emergency open/ close control station located outside dyke wall for tank body MOVs shall be provided.

5.14.2 The control station shall include the following equipment as per individual requirement:

- Start/stop push button
- Ammeter (as applicable)
- Local/ Off/ Remote selector switch (if specified)
- Speed lower/ raise switch, speed indication (for VFD motors, if specified)

5.14.3 Stop push button shall generally have stay put feature except in the case of critical drives such as lube oil pump etc.

5.15 Convenience Receptacles

5.15.1 These shall have the necessary mechanical interlocks and earthing facilities. The enclosure shall have suitable protection for site conditions specified (flame proof, weather proof, dust proof, corrosion resistant, etc.).

5.15.2 Adequate number of welding receptacles shall be provided at suitable locations to ensure accessibility with a 50 m length of trailing cable to any point in the process area and in substations & control rooms. These shall be rated for 63A suitable for 415V, 3 phase system with a scraping earth.

5.15.3 Adequate number of three-pin sockets for lamps and portable tools shall be provided at suitable locations to ensure accessibility with a 15 m length of cable to all manholes of process equipments, other important areas in the process units and in substation, control rooms and other buildings. These shall be rated for 15A, 240 V single phase with earth connection. Hand lamps and portable tools shall be earthed through flexible cords. In hazardous areas, flameproof hand lamps shall be rated for 24V.

5.15.4 If specified in project specification, dedicated 415V TPN load break switches/ receptacles shall be provided in the process units at suitable locations and elevations for feeding loads during shut down & maintenance activities.

5.16 Actuators for Motor Operated Valve

5.16.1 MOVs shall be provided with integral starters. MOV actuators shall be non- intrusive type unless specified otherwise. The necessary local/remote selector switch, open/ close control switches or push buttons, torque limit switches etc. shall be provided on actuator for local/remote control depending on the mode of selection. In case of failure of torque limit switches, the mechanical design shall be adequate to stall and trip the motor without damage.

5.16.2 The type of MOV control i.e. conventional type or 2 wire control or compatible with instrumentation field bus, etc. shall be as per instrumentation design basis.

5.17 EHV System

The EHV power supply arrangement shall be provided with either conventional switchyard having CT, VT, disconnector, circuit breaker, lighting arrestor, etc. located in outdoor fenced area or Gas Insulated Switchgear (GIS). The GIS panels shall be located indoor inside the substation building however, outdoor GIS can also be provided as per project specific requirement.

5.18 Variable Frequency Drive

5.18.1 VFD shall be provided with bypass as a standard practice, unless prohibited due to process requirement. In exceptional cases, wherein DOL starting of motor is not possible due to power system limitations, bypass complete with soft starter or no bypass can be considered as specified in project specification.

5.18.2 Control supply to VFD shall be provided from either DC system or UPS system, as specified in project design data sheet.

5.18.3 VFD sizing shall be done to take care of voltage variation in the incoming power supply, voltage drop inside VFD module & equipment and voltage drop in outgoing cables to motor. Further minimum fault level of the incoming power supply shall be considering for harmonics analysis and sizing of associated components.

5.19 Generator

5.19.1 Generators shall be installed in Non-Hazardous area and shall be installed close to their step up transformer if provided. Further generator cooling system shall be independent of its acoustic enclosure ventilation system.

5.19.2 The generator rated power factor shall be 0.8 lagging, unless otherwise specified.

5.19.3 Bus ducts, if provided for connection between generator and transformer shall be phase segregated or phase isolated type to minimize the possibility of short circuits.

5.19.4 Generators shall be provided with its own MV auxiliary switchboard to cater its motor driven auxiliaries & other loads.

5.19.5 Generators shall be provided with necessary controls & protection devices for synchronizing, voltage control system suitable for island & parallel operation, reactive power control system to control generator power factor, devices to protect the generator & its prime mover and other features as specified in project design data sheet.

5.19.6 The synchronizing controls shall preferably be located from where control of voltage and frequency of generating system can be exercised.

6.0 SUBSTATION / MCC ROOM DESIGN PHILOSOPHY

6.1 The sub-stations shall be located in a safe area close to the load center. Proper access shall be provided/ ensured for operation/ maintenance of indoor and outdoor equipment.

6.2 EHV and HV sub-station switchgear floor shall be raised above grade level and the space below the switchgear room shall be utilized as cable cellar. The cable cellar floor shall be at least 300 mm above the approach road level and shall be paved and cemented. The cable cellar shall have a minimum clear height of 3.5 m and shall house all cable trays & their supports. Further, the cable cellar height of sub-station housing EHV GIS panels may be increased beyond 3.5 m as required to facilitate bending and termination of EHV cables.

6.3 The substation switchgear floor shall have a minimum clear height of 4.5 m. For switchgear floor provided with false ceiling, the minimum clear height below false ceiling shall be 4.5 m. Further, for switchgear floor without false ceiling, the clear height may be increased beyond 4.5 m, as required to accommodate bus duct, air conditioning duct/ pressurization duct etc.

6.4 MV sub-stations and MCC rooms shall be elevated by compacting the soil so that

- The finished floor level shall be above the approach road level to the building.
- The finished floor level shall be minimum 1000 mm above the surrounding grade level.
- The bottom of the cable trench within sub-station is minimum 150 mm above the surrounding grade level.

6.5 In addition to the entry to substation for operating personnel, a separate entry of minimum 3m (W) x 3.5m (H) with rolling shutter shall be provided for drawing in all equipment for installation. The main entry for operating personnel for pressurized and air conditioning substations shall be provided with double door system with an airlock lobby. The Sub-station shall also have an emergency door opening outwards.

6.6 Sub-station wall adjacent to the transformer bays and walls separating transformers shall be 355 mm thick (inclusive of plastering) in case of brick construction or 230 mm thick in case of RCC construction.

6.7 Sub-station building shall be without any columns within the switchgear room to ensure optimum space utilization, unless otherwise specified.

6.8 Battery banks shall be located in a separate adequately ventilated room in the sub-station building, along with the necessary exhaust system and water connection with sink. Floor of the battery room and walls up to 1.5 m height shall have acid/alkaline resistant protective epoxy coating. Separate battery room may not be required for VRLA batteries, as the VRLA battery stack can be located in the air-conditioned room housing chargers and UPS systems. The battery room shall be provided with minimum two exhaust fans (flameproof, gas group IIC) and louvered opening in opposite wall/door.

6.9 UPS system and other electronics equipment e.g. Data concentrator, Substation Automation System, ECS, HMI, RTCC, variable frequency drive panels, soft starter panels, battery chargers, thyristor heater control panels, control & relay panels, excitation panel, digital voltage regulator panels, etc. shall be located in air-conditioned area, unless otherwise specified in project design data sheet.

6.10 Sub-station shall have fire extinguishers, first aid boxes and other safety equipment as per statutory requirements. Insulating mats of required voltage rating shall be provided in front and rear of switchboards and GIS panels. Further illuminated Single line diagrams depicting power supply arrangement of the sub-station shall be provided in the switchgear room.

6.11 Separation walls between transformers in all substations and safe inter transformer distances for switchyard transformers shall be as per OISD-STD-173. Fire protection for transformers and switchgear room shall be provided to comply with requirements of OISD-STD-116, 117 and 173.

6.12 Equipment like transformers, neutral grounding resistors, reactors and HV capacitor banks shall be located in outdoor bays adjacent to the sub-station building. The requirement of roof for bays shall be as defined in project design data sheet. All bays shall have well drained floor, surfaced with gravel or other suitable material.

6.13 In order to prevent oil, whether from a small leakage or outflow from transformer tank, from reaching and polluting the water bearing stratum, transformers shall have the following provisions, depending on the oil capacity of the transformer -

6.13.1 Oil Capacity upto 2,000 litres:

Transformers installed adjacent to sub-station/buildings or in Switchyards shall be provided with a layer of 100 mm deep stones of about 40 mm granulation, all around the transformer, for a width of 20% of the transformer height subject to minimum width of 800 mm. However complete transformer bay/ fenced area shall be provided with stone gravels.

6.13.2 Oil Capacity exceeding 2,000 litres:

Transformers installed adjacent to sub-station/building or in Switchyards shall be provided with oil containing pits. Also Nitrogen Injection Fire Protection System (NIFPS) shall be provided for transformers, unless otherwise specified.

The oil containing pit may be shaped as per OISD STD-173. The pit shall extend all around the transformer for a width of 20% of the transformer height, with a minimum width of about 800 mm around the transformer tank/radiator. In case oil capacity exceeds 9,000 litres, in any chamber, provision shall be made for draining away of any oil, which may escape or leak from the tanks, to a waste oil tank.

6.14 NIFPS control panel shall not be kept in the same bay as of transformer, which is being protected by that panel. Piping from transformer to panel shall not block/ obstruct free movement.

6.15 The substation building shall be sized to maintain adequate clearances between equipment for ease of maintenance. The following minimum clearances around various equipment shall be maintained:

Sl. No.	Location	Clearance
a)	Front clearance for HV switchboard including HV GIS	2000 mm
b)	Front clearance for various switch boards/panels	1500 mm
c)	Clearance between front to front of two switchboards facing each other	2000 mm
d)	Rear clearance for panels having maintenance access from front only	Less than 200 mm or more than 750 mm
e)	Rear clearance for panels requiring maintenance from rear	1500 mm (HV swbd) & 1000 mm (MV swbd)
f)	Side clearance between two switch boards or from nearest obstruction	1000 mm after considering space for future panels as per cl. 6.16
g)	All around clearance for transformers	1000 mm
h)	All around clearance for NGR	1000 mm on two sides, 200 mm on other two sides
i)	All around clearance for capacitor bank/ series reactor	1000 mm
j)	Battery rack to wall clearance for - Single row, single/double tier - Double row, single tier - Double row, double tier - Multistep racks	 100 mm 100 mm 750 mm 750 mm
k)	Battery rack to rack clearance	750 mm
l)	Head room clearance below bus ducts or any other overhead equipment	2000 mm
m)	Front clearance for wall mounted equipment	1000 mm
n)	Front clearance for operation work station/ annunciation/ control panel/ HMI	2000 mm

Clear vertical clearance above the top of the highest equipment shall be minimum 1000 mm measured from the bottom of the lowest roof beam. However for the areas with false ceiling, minimum clearance of 750 mm shall be provided between false ceiling and top of any equipment.

For EHV GIS, minimum all around clearance and vertical clearance shall be as per manufacturer recommendation.

6.16 In all Substations/ MCC rooms, space for future extension of switchboards shall be provided. One panel extension space on each side (for each Bus section) or two panel extension space on one side (in exceptional cases) shall be provided for all GIS, HV Switchboards, PCCs, MCCs, ASBs and LDBs. In addition, space for future extension of the substation/ MCC room building shall be considered, as specified in project design data sheet.

6.17 Necessary arrangement shall be provided in switchgear room for routing of pressure relief duct of switchboard, if provided, after co-ordination with pressurization/ air conditioning ducts/ bus ducts, in case the exhaust gases are required to be released outside substation building as per manufacturer's design. In case gases can be released inside switchgear room as per manufacturer design, absorber shall be provided at the end of pressure relief duct.

6.18 The DG sets shall be preferably located in a separate building other than the substation, in a safe area to reduce noise level in substation. However in case the same is located in the substation building, the DG set foundation shall be structurally delinked from the slab/floor of the rest of the substation building. Exhaust of diesel engine shall be kept away from the process/hydrocarbon handling areas and diesel day tanks shall be located outside the DG room. Suitable ventilation system shall be provided to avoid heat accumulation in the DG room.

6.19 Fire protection for transformers and substation shall be provided to comply to requirements of OISD-STD-173.

6.20 Exhaust fans shall be provided in the cable cellar for ventilation. However, fire integrity of wall between transformer bays and cable cellar/ switchgear hall shall not be compromised.

6.21 Overhead EOT crane of required capacity shall be provided in switchgear hall housing EHV GIS panels. However where EHV GIS isolating breaker panels are only envisaged, monorail arrangement can be considered in-lieu of EOT crane, if specifically agreed upon.

7.0 INSTALLATION DESIGN PHILOSOPHY

7.1 General

The installation work for equipments, cabling system, earthing system and lighting system shall generally conform to EIL standard specifications and installation standards.

7.2 Cabling System

7.2.1 Cabling system for various areas shall be as specified in Project design data sheet.

7.2.2 The cable trenches shall be sized depending upon the number and voltage grade of cables. The cable trenches in hazardous areas and in transformer bays/ substation cellar shall be filled up with sand/ stone dust. Where underground cables cross road ways, pipe sleepers at grade etc. they shall be protected by being drawn through sleeves/ culvert to provide a permanent crossing.

7.2.3 RCC cable trenches shall be sealed against ingress of liquid and gases wherever the trenches leave or enter a control room or substation. Pipes laid for mechanical protection shall be sealed at both ends. In case of direct burial, cable route markers shall be installed at 30 m interval all along the cable routes and where the direction of cable trench changes.

Additionally, markers shall be provided at cable straight through joint locations. In cable trenches, earthing conductor shall also be installed and shall be regularly bonded to the earthing system.

7.2.4 Above ground cables shall be well supported on cable trays and suitably protected against mechanical damage. Routing shall be decided to avoid interference with hot surfaces or places subject to undue fire risk. Requirement of walkway for cable trays on overhead piperack shall be as specified in project design data sheet.

7.2.5 Cable trays, racks and trenches shall be sized to allow for 10 % space for future cables. Cable installations shall provide minimum cable bending radii as recommended by cable manufacturer. Separate trays shall be provided for EHV cables, HV Cables, MV power cables, MV control cables and plant communication cables to the possible extent. However, where specifically agreed upon in exceptional cases, HV and MV power, control cables may be laid together, with a barrier plate separating HV and MV cables. EHV, HV and MV power cables shall be laid in single layer on cable trays. MV power cables can be laid in maximum two layers in case of space constraint, if specifically agreed upon.

7.2.6 For EHV cables, the radius of cable trays bends and vertical distance between cable trays shall be finalized based on EHV cable sizes & laying requirements.

7.2.7 Separate cables shall be provided for AC and DC signal/control circuits, except for cables to Local control stations/ local control panels/ MOVs. Separate control cables shall be provided for status and command signals to ensure that mixing of two separate voltage sources shall not occur in a multi core cable.

7.2.8 Cables connected in parallel shall run together so that their length remains the same.

7.2.9 Type of cable tray and accessories shall be as specified in project design data sheet. For tray system design, in addition to self load and wind forces, following guidelines for design shall be considered.

a) Maximum Support span : 3000 mm

b) Cable load for

i.	150 mm wide cable tray	:	30 kg/linear meter
ii.	300 mm wide cable tray	:	60 kg/linear meter
iii.	600 mm wide cable tray	:	75 kg/linear meter
iv.	750 mm wide cable tray	:	75 kg/linear meter.

c) In addition to this, 70 kg concentrated load at center span shall be considered. All structural steel design shall be as per Indian Standards.

7.2.10 Bends, tees, reducers, crosses, droppers etc. shall have the required bending radii as required for various cable sizes.

7.2.11 All cables shall carry the cable tag numbers for easy identification.

7.2.12 Signal cables i.e. Instrumentation, communication, fire alarm, LAN and data highway, etc. shall preferably not be laid in the same trench/ tray along with electrical cables. In case these are laid in the same trench/ tray, a clearance of minimum 300 mm from electrical cables shall be provided. The overall cable layouts shall be designed for minimum interference between signal and power cables.

7.2.13 For single core cables rated 33 kV and above, the armour and metallic screen shall have either single point bonding or cross bonding scheme. Both side bonding scheme shall not be considered due to reduction in cable current carrying capacity. The screen bonding scheme for complete cable route shall be finalized considering link boxes with/ without SVL as per screen/ sheath voltage calculation. Single core cables laid in trefoil formation, shall be braced with non-magnetic clamps suitable to withstand short circuit dynamic forces.

7.2.14 Cable tray covers shall be provided for top most cable trays and for the outermost tray of vertical droppers. Further, bottom cable tray covers shall be provided for cable trays crossing above hydrocarbon pipelines.

7.2.15 All above ground cable tray entries into buildings shall be properly sealed.

7.2.16 Fire proofing paint on cables shall be provided near end terminations of cables upto 1 meter.

7.2.17 Ariel Bunched Cables, wherever used, shall be erected with the minimum clear height of 6.0 m on roads with vehicular traffic and 3.5 m on roads where vehicular traffic is prohibited. These shall not pose any restriction for movement of ODC consignment, cranes and construction work.

7.3 Earthing and Lightning Protection System

7.3.1 All electrical equipment shall be suitably earthed. Earthing system shall, in general cover the following:

- Equipment earthing for personnel safety.
- System neutral earthing.
- Protection against Static and Lightning discharges.
- Separate clean earth system for Instrumentation, DCS, ECS etc. as per vendor specified requirements.

7.3.2 Plant earthing design shall generally be carried out in accordance with the requirements of CEA regulations and IS: 3043. The earthing system shall have an earthing network with required number of earth electrodes connected to it. The following shall be earthed:

- System neutral
- Current and potential transformer secondary neutral.
- Metallic non-current carrying parts of all electrical apparatus such as transformers, switchgears, motors, lighting / power panels, terminal boxes, control stations, lighting fixtures, receptacles, feeder pillars, NGT/ NGR Panels, etc.
- Steel structures, loading platform etc.
- Cable trays and racks, lighting mast and poles.
- Storage tanks, spheres, vessels, columns and all other process equipment.
- Electrical equipment fencing (e.g. switchyard, compact substation etc.)
- Cable shields and armour.
- Flexible earth provision for wagon, truck.
- Driven equipment handling Hydrocarbon if its base Plate is separate from motor base plate.
- Turbo driven equipment handling hydrocarbon.

7.3.3 Unless adequately connected to earth elsewhere, all utility and process pipelines should be bonded to a common conductor by means of earth bars or pipe clamps and connected to the earthing system at a point where the pipelines enter or leave the hazardous area except where conflicting with the requirements of cathodic protection.

7.3.4 Lightning protection system for buildings shall be provided in accordance with IEC 62305 to protect structures from fire or mechanical destruction. External lightning protection comprising of air termination for intercepting lighting strikes, down conductors to safely conduct lightning current to ground and earth terminations to distribute lightning current in the ground shall be provided.

7.3.5 Lightning protection of storage tanks handling flammable liquids including floating roof tanks shall be done in accordance with OISD-GDN-180 and API-RP-545 complete with bypass conductors, shunts and accessories, etc. Self-conducting structures having metal thickness of more than 4.8 mm may not require air termination and down conductor, but shall be connected to earthing system, in line with OISD-GDN-180.

7.3.6 The resistance values of an earthing system to the general mass of earth should be as below:

- For the electrical system and equipment a value that ensures the operation of the protective device in the electrical circuit but not in excess of 4 Ohms. However, for the generating stations and large sub stations, this value shall not be more than 1 Ohm.
- 10 Ohms in the case of all non-current carrying metallic parts of major electric apparatus or any metallic object.
- For lightning protection, the value of 4 ohms as earth resistance shall be desirable but in no case it shall be more than 10 ohms.
- Earthing of Tanks shall comply to OISD-STD-173, API-RP-545. Earth resistance value for storage tanks shall not exceed 7 Ohms.
- All joints in pipelines, valves, plants, storage tanks and associated facilities and equipment for petroleum shall be made electrically continuous by bonding or otherwise; the resistance value between each joint shall not exceed 1 Ohm.
- Earth resistance of individual electrode to general mass of earth shall not exceed 2 Ohms in line with OISD-STD-137.

7.3.7 Earth rods and conductors shall be designed to cope with the conditions imposed. The earth conductor shall be adequately sized to carry the applicable maximum earth fault current without undue temperature rise. All joints shall be protected against corrosion.

7.3.8 All the electrical equipment operating above 250 volts shall have two separate and distinct connections to earth grid. Transformers, including lighting transformers shall be provided with two dedicated earth electrodes for earthing of neutral and transformer tank earthing.

7.3.9 All earth connections shall be visible for inspection to the extent possible. In all cases, connection to earth should be made in accordance with IS: 3043.

7.3.10 The main earthing network shall be used for earthing of equipment to protect it against static electricity. The lightning protection system shall be bonded with the main earthing network below ground, minimum at two points.

7.3.11 An approach for removing fire or explosion danger is to provide means for adequate dissipation and prevention of accumulation of static electricity, thereby ensuring that static discharges do not occur. One of the methods to eliminate risk of static electricity build up is earthing and bonding.
The subject of static accumulation caused by flow of petroleum products and the mitigation methods are dealt in detail in OISD-STD-110 and same shall be followed.

7.3.12 The earthing system shall comprise of earth conductors, earthing clamps, earth plates, earth electrodes in test pit etc. Normally earthing system shall have main earth grid alongwith suitably located disconnecting plates to provide multiple earth connections between earth grid & equipment and for connections between main earth grid & earth electrodes in test pit.

All connections shall be adequately secured against loosening.

Connections between earth electrode and the disconnecting plates shall be done by GI strip. Connection between the disconnecting plate and various equipments shall be done by GI strip, GI wire or GI wire rope or cable as specified in project design data sheet.

7.4 Lighting System

7.4.1 Plant lighting system shall comprise:

a) Normal lighting
b) Emergency lighting
c) Critical lighting.

Normal and emergency lighting shall be fed by AC supply (415/240V, three phase four wire except in case of Mines and Oil fields where it shall be in line with Chapter IX of CEA regulations and statutory requirements) while critical lighting shall be fed by DC supply. Additional precautions as per Chapter IX of CEA regulations to be adopted in mines and oil fields shall not apply to apparatus above the ground level except where such apparatus may directly affect the safety of the persons employed in underground mines, open cast mines and oil fields.

7.4.2 All emergency and DC critical lighting fixtures and associated Junction Boxes in Hazardous areas shall be Flameproof type.

7.4.3 Normal lighting system shall provide enough illumination so as to enable plant operators to move safely within the accessible areas of plant to perform routine operation including reading of field instruments, operation of all valves etc. and to carry out all the necessary maintenance and adjustment to equipment.

7.4.4 Areas requiring AC emergency lighting shall include, but not be limited to, the following:

- All Areas requiring DC critical lighting.
- Strategic locations in process, utility areas where specific safety/shutdown operation are to be carried out.

Generally 20-25 % of the total lighting fixtures shall be fed from AC emergency supply.

7.4.5 Areas requiring DC critical lighting shall include, but not be limited to, the following:

- Control rooms
- Substations
- DG shed
- Central fire station
- Fire water pump house
- Compressor houses
- First aid center
- Emergency escape routes
- Non plant buildings as specified in project design data sheet.

DC critical lighting shall be provided in the pipe rack, exit/entry point only in case considered for process units

Adequate number of self contained portable hand lamps and battery operated emergency lighting units shall be provided for immediate use for buildings where no DC supply is available.

7.4.6 During normal operation, both emergency and normal lighting shall be fed by normal power source. On failure of normal supply, emergency lighting load shall be transferred to emergency power supply source. Critical (DC) lighting shall be normally kept 'ON' and during failure of AC power; battery bank shall feed the critical lighting system.

7.4.7 Complete lighting shall be through LED lamps only, unless specified otherwise. Accordingly, LED lamp fixtures shall be provided for all types of lighting i.e. AC & DC lighting, indoor & outdoor lighting, hazardous area lighting, building lighting, decorative fixtures, street lighting, high mast lighting, etc. The chemical handling facilities shall be provided with chemical resistant fixtures.

7.4.8 Tall structures shall have aviation obstruction marker lighting as per DGCA civil aviation statutory regulations, Type C Medium intensity lighting fixtures, i.e. Red, fixed (not flashing), 2000cd.

7.4.9 Telescopic tubular high masts shall be provided for illumination of tank farm/general area. Generally street lighting poles may be avoided where lighting high masts can provide adequate illumination. The high masts shall be of continuously tapered polygonal cross section and fabricated out of steel plates. The masts shall be provided with motorized racking mechanism for lowering and hoisting lantern carriage.

7.4.10 Lighting system shall consist of lighting transformers, lighting distribution boards (LDBs), lighting and power panels, lighting fixtures, junction boxes etc. as required. All outdoor lighting shall be automatically controlled by means of photoelectric cell/synchronous timers with manual overriding control as specified. Lighting and power panels shall be fed from LDB through 415/415V, Dyn-11, dry type lighting transformer having taps up to +5%/ -7.5% (Refer clause 7.4.1 above for mine and Oil fields installations).

7.4.11 The lighting and power panels shall be provided with MCB & ELCB as incomer and Miniature Circuits Breakers (MCBs) for outgoing feeders control & protection of lighting circuits. ELCB may not be provided at the incomer of lighting and power panels, in case ELCB is provided in the outgoing feeders of LDBs/ASBs feeding to these lighting and power panels. MCBs shall not be loaded beyond 80% of rated capacity. A minimum of 20% of miniature circuit breakers of each panel shall be left as spares. In general, the load on each circuit shall be limited to 1.5 kW and MCB rating shall not be more than 16A. In areas having less lighting load, lighting transformer can be avoided subject to meeting the fault level rating at lighting panels within permissible limits, if specifically agreed upon

7.4.12 **Lighting Lux Levels**

Lighting system design shall be based on minimum illumination levels as specified below:

S NO.	AREA	LUX
a)	Main roads (along process units, power houses, workshops, etc.)	7-10
b)	Secondary roads (along storage tanks, settling basins, etc.)	3-5
c)	Tank farm	10
d)	Pump houses, Sheds	100
e)	Main operation platforms & access stairs	60
f)	Ordinary platforms	20
g)	Process areas, pipe racks, heat exchanger, heater, separators,	60

	cooling tower, columns, pig launching/ receiving loading area, flare etc.	
h)	Switchgear room, Rack room	150-200
i)	Cable cellar	70
j)	Transformer bay	100
k)	Battery room	150
l)	Control room (Console Area), Laboratory	400
m)	Boiler house	150
n)	Charger/ UPS rooms	150-200
o)	Cooling Tower	60
p)	Switchyard	
	Operating area	100
	Other areas	50
q)	Warehouse	100
r)	Office, Operator Room	300
s)	Compressor operating area	200
t)	Watch room	100
u)	Stairs	50
v)	Corridors/ lifts	70
w)	Tube well, Gate & watchman booth	100
x)	Fire house, Garage	100-150

However, lighting levels in all areas shall take into consideration the requirements from point of view of safety, ease of operation and maintenance.

7.4.13 Lighting design shall conform to relevant Indian and International Codes and Standards, IES Hand Book and shall take into consideration the requirements from point of view of safety and ease in operation and maintenance. Maintenance factor (Light Loss Factor) shall be calculated considering lamp lumen maintenance factor, lamp survival factor and luminaire maintenance factor. Utilization factor (coefficient of utilization) shall be calculated considering reflectance from ceiling, wall and floor in case of indoor lighting and from nearby equipment/ structure in case of plant lighting. Maintenance factor shall not be more than 0.65 for indoor lighting and shall not be more than 0.6 for outdoor lighting. Utilization factor shall not be more than 0.8, however depends on light reflecting property of the material. Further, for dusty areas, maintenance factor as per relevant codes and standards shall be considered.

7.4.14 Wiring for lighting and convenience outlets in outdoor areas shall be carried out with PVC/ XLPE insulated armored FRLS cables run along the column/platforms and structures. Double compression cable glands required for terminating of armoured cables in lighting fixtures and junction boxes in hazardous areas shall meet the requirements of IS/IEC 60079-0. For outdoor/ indoor safe area equipment, double/single compression cable glands shall be used respectively.

7.4.15 Adequate number of ceiling fan points shall be provided in Administration Building, Offices, rooms allocated for operating and maintenance personnel etc.

7.4.16 Two pole isolation devices shall be used for controlling lighting fixtures and sockets in hazardous areas to isolate phase as well as neutral. (For all Mine and Oil field installations refer clause 7.4.1 above).

7.4.17 For buildings with false ceiling, concealed conduit wiring shall be employed below the false ceiling and surface conduit wiring above the false ceiling. Metsec channel shall be used above false ceiling for lighting circuit wiring in Sub-stations and control rooms.

7.4.18 Adequate number of pull boxes shall be used to aid wire pulling and inspection. No joints shall be allowed inside these pull boxes.

7.4.19 Battery room shall have lighting fixtures mounted on wall in order to facilitate easy replacement of lamps. Switches controlling the lighting fixtures and exhaust fans shall be installed outside the battery room. Lighting fixtures, sockets and exhaust fans in battery room shall be flameproof type suitable for gas group IIC.

7.4.20 Locally mounted lighting fixtures on platforms, walkways, stairs shall be installed in such a way that maintenance can be done without the use of ladders.

7.4.21 Telephone wiring/ sockets and LAN wiring/ sockets (as required) shall be provided in plant and non plant buildings/ rooms which are normally manned during operation and maintenance of the plant.

7.4.22 LED solar lighting system shall be provided for street lighting purpose, if specified in project design data sheet.

वातानुकूलन तंत्र के लिये मानक विनिर्देश

STANDARD SPECIFICATION FOR AIR CONDITIONING SYSTEM

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
1	08/07/2020	REVISED AND REISSUED	AA	KCP	PPP	SKS
0	25/09/2013	ISSUED AS STANDARD SPECIFICATION	SD/AA	PPP	PB	DM

Abbreviations:

AHU	:	Air Handling Unit
AMCA	:	Air Movement and Control Association
ANSI	:	American National Standards Institute
AHRI	:	Air-conditioning & Heating Refrigeration Institute
ASME	:	American Society of Mechanical Engineers
ASHRAE	:	American Society of Heating, Refrigerating and Air Conditioning
ASTM	:	American Society for Testing and Materials
BS	:	British Standards
CFC	:	Chlorofluorocarbons
CRCA	:	Cold Rolled Closed Annealed
DX	:	Direct Expansion
GI	:	Galvanised Iron
GSS	:	Galvanised Steel Sheet
HVAC	:	Heating, Ventilation & Air-conditioning
IS	:	Indian Standard
ISHRAE	:	Indian Society of Heating, Refrigerating and Air Conditioning
MCC	:	Motor Control Centre
NC	:	Noise Criterion
ODP	:	Ozone Depletion Potential
OISD	:	Oil Industry Safety Directorate
QA	:	Quality Assurance
SS	:	Stainless Steel
SMACNA	:	Sheet Metal and Air Conditioning Contractor's National Association
TR	:	Ton of Refrigeration
TEMA	:	Tubular Exchanger Manufacturers Association
TPI	:	Third party Inspection
VOC	:	Volatile Organic Compound
UL	:	Underwriters Laboratories

Packaged Equipment Standards Committee

Convenor : Mr. P.P. Pandey

Members :
Mr. Sanjay Mazumdar
Mr. Shishupal Choudhury
Mr. R. R. Shrivastava
Mr. K. C. Paikar
Mr. A. Natarajan
Mr. Plaban Dan
Mr. Ayush Mathur (Projects)

CONTENTS

1.0 GENERAL

1.1 This specification outlines the minimum requirements for design, engineering, manufacture, inspection, testing, painting, supply, erection, commissioning and performance testing of air-conditioning system, complete with all accessories.

1.2 The Heat Load Calculation shall be carried out individually room wise for all the Building as listed in Job Specification as per ASHRAE / Carrier Standards.

2.0 CODES, STANDARDS AND REGULATIONS

2.1 This standard specification is based on the following standard specifications and the standards referred therein, which shall be deemed to be part of this standard specification:

IS:659	Safety code for Air conditioning.
IS:660	Safety code for Mechanical Refrigeration.
IS:655	Specification for Air ducts
IS:2494 (Part-1)	V-Belts - Endless V-Belts for Industrial Purposes - Part 1 : General Purpose - Specification
IS:2494 (Part-2)	V-belts - Endless V-belts for industrial purposes-Part 2 Fire resistant and antistatic V-belts - Specification
IS:3142	Pulleys-V-Grooved Pulleys for Endless V-Belts Sections Z, A, B, C, D and E and Endless Wedge Belts Sections SPZ, SPA, SPB and SPC - Specification
IS:1239 (Part 1)	Steel Tubes, Tubular and Other Wrought Steel Fittings - Specification - Part 1 : Steel Tubes
IS:3589	Steel Pipes for Water and Sewage (168.3 to 2 540 mm Outside Diameter)
IS:277	Galvanized Steel Sheets (Plain and Corrugated)
IS:2062	Hot Rolled medium and high tensile structural steel
IS:4894	Centrifugal fans
IS:8148	Packaged Air Conditioners
IS:3615	Glossary of terms used in Refrigeration and Air Conditioning
ISO:15138	HVAC for Offshore Production and Installation
OISD STD 163	Safety of Control Room for Hydrocarbon Industry
ANSI/ISA-S71.04	Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants
AHRI-450	Performance Rating of water cooled refrigerant condensers, Remote Type
AHRI-460	Performance Rating of remote mechanical draft air cooled refrigerant condensers.
AHRI-480	Performance Rating of Remote Type Refrigerant-Cooled Liquid Coolers
AHRI-520	Performance Rating of Positive Displacement Condensing Units
AHRI-550/590	Performance Rating of Water Chilling Packages using Vapour Compression Cycle.

AHRI-560	Absorption Water Chilling and Water Heating Packages.
ATC-105	Acceptance test code for water-cooling tower
ASME Section VIII Div.I	Boiler and Pressure vessel code- Pressure Vessels.
TEMA	Tubular Exchanger Manufacturers Association.
ASTM B-111	Standard Specification for Copper and Copper Alloys Seamless Condenser Tubes and Ferrule Stock.
ASTM B-359	Standard Specification for Copper and Copper Alloys Seamless Condenser and Heat Exchanger Tubes with Integral Fins.
ASTM B-280	Standard Specification for Seamless Copper Tubes for Air Conditioning and Refrigeration Field Service.
ASTM A516	Specification for pressure vessel plates, carbon steels, for moderate and low temperature service. SMACNA Sheet Metal and Air Conditioning Contractors' National Association-HVAC Duct Construction Standards-Metal and Flexible.
AMCA-210	Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
ASHRAE	Handbooks of: - Fundamentals. - HVAC Systems and Equipment. - HVAC Applications. - Refrigeration.
ISHRAE	Indian Society of Heating, Refrigerating and Air Conditioning
BS EN 779	Particulate air filters for general ventilation – Determination of the filtration performance.
UL-555	Specification for safety for fire dampers
UL-555S	Specification for safety for smoke dampers
NFPA-90A	Standard for Installation of Air-conditioning and Ventilation Systems
6-41-0003	Standard Specification for Centrifugal Pumps (Water Service)
6-36-0007	Standard Specification for Vapour Absorption Refrigeration Package
NBC	National Building Code of India

Latest revisions of the above mentioned standards as on the date of enquiry shall be applicable.

2.2 Other international standards may also be acceptable subject to their being equivalent or superior to those listed above, with prior approval of Purchaser.

2.3 For provisions not covered by the above codes & standards, applicable good engineering practices and norms shall govern.

2.4 National laws and statutory provisions, together with any local by-laws for the state wherein the Air-conditioning system is required to be installed shall be complied with.

3.0 TECHNICAL REQUIREMENTS

3.1 Duty

All major equipment shall be designed for minimum 20 years life unless otherwise specified elsewhere in bidding documents.

3.2 Refrigerant

Refrigerant shall be non-CFC, non-ODP environmental friendly unless otherwise specified elsewhere in bidding documents.

3.3 Vapour Compression System

3.3.1 Refrigerant Compressor

Based on the capacity & selection criteria as specified in job specification, the compressor shall be one of the following types:

- Reciprocating or Scroll Compressor
- Screw Compressor
- Centrifugal Compressor

3.3.1.1 Special Requirement for Screw Compressor :

i) The compressor shall be equipped with automatic unloaded starting arrangement. It shall have automatic sliding valve capacity control arrangement actuated through suction pressure sensor.

ii) Economiser port may be used to improve the system efficiency & performance.

3.3.1.2 Special Requirement for Centrifugal Compressor :

i) Casing hydrostatic test pressure shall be at least 130% respectively of design pressures.

ii) Lubrication system shall be provided as per proven vendor standard.

iii) Variable inlet guide vanes shall be provided in the suction of compressor. Variable inlet guide vanes shall be operated by hydraulic oil pressure/separate electric/pneumatic motor/solenoid valve, for capacity regulation purposes. Automatic capacity regulation feature is required on compressor along-with manually operated device.

3.3.1.3 Purge recovery unit, if required, shall be provided to efficiently separate out non-condensable gases and moisture from refrigerant as per Manufacturer's Standard.

3.3.2 Electric Drive

3.3.2.1 All Electric drivers rating for mechanical equipment shall be rated minimum 110% of the maximum power required at motor shaft (including transmission losses) at operating conditions.

3.3.2.2 All electric drives shall be in accordance with the specified Electrical Specifications/Requirements.

3.3.3 **Condenser**

3.3.3.1 The tubes shall not be less than 12.5 mm diameter and shall be adequately supported to prevent tube vibration.

3.3.3.2 Condensers for 160 TR & above rated AC machines shall have water boxes & covers so that each tube sheet can be exposed without disturbing the piping connections.

3.3.3.3 Air cooled condensers, if specified, shall have seamless tubes and shall be complete with all accessories including fan with drive motor, refrigerant receiver (for condensing unit), refrigerant headers, supports etc.

3.3.4 **Evaporator**

3.3.4.1 Tubes shall not be less than 9.52 mm diameter. Tubes shall be adequately supported to prevent tube vibration.

3.3.4.2 Gas superheating in DX-evaporator it-self shall be ensured. Liquid entrainment to compressor shall be restricted by suitably designed arrangement for flooded chiller.

3.3.4.3 Evaporators for 160 TR & above rated water chillers shall have water boxes & covers so that each tube sheet can be exposed without disturbing the piping connections.

3.3.4.4 In case of chilled water system, chiller/evaporator shall be of shell and tube type (as per TEMA standard) with shell and tube sheet material as carbon steel and tubes in copper construction.

3.3.5 **Vapour Compression Package Assembly**

3.3.5.1 Refrigeration package using reciprocating/scroll/centrifugal compressor shall be mounted on a single skid comprising of compressor, drive motor, gear box, condenser, and evaporator (applicable for chilled water system), local control panel with gauges/indications. However, refrigeration package using screw compressor may be furnished in two skids - One compressor skid and other comprising condenser, evaporator (applicable for chilled water system), local control panel with gauges/indications.

3.3.5.2 Skid shall be designed so as to provide maintenance accessibility and operation ease of valves and controls. Instruments shall be easily readable.

3.3.5.3 Lifting hook/eye shall be provided for handling of equipment during maintenance.

3.3.5.4 Steel structural members of the skid shall conform to IS-2062/ASTM A 36.

3.4 Vapour Absorption Refrigeration (VAR) System

For VAR System, EIL Standard Specification no. 6-36-0007 shall be followed.

3.5 Air Handling Unit

3.5.1 The air-handling unit shall be of double skin construction with sandwiched insulation between the two sheets/skins. The air handling unit shall comprise of filter section, damper section, heating section (if required), humidifier section (if required), cooling coil section, fan section and drain pan.

3.5.2 Cooling coil shall be minimum 4 rows deep and shall be selected for a maximum face velocity of 2.5 m/s. Coils tube shall be of copper with aluminium fins (12-14 fins/inch). In case of chilled water system, water velocity in cooling coil shall not exceed 1.80 m/s.

3.5.3 For part load operation of DX units, Condensing units shall be with multiple independent refrigeration circuits which are switched on/off depending upon the actual load. The AHU coil shall be designed and manufactured accordingly to facilitate part load operation.

For part load operation of Chilled water system, Chilled water cooling coil shall be equipped with flow control valve with modulating temperature controller and globe valve in bypass.

3.5.4 Fan section will have centrifugal type backward curved bladed fan with electric motor. Fan rotating assembly shall be dynamically balanced.

3.5.5 Fan outlet velocity shall be restricted within 9.2 m/s.

3.5.6 Fire resistant canvas connection with metallic flanges shall be provided between fan outlet & duct.

3.5.7 Taper lock pulleys shall be provided with antistatic V-belts for drive. Direct driven fan shall also be acceptable.

3.5.8 Drain pans for condensate shall be of stainless steel construction and thermally insulated. Water seal shall be provided in the drain outlet.

3.5.9 All damper linkage arrangement (automatic/manual) shall be of SS 304 material.

3.6 Air Filters

3.6.1 **Pre-filter at AHU / Package/ Precision AC Unit Inlet** :

3.6.1.1 Filter section shall be provided with cleanable synthetic media filters

3.6.1.2 Filters shall be selected for a pressure drop of 4 mm WG maximum in clean condition.

3.6.1.3 Filters shall have filtering capacity of 90% efficiency upto 10 microns for AHU and 80% efficiency upto 20 microns for Package Units.

3.6.1.4 For precision AC, pre filter shall be provided in case fresh air supply is envisaged. Pre filter for fresh air can be provided inside or outside the unit as per manufacturer's design. Fresh air fan (if required) to take care of the pressure drop shall be provided.

3.6.1.5 Magnehelic mechanical gauge shall be provided for measuring pressure drop across filters.

3.6.2 **Fine Filter** :

3.6.2.1 Fine filters, if specified in Data Sheet/Job Specification shall be provided within AHU/downstream of Package Unit/within Precision Unit. Filters shall be capable of filtering dust up to 5 microns particle with an efficiency of 95%.

3.6.2.2 Fine filters shall be selected for a pressure drop of 6.5 mm WG maximum in clean conditions.

3.6.2.3 Magnehelic mechanical gauge shall be provided for measuring pressure drop across filters.

3.6.3 **Chemical Filter :**

3.6.3.1 Chemical Filter shall be provided in fresh air circuit of AC system wherever specified in Job Specification. Filtered fresh air shall be mixed with room-recirculated air before passing through air handling unit (AHU) /Package AC unit/ Precision AC unit.

3.6.3.2 Chemical filter unit shall be skid mounted accommodating pre filter, after filter, fresh air fans with motors (one no. working & one no. standby) and accessories. Outdoor located chemical filters (if specified in Job Specification/ Data Sheet) shall be provided with suitable dismantling rain-cover and rain-hood and bird screen at air intake.

3.6.3.3 Chemical filter unit in panel form shall also be acceptable provided the same is of double skin construction.

3.6.3.4 Unless otherwise specified in Job specification, Chemical filters shall be selected to capture Group-A gases as per ISA-71.04 standard (From GX environment at outlet to G1 environment at inlet).

3.6.3.5 Chemical filter shall be designed for the chemical media life of minimum one (1) year. Chemical filter supplier shall furnish required chemical media quantity calculations which shall be duly vetted (signed, stamped with relevant date of submission) by media manufacturer at post order stage.

3.6.3.6 Chemical Media shall be nonflammable, suitable to work under extreme humidity and temperature conditions as per applicable site conditions & Environmental norms/regulations.

3.6.3.7 For Refinery and Petrochemical environment: - Two stage deep bed chemical filters shall be provided - first bed shall contain required quantity of chemical media of activated carbon and activated alumina as a base material, together made into number of single pellets (i.e. each pellet made up of a mixture of activated alumina + activated carbon) with alkali impregnation as per media manufacturer standard. Second bed shall contain required quantity of chemical media of activated alumina pellets impregnated with oxidizing agent such as Potassium Permanganate or Sodium Permanganate etc. as per media manufacturer standard. Activated Carbon shall not be used in isolation in any bed and it is not permitted either as impregnated form or as separate pellet in blend media. Chemical media in both beds must have min. 15% moisture for effective neutralization & oxidation reactions to take place.

3.6.3.8 The pre-filters at inlet shall be capable of removing dust particles of size above 10 microns with minimum 90% efficiency and fine filters at outlet shall be capable of removing particles of size above 5 microns with minimum 95% efficiency.

3.6.3.9 Chemical filter unit shall be designed/sized considering the velocity across filter media as ~0.51 m/sec (100 FPM). Quantity of chemical media shall be calculated considering above velocity with residence time furnished and guaranteed by chemical media manufacturer for the proposed media.

3.6.3.10 Unit shall be suitable for outdoor/indoor installation (as applicable) & for continuous operation.

3.6.3.11 For outdoor located chemical filter units, fan shall be in blow through mode (Forced Draft) with respect to chemical filter media. For indoor installations fan shall be in Induced Draft mode with respect to chemical filter media. Intake of Fresh Air only through main HVAC blower is not acceptable.

3.6.3.12 Chemical filter unit should have adequate provision for easy removal & servicing of filter packs. Necessary handholes / Media filling nozzles with blind flange, gaskets and fasteners along with 1 set of spare gaskets & fasteners for each size and type shall be provided.

3.6.3.13 Chemical Filter Unit shall be provided with Magnehelic mechanical gauge for measurement of differential pressure across filters.

3.6.3.14 Fan shall be selected corresponding to air density at lowest ambient temperature as per site conditions. Fan curves and Motor power selection calculations shall be furnished accordingly.

3.6.3.15 Chemical media shall be supplied in separate air tight, water proof packed containers for filling at site. Vendor shall furnish the procedure for media filling for Purchaser's reference. Chemical media shall be identified with authentic documents which shall be furnished from media manufacturer indicating type of media, year of manufacture, batch number of media and test certificates.

3.6.3.16 A Certificate/undertaking from Media manufacturer shall be furnished indicating the suitability of the proposed media for the specified application along with guaranteed gas removal capacity values with guaranteed life against applicable corrosive gas (H_2S, SOx, NOx, Cl_2 etc.). Type test certificates of H2S gas removal capacity for the offered media in accordance with ASTM D6646 or Equivalent from an independent laboratory shall be furnished by vendor which shall establish the guaranteed H_2S removal capacity of the proposed media. Gas removal capacity of H_2S for the chemical media should not be less than 12%. Purchaser/EIL reserve the right to get the supplied chemical media tested independently at their end to ascertain the quality of the media. Non conformance to the indicated/offered specifications/quality may lead to severe penalties including blacklisting of the chemical filter supplier for any future EIL projects.

3.7 Heating Unit

3.7.1 Heater shall be re-heating type as per psychometric process requirement.

3.7.2 Heating shall be electric/hot water as specified in Job Specification/Data Sheet.

3.7.3 Heater rated capacity shall have a minimum 10% margin over required capacity.

3.7.4 Electric strip heaters, if provided, shall be complete with heating thermostats, safety thermostats. Hot water coils shall be complete with control valve and proportionating thermostat etc.

3.8 Humidifier Unit

3.8.1 Humidifier shall be steam pan type / Electrode type/ Infrared Type or water spray type as per Job Specification/Data Sheet.

3.8.2 Pan humidifier shall be complete with immersion type electric heaters actuated by humidistat, water float valve, stop valve in water make up line, level switch interlocked with heaters. Pan shall be in stainless steel construction. The outer surface shall be thermally insulated.

3.8.3 Water spray type humidifier shall comprise of spray header, nozzles, arms, etc; fractional H.P pump set, humistat, solenoid valve, etc. Make-up tank, water collecting trough complete with drain, quick fill, overflow, strainer, make-up connection with ball and float valve shall be provided.

3.8.4 Drain pan / water collecting trough of water spray humidifier shall be of SS-304/16G GSS / CRCA and thermally insulated.

3.8.5 The humidifier shall have a minimum 10% margin over required capacity.

3.9 Cooling Tower

3.9.1 Cooling tower, if required as per Job Specification, shall be of induced draft and counter flow type. The air inlet design W.B. temperature will be as specified in the Job Specification/data sheet.

3.9.2 In counter flow cooling tower, cells having more than one louver face, longitudinal partition wall shall be provided from water level to top air inlet louvers to prevent air from blowing through the louvered portion of the tower.

3.9.3 Material of construction of cooling tower components shall be as follows:

Structure	:	FRP
Casing	:	FRP/ GRP
Louvers	:	FRP/ Vacuum formed virgin PVC
Packing/ fill	:	Vacuum formed virgin PVC / PP
Fill supports	:	GRP grid / PVC coated steel wires
Drift eliminators	:	Extruded PVC
Spray nozzles	:	PP/ Bronze
Hot water distribution basin	:	FRP/ GRP
Basin cover	:	FRP / HDG steel
Fan stack	:	FRP
Fan blades	:	FRP/ Cast aluminium alloy
Fan hub	:	CI/ HDG steel / Cast aluminium alloy
Ladder :	:	HDG steel
Nuts/ bolts/ washers	:	SS304
Structural connections	:	HDG Steel / SS304.
Anchor bolts and brackets	:	SS 304

3.9.4 **Framework**

3.9.4.1 Cooling tower framework shall not be stressed greater than the maximum allowable values.

3.9.4.2 Non framework members such as casing, louvers, partitions and fill shall not be used for the structural loads. Structural frame of tower shall be designed to withstand the specified wind and seismic conditions.

3.9.4.3 Steel components such as the mechanical equipment support members, shall be heavy gauge steel and protected against corrosion by hot dip galvanizing.

3.9.5 **Casings and louvers**

3.9.5.1 Casing shall be of bolted constructions.

3.9.5.2 Louvers, if provided, shall be spaced to minimise air resistance and prevent water splash out.

3.9.5.3 Leakage shall not be permitted through casing.

3.9.6 **Fill**

3.9.6.1 Fill shall be easily removable. Movement or sagging of fill assembly shall be prevented.

3.9.6.2 Material of fill shall be impervious to rot, decay, fungus or biological attacks.

3.9.6.3 Maximum allowable drift loss shall be 0.05% of total throughput.

3.9.7 **Stacks and deck**

3.9.7.1 Fan stack shall be of self-supporting type designed to withstand applicable wind load without external support ties or cable bracing. HDG steel bird screen shall be provided at stack discharge.

3.9.7.2 Maximum tip clearance shall be 13 mm or 0.5% of the fan diameter, whichever is greater.

3.9.8 **Water Distribution System**

3.9.8.1 The distribution system shall operate satisfactorily at one half the design water circulation rate and also be designed to operate under at least 1.25 times the design water circulation rate without excessive head loss or overflow of the water distribution basin.

3.9.8.2 FRP/ HDG steel distribution basin cover shall be provided to prevent the accumulation of debris and algae in the hot water distribution basin.

3.9.9 **Access**

3.9.9.1 Cat ladder shall extend from fan deck to grade level to access the fan, motor and drive assembly for maintenance.

3.9.9.2 Doors and walkways shall be provided at basin level for access to the tower internals and interior walls.

3.9.10 **Fan blades, drivers and transmission**

3.9.10.1 Fan blades and hubs shall be statically and dynamically balanced and have provision for field balancing. The noise level of the fan and the drive unit shall be limited to 85 dB(A) at one meter periphery from noise source.

3.9.10.2 Motor shall be located outside the moist air stream. Suitable gearbox and cardan shaft of HDG steel construction (or V-belt for small size) shall be provided.

3.9.10.3 Service factor for coupling, shaft and gearbox shall be 2.0 minimum on motor rating.

3.9.10.4 Speed reducer shall be helical type. Oil level indicator and filling connections shall be located outside the fan stack. Proper care shall be taken to avoid leakage of lube oil.

3.9.10.5 Metal safety guards shall be provided on all rotating equipment. Guards shall be provided at each end of the floating shaft to protect against shaft whip in the event of shaft failure. Shaft and coupling shall be dynamically balanced.

3.9.10.6 Motor shall be dual speed, specially designed for cooling tower duty. Motor rating shall have at least 15% margin over fan shaft power consumption. Motor shall be furnished with special moisture protection on windings, shaft and bearing.

3.9.10.7 Motor shall be in line with relevant Indian standard.

3.9.10.8 Bearings shall have an L10 life of not less than 1,00,000 hours, unless otherwise specified.

3.9.10.9 Fan and shaft shall be supported by heavy duty self-aligning, grease packed bearings with moisture proof seals. Vibration monitoring switch shall be provided for fan. Acceptable vibration level shall be 100 micron. Potential free contact shall be provided for indication in control panel.

3.9.10.10 Necessary cable tray supports of FRP shall be provided from fan to basin curb. Also necessary FRP support for installing push button station shall be provided.

3.9.11 Local push button station in weatherproof enclosure with a canopy cover shall be provided.

3.10 Water Pumps

3.10.1 The pumps shall conform to EIL standard specification no 6-41-0003.

3.10.2 Pumps shall be provided with mechanical seal.

3.10.3 The pumps shall be complete with drive motor, coupling with non-sparking guard, common base plate, fixing and hold down bolts.

3.10.4 Pump assembly shall be dynamically balanced.

3.11 Refrigerant Piping for Vapour Compression System

3.11.1 Refrigerant piping shall be of copper as per manufacturer's standards.

3.11.2 All piping network shall be leak tested with nitrogen at 1.1 times of design pressure using soap water solution for minimum 24 hours. After establishing the capability to withstand test pressure, the piping network shall be dried and vacuumised to 2.5 mm Hg absolute. Vacuum shall be broken with dry nitrogen and the system shall be re-vacuumised to 2.5 mm Hg absolute. This vacuum shall be held for 12 hours before charging the refrigerant. After charging of refrigerant, leak detection shall be done using electronic or halide torch leak detector.

3.11.3 Refrigerant piping shall be arranged in a manner so as to avoid tripping or headroom problem. If pipes are routed on the floor, proper protection cover for pipes shall be provided.

3.12 Water Piping

3.12.1 All water piping shall be of Carbon steel as per project Piping Material Specification.

3.12.2 Isolation valve with reducer / expander (as required) along with companion flanges shall be provided by vendor for all battery limit connections with purchaser utility lines.

3.12.3 Piping shall be arranged in a manner so as to avoid tripping or headroom problem.

3.12.4 UPVC pipe with 9 mm Closed Cell Flexible Elastomeric Nitrile Rubber insulation shall also be acceptable for drain piping.

3.13 Combination Fire & Smoke Dampers

3.13.1 Combination fire & smoke dampers shall be installed in supply air and return air path. These shall be tested and certified as per UL-555 and UL-555S for 1.5 hour fire rating and smoke leakage class-I with temperature category 176 °C. Type test certificates for the same shall also be provided.

3.13.2 Dampers shall be spring return, motorized (pneumatically operated in control room / SRR buildings as per OISD requirement) & fail safe type with indication for open / close position.

3.13.3 Damper operation shall be interlocked (through HVAC Panel) with the signal from purchaser's fire and gas panel.

3.14 Closed Pressurised Expansion Tank

3.14.1 Closed expansion tank shall be of minimum 500 liter capacity (unless otherwise required because of system design requirement)

3.14.2 The closed expansion tank will be of M.S. construction (finished with EPOXY coating) of 6 mm thick with interchangeable EPDM-BUTYL rubber membrane. The expansion tank shall be complete with safety relief valve, pressure reducing valve and pressure gauge.

3.14.3 The tank will be of pressure rating to suit the system pressure and will be sized to adequately compensate for water expansion due to operating temperature variations. The tank shall be fabricated as per IS 2825-1969 for "non-fired pressure vessels" and the flanges shall be as per IS 6392-1971.

3.14.4 For chilled water application, it will be insulated with 32mm thick insulation to the specifications and cladded with 26G-aluminium cladding.

3.14.5 The expansion tank shall be supplied along with pressurization unit. The pressurization unit shall consist of two nos. (one working + one stand by) high pressure pumps of suitable pressure rating mounted on M.S. frame, complete with interconnecting piping, isolation valves, NRV, Y-strainer, pressure gauge, pressure transmitter, auto-logic panel (IP 55) with dry-run protection, electrical MCB and interconnecting wiring.

3.14.6 The unit shall be housed in powder-painted canopy suitable for external installation, if required.

3.14.7 Tank shall have rigid supporting arrangement of structural steel per IS-2062/ASTM A 36.

3.15 Plant Room Ventilation

3.15.1 A.C. Plant room shall be ventilated by wall mounted exhaust fan(s) complete with electric motor, louver shutter and galvanised expanded wire-mesh protection guard on intake side of exhaust fans.

3.15.2 The capacity shall be decided based on 15 air changes per hour.

3.15.3 In case of air intake through wall, weather protection louvers along-with bird protection screen shall be provided with suitable structural steel frame in wall.

3.16 Air Distribution, Ducting, Diffusers / Grilles

3.16.1 Ducts shall be designed, fabricated and flanged as per IS-655 for static pressure up to 65 mm WG. In case, static pressure is more than 65 mm WG, SMACNA code shall be followed for design and fabrication of duct.

3.16.2 Ducts shall be fabricated using GI sheets having minimum 120 g/m^2 of zinc coating.

3.16.3 Duct hangers shall be supported with anchor fasteners in the roof. Anchor fasteners shall be provided by vendor.

3.16.4 All flange joints shall have 6 mm thick Neoprene packing as gasket stuck to the flanges with adhesive (viz., resins like araldite or equivalent).

3.16.5 All the duct shall be made air tight with the help of sealant. Leak test shall be conducted on the duct before insulation.

3.16.6 Ductwork shall be provided with following accessories.

- Turning Guide Vanes.
- Extractor with operating lever (if required).
- Volume control Damper in main and branch duct (opposed bladed type with 18 gauge 150 mm wide blades and 16 gauge casing of GSS).
- Fire resistant flexible connection between duct chute and diffuser (if required).

- Access doors for heaters, fire & smoke dampers and filters.

3.16.7 Supply air diffusers shall be provided and shall be fitted with sponge foam tape. Grilles/linear grilles may be used for supply if considered essential during detailed engineering subject to approval of owner/consultant. Volume control damper shall be provided with each supply air diffuser/grille. Volume control damper shall be key operated from the front of diffuser/grille. Supply air grilles shall be provided with vertical & horizontal adjustable louvers.

3.16.8 All return air diffusers/grilles, if required, shall be without volume control damper.

3.16.9 Diffusers shall be with outer frame of extruded aluminium for gypsum ceiling and stamped aluminium for grid ceiling. The inner core shall be of stamped aluminium. The diffuser finish shall be powder coated as per required colour shade.

3.16.10 Grilles shall be fixed bar type with extruded aluminium bar and aluminium angle frame. The grille finish shall be powder coated / anodized.

3.16.11 Diffusers/grilles shall not be supported from False Ceiling.

3.16.12 Both horizontal branch and low-pressure ducts shall be designed by the "Equal Friction" method with a pressure drop less than 2.5 mm WG/30 m. Duct velocity shall not exceed 9.2 m/sec for main supply air duct and 66% of supply duct air velocity for return air duct. For branch ducts leading to diffusers, velocity shall be restricted to 5.1 m/sec. Booster fan shall be provided if static pressure conditions by AHU/Package Unit blower are not met.

3.16.13 All outlets / diffusers shall be designed with a terminal velocity not exceeding 3.0 m/sec. Manufacturers' published data shall be taken into account for proper air throw/distribution, noise, and pressure drop. Selection must be made to ensure sound levels below NC 35. Sound attenuators shall be installed in ducts, as required.

3.16.14 Transition sections should be constructed such that the included angle for a converging section is less than 15 degrees and for diverging section, less than 10 degrees. When space limitations require transitions using larger angles, guide vanes shall be installed in the transition (except for fan discharge). Duct transition through fire rated wall should not impair the rating of wall.

3.16.15 Duct work shall be suitably supported with a maximum spacing of 2.0 meter. Hangers shall be provided for all fittings.

3.16.16 All damper linkage arrangement (automatic/manual) shall be of SS-304 material.

3.17 Insulation

3.17.1 The application, insulation material and recommended thickness are summarised in APPENDIX 1

3.17.2 The surfaces to be insulated shall be thoroughly cleaned and allowed to dry. Leak test shall be carried out before insulation.

3.17.3 **Hot Insulation**

3.21.2.1 Insulation is not desired for piping and equipment for which heat loss is desired except for personnel protection and to avoid thermal stress problem. Bare surfaces of pipe/equipment shall be provided with one coat of 20 micron min. (dry film thickness) heat resistant primer up to 120°C operating temperature. Insulation for personnel protection is applicable where exposed surface temperatures exceed 65°C in normal and short term operating conditions.

3.21.2.2 The material for hot insulation shall be flexible silica-aerogel (mineral fibre) blanket compliant to ASTM C 1728, Type III, Grade 1A or Equivalent Standard with thermal conductivity of not more than 0.024 W/mK at mean temp of 24 deg C as per ASTM C 177 or Equivalent Standard. The density of the material shall be 160 – 240 Kg/m3.

3.21.2.4 Hot insulation shall be cladded with 26 SWG aluminium sheeting.

3.21.2.5 The hot insulation installation procedure for pipes shall be as per APPENDIX 2

3.17.4 **Cold Insulation**

3.17.4.1 The cold insulation shall be provided for Ducts, Pipes, Suction Line, Pumps and Expansion Tank etc. The insulation material shall meet the following requirements:

i) Closed Cell Flexible Elastomeric Foam Nitrile Rubber based Insulation complying to EN 14304/ASTM C518-15 or Equivalent Standard with thermal conductivity not to exceed 0.037 W/m-K at 20°C mean temperature differential tested as per EN 12667 / EN ISO 8497 or Equivalent Standard.

ii) Water vapor diffusion resistance (μ) not less than 7000 minimum for the plain material without any vapor barrier like aluminium foil etc.

iii) Density of the nitrile rubber shall be between 40-60 Kg/m3, The product shall have temperature range of -40^0C to $+105^0$C.

iv) Fire rated for Class 0 as per BS 476 Part 6:1989 for fire propagation test and for Class 1 as per BS 476 Part 7, 1987 for surface spread of flame test.

v) Tested for Smoke Toxicity and Smoke Density

vi) CFC / HCFC free.

3.17.4.2 Nitrile Rubber with single side factory laminated 12 micron (minimum) thick Aluminum foil.

3.17.4.3 For Exposed ducts (without false ceiling or exposed to open atmosphere) extra cladding with 26 SWG aluminum sheeting.

3.17.4.4 The Cold insulation installation procedure for Pipes shall be as per APPENDIX 3.

3.17.4.5 Duct Insulation Installation Procedure shall be as per APPENDIX 4

3.17.5 **Acoustic Insulation**

3.17.5.1 Duct acoustic insulation shall be provided on the inner surface of ducting for a minimum distance of 6 m from AHU / Package/ Precision Air-conditioning Unit outlet.

3.17.5.2 Thickness of the acoustic insulation inside the duct shall be minimum 15mm. The insulation material shall meet the following requirements:

i) Duct liner material shall be Flexible Elastomeric Nitrile Rubber Open Cell Engineered Foam with a density between 140 - 240 Kg/m^3 with thermal conductivity not to exceed 0.047 W/m-K at 20 Deg C mean temp as per EN12667 or Equivalent Standard having Class 1 Fire Performance as per BS 476 Part 7 and tested as per UL 94

ii) Noise Reduction Coefficient should not be less than 0.48 for 15mm Thickness as per ASTM or Equivalent Standard.

iii) In-built resistance to fungal growth and bacterial growth.

iv) Operating temperature range of -20 deg C to +85 deg C as per ISO/EN/BS Standard.

v) Acoustic Lining (Inside The Duct) Installation Procedure shall be as per APPENDIX 5

3.18 Controls And Instruments

3.18.1 Vendor shall include all controls & instruments as required for safety & operational requirements of the plant.

3.18.2 Main HVAC Control Panel

3.18.2.1 Automatic operation of all controls, wherever feasible, is required, with manual overdrive for maintenance etc. The "Manual/Off/Auto" select switch shall be located on the front of HVAC Control Panel. The "Auto" mode means that HVAC equipment are controlled by a standalone PLC/Microprocessor based HVAC control panel/DDC (Direct Digital Controller). The "Manual" mode shall be used only for testing purpose & manual operation & control of HVAC system.

3.18.2.2 Electric duct heaters shall be controlled in one or more steps by the return air temperature and interlocked with the flow switch installed on each electric duct heater so that electric duct heater can not be operated without the supply air flow. An automatic reset thermal cut-off shall stop the electric duct heater when the high limit temperature is reached. Electric duct heater shall restart automatically when the related return air temperature drops below the setting point.

3.18.2.3 Humidistat shall also be provided for monsoon reheat control. One humidistat shall activate the electric heaters (reheat) in case the space humidity rises beyond the preset limit. Another humidistat shall energize the humidifier when the humidity falls below the preset limit. These humidistats shall also de-energize these devices when the desired humidity is reached. Humidifier heaters shall be actuated by humidistat located in return air duct.

3.18.2.4 Monsoon re-heaters /winter heaters shall operate only on running of Package AC / AHU blower.

3.18.2.5 Potential free contact shall be provided by vendor for closing of fire & smoke dampers and simultaneously tripping the AHU/Package AC blower motor on receiving the fire/smoke alarm signal from relevant Fire & Gas Panel.

3.18.2.6 On expiry of fire signal, fire & smoke dampers shall be opened manually through reset button.

3.18.2.7 Upon receiving of a gas high alarm signal from the relevant fire and gas panel, outdoor air intake into the building shall be shut off automatically. Also upon receiving of a gas high high alarm signal from the relevant fire and gas panel, all HVAC system shall be automatically shut down.

3.18.2.8 Potential free contact shall be provided in control panel for duplication of alarm in Purchaser's main panel. The necessary wiring beyond this contact shall be done by Purchaser.

3.18.2.9 Supply air fan of AHU/Package AC & chemical filter unit (if required) shall be started from the HVAC control Panel. If standby fan is provided, standby fan shall be change over automatically by the failure signal of the running fan.

3.18.2.10 Units shall be equipped with automatic switchover as per planned operation sequence.

3.18.2.11 **Special requirement for Central Air-conditioning System :**

i) All controls shall be suitably interlocked for safe & sequential operation of plant generally in the following order:

a) Start AHU blower.
b) Start cooling tower fan.
c) Start Condenser water flow /condenser fan.
d) Start Chilled water pump.
e) Start Refrigeration unit/chiller

While shutting down the plant, equipment will stop in the reverse order as listed above.

ii) Chilled water circulation pumps shall be started manually or automatically at HVAC control panel in the sequence as stated above. The standby chilled water circulation pump(s) shall be changed over automatically by the failure signal of the running chilled water pump(s).

iii) Flow control valve at chilled water coil with modulating temperature controller shall be controlled by return air temperature.

iv) Flow meters in chilled water and condenser water lines with signal to control panel shall be provided. Temperature and Pressure Gauges in inlet and outlet of cooling water and chilled water shall also be provided locally. Chilled water temperature shall be maintained constant at chiller outlet, the control for the same shall be provided accordingly.

3.18.2.12 **Special requirement for Packaged Air-conditioning System :**

1) The standby Packaged Unit shall be changed over automatically by the failure signal of the running Packaged Unit.

2) Flow meters in condenser water outlet lines (for water cooled systems) with signal to control panel, temperature and Pressure Gauges in inlet and outlet of cooling water shall be provided locally.

3) Calibration of all instruments shall be done by Vendor.

4) Pressure gauges shall be provided with bleed and block valves.

3.18.3 **Machine Control Panel**

3.18.3.1 Control panel shall consist of indications, controls and annunciation.

3.18.3.2 The control panel shall be fully wired and factory tested before dispatch. The Control panel shall contain at-least the following control for the automatic operation of chilling unit.

i. Compressor capacity control device.
ii. Start/stop push button station for the machine.
iii. Automatic temperature controller for oil temperature and chiller water temperature.

3.18.3.3 **Requirements for Reciprocating or Scroll Chiller / Condensing Units**

3.18.3.3.1 Control Panel shall be either machine mounted or floor mounted as per manufacturer's standard and shall provide the following indications as a minimum:

i. Suction & Discharge Pressure indicator.
ii. Lubricating oil pressure indicator.
iii. Oil temperature indicator.
iv. Chilled water in & out temperature indicator
v. Condenser cooling water in & out temperature (in case of water cooled condenser) indicator
vi. All safety interlocks

3.18.3.3.2 Control panel shall have protection against following situation as a minimum:-

i. Low chilled water temperature
ii. High Condenser Pressure
iii. Low lube oil pressure
iv. Low Evaporator Pressure
v. Low/No chilled water flow
vi. Low condenser cooling water flow
vii. Overload protection for all motors.
viii. Sensor Failure/Diagnostics

3.18.3.4 **Requirements for Centrifugal Chiller Package**

3.18.3.4.1 Control Panel shall be either machine mounted or floor mounted as per manufacturer's standard and shall provide the following indications as a minimum:

i. Suction & Discharge Pressure indicator.
ii. Lubricating oil pressure indicator.
iii. Oil temperature indicator.
iv. Chilled water in & out temperature indicator
v. Condenser cooling water in & out temperature (in case of water cooled condenser) indicator
vi. Vane opening indicator calibrated in percent
vii. All safety interlocks

3.18.3.4.2 Control panel shall have protection against following situation as a minimum:-

i. High condenser pressure.
ii. Low lube oil pressure.
iii. High bearing temperature for compressor.
iv. Low evaporator pressure.
v. Low/No chilled water flow.
vi. Low condenser cooling water flow
vii. Overload protection for all motors.
viii. Low chilled water temperature.
ix. High lube oil temperature to cut off heater supply.
x. High Compressor discharge temperature.
xi. Low Compressor discharge temperature.
xii. Oil Filter differential pressure.
xiii. To ensure opening of inlet guide vanes after compressor motor has stabilized.
xiv. To ensure close guide vanes at start-up.
xv. Sensor Failure/Diagnostics

3.18.3.5 **Requirements for Screw Chiller Package**

3.18.3.5.1 Control Panel shall be either machine mounted or floor mounted as per manufacturer's standard and shall provide the following indications as a minimum:

i. Suction & Discharge Pressure indicator.
ii. Lubricating oil pressure indicator.
iii. Oil temperature indicator.
iv. Chilled water in & out temperature indicator
v. Condenser cooling water in & out temperature (in case of water cooled condenser) indicator
vi. All safety interlocks

3.18.3.5.2 Control panel shall have protection against following situation as a minimum:-

i. High condenser pressure
ii. Low lube oil pressure.
iii. High bearing temperature for compressor motor.
iv. Low/No chilled water flow.
v. Low evaporator pressure
vi. Low condenser cooling water flow.
vii. Overload protection for all motors.
viii. Low chilled water temperature.
ix. High lube oil temperature to cut off heater supply.
x. High Compressor discharge temperature.
xi. Low Compressor discharge temperature.
xii. Oil Filter differential pressure.
xiii. To ensure minimum position of slide valve at start-up.
xiv. Sensor failure/Diagnostics

3.18.3.6 **Requirements for Packaged Air-conditioning Units**

3.18.3.6.1 Control Panel shall be either machine mounted or floor mounted as per manufacturer's standard and shall provide the following indications as a minimum:

i. Suction & Discharge Pressure indicator.
ii. Condenser cooling water in & out temperature (in case of water cooled condenser) indicator
iii. All safety interlocks

3.18.3.6.2 Control panel shall have protection against following situation as a minimum:-

i. High Condenser Pressure
ii. Low Evaporator Pressure
iii. Low condenser cooling water flow (in water cooled system)
iv. Overload protection for all motors.
v. Sensor Failure/Diagnostics

3.18.3.7 **For VAR System, EIL Standard Specification no. 6-36-0007 shall be followed.**

3.18.4 **Audio-visual Annunciation Panel**

3.18.4.1 It shall consist of facia type Annunciators having translucent plastic window of 35 mm x 50 mm (min.) size engraved with appropriate function in block letters for each alarm trip point. Annunciators shall be suitable for operation on 24V D.C. and shall have a single alarm buzzer common to all points. Three push buttons for audible alarm acknowledge, reset and test with appropriate name plates shall be provided common to all alarm points.

Annunciators shall be solid state type of reputed make. Annunciators shall operate satisfactorily between 80 and 110% of rated supply voltage. Annunciators may be a part of HVAC control panel itself.

3.18.4.2 Annunciators shall be provided for all faults (as applicable for the system) covering atleast the following:-

i. Low oil pressure.
ii. Low chilled water flow.
iii. Low condenser cooling water flow.
iv. Low chilled water temperature
v. Low evaporator pressure.
vi. High condenser pressure.
vii. Compressor motor overload.
viii. Low water level in humidifier tank.
ix. Chilled water pump motor over load.
x. Condenser cooling water pump motor over load.
xi. Air handling unit motors overload.
xii. Cooling tower fan motors overload.
xiii. Treated water pump motors overload (in case water softening plant is furnished).
xiv. Crankcase heater.
xv. Open/close position of fire/smoke dampers.
xvi. Water Chiller/Air-conditioning unit status-Run/Stop.
xvii. Fresh Air fan(Chemical Filter Unit) status-Run/Stop.
xviii. AHU fan status-Run/Stop.
xix. Chilled water pumps(s)-Run/Stop
xx. Auto change-over of standby pump, fan & air-conditioning unit
xxi. Any other as necessary.

In the event of a fault, the particular window shall glow and the window will remain lighted till the fault is rectified.

Minimum 20% spare windows shall be provided on annunciator.

3.19 Specific Requirements for Offshore Applications

3.19.1 The system shall be centralized chilled water type with the chilled water circulating in a closed-loop through the Air handling units. The required pressure in the air conditioned areas shall be maintained by pneumatically controlled purge/exhaust dampers through pressure switches.

3.19.2 **Standard Operating Cycle: -** As a standard operating cycle, the system is to maintain a space pressurisation of minimum 5.0 mm WG by modulation of the outside air and relief dampers unless specified otherwise. In air-conditioned areas, pressurization takes a foremost role. If one fan of AHU fails, the standby fan should be energized automatically, and the outlet damper of the failing fan shall automatically close.

3.19.3 **Purge Cycle: -** A purge cycle of the air-conditioned space shall occur upon start up and upon a loss of pressurization (less than 3.0 mm WG). To purge the pressurized space of undesirable air, the fresh air damper should be full open. During the purge cycle return air damper of air conditioning system shall be in closed position. The remote purge dampers will fully open to exhaust the purge air. This cycle should operate a minimum of 5 air changes per hour to assure a complete purge. In such a situation air conditioning becomes non critical. Humidity and temperature control are not necessarily maintained during the purge cycle. Purge cycle switching shall be automatic.

3.19.4 Non explosion proof electrical equipment shall be energized only after the purge cycle is complete.

3.19.5 All air conditioned areas (other than spot-cooled) shall have minimum three (3) fresh air changes/hour besides the air lost through exhausted areas. In addition to AHU blowers, fresh air fans shall be installed to meet the fresh air requirements. Necessary filtration arrangement with coalescer filters shall be provided at fresh air intake. All intakes and exhausts shall be protected with weather covers and removable 12.5 mm mesh screen and adjustable louvers etc. of corrosion resistant material. Suitable provision shall be made for installation of gas detectors at the outside air intake ducts.

3.19.6 The fresh air consideration for heavy occupancy areas shall also be cross-checked from human-occupancy considerations as per ASHRAE norms.

3.19.7 Fresh air requirements shall be based on the worst of above considerations.

3.19.8 The fresh air intake (through necessary filtration arrangement) shall be taken from safe areas. Air intake in all cases shall be away from exhausts. Safe areas for this purpose would be considered as minimum 3.0 m away from the edge of platform or 7.6 m away from the nearest source of hazard, whichever is more.

3.19.9 For dining room, Kitchen, laundry, TV room, Recreation room and Tea room, ASHRAE norms and heat dissipation details to be considered, keeping in view the equipment/appliances located in these areas.

3.19.10 Toilet room / washroom (laundry) areas shall be spot cooled and inside condition shall be exempted from guarantee. Return air shall not be taken from kitchen, dinning hall, toilets, washrooms, laboratories and battery charger room etc.

3.19.11 Besides air conditioning, toilets & wash rooms shall be provided with exhaust fans designed for 12 air changes per hour and the area shall be maintained on a slightly negative pressure so that any obnoxious / foul smell does not get transmitted to the adjoining air conditioned spaces, but instead it is vented off. Air from Corridor/ Room shall be sucked in and vented through toilets.

3.19.12 All skid mounted equipment located outside pressurised areas shall be suitable for operation in a hazardous area as defined by Class 1, Zone 2, Gas Group II A, II B, Temperature Class T3 as per IEC and Category B of the Air Moving and Conditioning Association. Building interiors shall be considered unclassified or safe after purging and pressurisation. All rotating equipment shall be of spark-proof construction.

3.19.13 All equipment of Air Conditioning, Ventilation and pressurisation plant, installed outdoor, shall be capable of withstanding the corrosion and other deleterious effects of a saliferous, humid environment.

3.19.14 There shall be 100% standby for chilled water package(s). Each package shall comprise compressor, driver, chiller, air cooled condenser and associated hook-up piping, fittings and valves etc. Condenser fans shall have their independent motors. Condenser shall be mounted to discharge hot air horizontally, away from the platform. The number of working units shall be decided such that the compressor motor rating does not exceed the purchaser's acceptable KW limit for LT motor.

3.19.15 Condenser shall be air cooled by electric motor driven fans having direct drive. If located in hazardous area, fans shall be of spark-proof construction as per AMCA category B. Condenser coils shall be constructed of Copper Tubes Electrotinned and Copper Fins Electrotinned. Heresite coated coils will also be acceptable, if this is vendor's standard proven design. Impeller shall be of cast aluminium bronze/high tensile brass. To minimize

the noise, only low rpm (preferable750 rpm) fan shall be used. Condenser fan wire guard shall be of SS-304 material.

3.19.16 Heat transfer areas for Condenser Coils and evaporator tubes shall have minimum 10% margin over and above the calculated surface areas required (This shall be over and above the safety margin taken for sensible and latent heat in heat load calculations)

3.19.17 AHU shall be equipped with two nos. (1 working + 1 standby) centrifugal, double inlet double width (DIDW) type blowers each of 100% capacity, mounted within the fan section of the AHU. The working and the standby fans within the AHU shall be isolated by providing separate chambers with pneumatic dampers on the chamber suction and back draft damper at blower outlet to prevent short circuit of air flow, as well as to facilitate the maintenance of one blower while the other is working. Air flow switch shall be provided at outlet of the blower to sense the pressure and the blower shall be interlocked such that in the event of one blower failing the respective pneumatic damper at the suction shall close and the other blower shall start with pneumatic damper open automatically so as to maintain the desired pressure in the system. In the event of failure of the air conditioning system, the operating blower would continue to run to maintain the specified positive pressure. AHU casing shall be minimum 50 mm thick double skin construction with 1.5 mm thick SS-316L outer sheet and 1.0 mm thick SS-316L inner sheet with thermal insulation sandwiched in between to prevent casing deformation, and coil face velocity shall not be more than 2.5 m/s. Cooling coils are to be chilled water type constructed of Copper Tubes Electrotinned with externally bonded Copper Electrotinned Fins.

3.19.18 All automatic modulating dampers and fire dampers shall be pneumatically operated.

3.19.19 Fire dampers shall be automatic, fail safe type (i.e. damper shall automatically close by spring action in case of failure of pneumatic air supply) and shall operate pneumatically.

3.19.20 All sheet metal duct work shall be constructed of tested quality Stainless Steel (SS-304) sheets. All ductwork and thickness shall be as per SMACNA.

3.19.21 Insulation of chilled water piping, ducts and equipment for offshore applications shall be covered with SS-304 0.25 mm thick cladding. This shall supersede insulation cladding material specified in clause 3.21.2.4, 3.17.4.2 & 3.17.4.3

3.19.22 Material of construction of major HVAC equipment shall be as follows. All other items shall be as per manufacturer's standard design suitable for outdoor saliferous and humid environment of an offshore platform.

Equipment	M.O.C.
Condenser Tubes	Copper with electro tinning/Copper with Herisite coating if vendor's proven standard design
Condenser Tubes fins	Copper with electro tinning/Copper with Herisite coating if vendor's proven standard design
Condenser Casing	SS-316L
Condenser fan casing	SS-316L
Condenser fan Impeller	Cast Aluminium Bronze/High tensile brass
Chiller Tubes	Copper ASTM-B-111
AHU Cooling Coil Tubes/Fins	Copper with electro tinning
AHU Casing	SS-316L
AHU and ventilation fan Impellers	Steel epoxy coated with brass ring/lining for spark proof design/Aluminium Bronze Blades
Fan Shafts	SS-304

Equipment	M.O.C.
AHU Filters	SS Mesh
Filter Casing	SS-304
Chilled Water Pump	
- Shaft	SS-304
- Shaft Sleeve	Al. Bronze ASTM # B111
- Casing	Cast Iron ASTM#A159
- Impeller	Cast Bronze ASTM # B 584
- Impeller Key	SS304
- Wearing Ring	Bronze
Refrigerant Piping	Cu / Cu-Ni
Grilles/Diffusers	Zn Electroplated or Heavy gauge anodised aluminium
Duct material	SS-304
Insulation on ducts	Fiber Glass
Insulation Cladding	SS 304 0.25mm thk
Chilled water pipe, fittings & valves	As per project Piping Material Specification
Instrument Air Tube	SS-316
Structural Steel	ASTM-A-36 or IS-2062 Grade-A
Expansion Tank	SS-304
Damper Casing	SS-304
Damper Bush	Bronze
Damper shaft and other operating linkages	SS-304

3.19.23 **Instrumentation, Controls and Electrical Work**

3.19.23.1 Control System for HVAC shall be PLC (Programmable Logic Controller) based. Vendor shall supply PLC based control system, software and hardware for meeting the requisite functional requirements. PLC based HVAC control panel shall be interfaced to platform safety shut down system encompassing (fire & gas) detection system. HVAC control panel shall also provide repeat indication for critical parameters for further wiring by contractor to the platform control room for remote monitoring.

3.19.23.2 Electric Heaters shall be U.L. listed.

3.19.23.3 The Vendor shall also provide all necessary pressurization control equipment. This shall consist of room mounted, low differential pressure sensors, with panel mounted controllers for 0-100% modulation of respective pneumatic dampers. The Vendor shall also provide the pneumatic actuators with complete mounting kit. Dial type gauges shall be provided to show over pressure (5 mm WG) inside air-conditioned space.

3.19.23.4 The chilled water system shall be provided with panel mounted on/ off/ auto and duty/ standby selector switches. The pump packages shall be provided with a differential pressure switch to automatically changeover to the standby pump on duty pump failure.

3.19.23.5 On pump start the chiller may enter its start time sequence from its own integrated control system which shall include flow switches and low water temperature cut out switches mounted in the chilled water line on the skid. These shall be interlocked to the compressors to prevent start up or cause shutdown due to no flow or low temperature.

3.19.23.6 **Control Panel**

Control panels shall be suitable for the area classification in which they are located as specified elsewhere.

4.0 INSPECTION AND TESTING

Equipment shall be subjected to expediting, inspection and testing at vendor's/sub-vendor's Works by Purchaser/its authorised inspection agency. Vendor shall perform tests and inspection necessary to ensure that the material and workmanship conform to the requirement of this specification. Vendor shall submit Quality Assurance (QA) plan before commencement of fabrication. Approved QA plan shall form the basis for equipment inspection. Following equipment/items shall be subject to inspection/test at works as a minimum:

i. Package AC units shall be subjected to Type Test as per applicable Indian Standard, Production Routine Test as per approved QAP.
ii. Condensing units shall be subjected to Type Test as per applicable Indian Standard, Production Routine Test as per approved QAP.
iii. Vapour compression chiller units shall be subjected to Acceptance Test as per ARI-550/590, Production Routine Test as per approved QAP.
iv. Mechanical Run test of AHU at shop for 30 minutes – one of each type and size.
v. Other items, equipment shall be inspected/ tested at shop as per approved QAP.
vi. For VAR System, EIL Standard Specification no. 6-36-0007 shall be followed.

4.1 For Inspection and Testing at Site, vendor must perform all inspection and tests of the system as a whole and of components individually as required, in accordance with the provisions of the applicable ASHRAE standards. Vendor shall comply with the following procedures:

i. Inspection of raw materials to be used for fabrication and assembly and inspection of manufacturer's test certificates.
ii. Inspection of welding including welder's qualification as desired by inspection engineer. Inspection of fabricated items.
iii. Pressure testing of pipe fit ups for refrigerant (Pneumatic test with dry nitrogen) and water services (hydro test).
iv. Pressure testing, leak testing of complete piping network for chilled water/brine, condenser water & refrigerant services (helium leak test, for details refer clause-3.15.2).
v. Inspection of air distribution system for proper location and installation against design drawings. Inspection of ducting supports, its location. Leak testing of ducting system before application of insulation.
vi. Inspection of duct insulation for its material, thickness and finish.
vii. Balancing of air distribution system to obtain the air quantities across various air terminals as called for in the engineering drgs.
viii. Noise level test for various rotating/reciprocating equipment.
ix. Checking of electrical circuits (Power and control) and checking functioning of controls of refrigerant system and other circuits of air conditioning plant.
x. Checking of assemblies for MCC, control panel, local panel, annunciation panel etc.
xi. Checking of calibration of controls and instrumentation.
xii. Inspection of complete electrical installation at site and clearance from local authorities.
xiii. Installation of main equipment like compressor, condenser, chiller, evaporator, AHU etc.

NOTE:

Inspection & testing procedure mentioned above is for general guidance & information of vendor and inspection by purchaser/consultant is strictly not limited to these. Inspection engineer of Purchaser/consultant will have full right to have detailed inspection of project as desired by inspection engineer. Co-ordination of inspection agency of purchaser/consultant with his factory/erection site will be sole responsibility of successful

vendor after placement of order for complete air conditioning plant covered under these specifications.

4.2 For VAR System, Standard Specification no. 6-36-0007 shall be followed.

4.3 Any or all the tests, at Purchaser's option, shall be witnessed by Purchaser/its authorised inspection agency. However, such inspection shall be regarded as check-up and in no way absolve the vendor of his responsibility.

4.4 Performance Testing and Guarantees

4.4.1 **Performance Testing**

4.4.1.1 Vendor shall give three seasonal tests for (i) summer, (ii) monsoon & (iii) winter to determine the equipment capacity and performance of the system in accordance with applicable Standards. Period of each test shall be at least 72 hours and time for each test will be fixed up mutually with the Purchaser.

4.4.1.2 The vendor shall operate, test and adjust all equipment and balance the system.

Following test readings shall be recorded during the performance testing (For VAR System, EIL Standard Specification no. 6-36-0007 shall be followed):

Test Readings

1. **Compressor (for VCR Chiller / Condensing Units)**

Refrigerant gas suction pressure	(kg/cm^2 g)
Refrigerant gas suction Temperature	(^0C)
Refrigerant gas discharge Pressure	(kg/cm^2 g)
Refrigerant gas discharge Temperature	(^0C)
Operating speed	(RPM)
Power consumption at 100% load and at each step of capacity regulation.	

2. **Evaporator (for chilled water system only)**

Refrigerant liquid temperature at inlet	(^0C)
Refrigerant Gas suction pressure	(kg/cm^2 g)
Refrigerant Gas suction Temperature	(^0C)
Water flow rate	(m^3/hr.)
Water temperature - entering	(^0C)
Water temperature - leaving	(^0C)
Water pressure - entering	(kg/cm^2 g)
Water pressure -leaving	(Kg/cm^2g)

3. **Condenser**

Refrigerant gas temperature at inlet	(^0C)
Refrigerant condensing pressure	(kg/cm^2 g)
Refrigerant liquid temperature at outlet	(^0C)
Air/Cooling Water flow rate	(m^3/hr.)
Air/Cooling Water temperature - entering	(^0C)
Air/Cooling Water temperature - leaving	(^0C)
Cooling Water pressure – entering	(kg/cm^2 g)
Cooling Water pressure - leaving	(kg/cm^2 g)

4. **Water Pump**

Flow rate	(m^3/hr.)
Discharge pressure	(kg/cm^2 g)
Suction pressure	(kg/cm^2 g)

	Operating speed	(rpm)
5.	**Air handling unit**	
	Refrigerant liquid temperature at inlet to coil	(^{0}C)
	Air temperature – entering (D.B)	(^{0}C)
	Air temperature – entering (W.B)	(^{0}C.)
	Air temperature – leaving (D.B)	(^{0}C.)
	Air temperature – leaving (W.B)	(^{0}C)
	In case of chilled water coils:	
	Water pressure - entering coil	(kg/cm^2 g)
	Water pressure - leaving coil	(kg/cm^2 g)
	Water Temperature - entering cool	(^{0}C)
	Water Temperature - leaving coil	(^{0}C)
	Blower air flow	(m^3 /hr.)
	Blower Speed	(RPM)
	Blower Static/Total Pressure	(mm WC)
	Blower outlet velocity	(m/s)
	Direction of rotation	CW/CCW
	Velocity of air across various components of air handling unit.	
6.	**Electric motor**	
	Starting current/No load current	(A)
	Motor terminal current	(A)
	Power factor	
	Supply voltage	(volts)
	kwh for compressor motor	
7.	**Supply Air Grilles/ Diffusers**	
	Air flow rate	(m^3 /hr.)
	Air temperature (D.B)	(^{0}C)
	Air temperature (W.B)	(^{0}C)
8.	**Room conditions**	
	D.B.T	(^{0}C)
	W.B.T	(^{0}C)
	Differential Pressure with respect to atmosphere/adjacent area (for pressurized area)	(mm of WC)

4.4.1.3 Vendor shall bring all required testing instruments at site duly calibrated. Plant shall be formally taken over by purchaser after witnessing the seasonal performance tests successfully.

4.4.2 **Guarantees**

The vendor guarantees that all equipment and accessories shall meet the design and operating conditions throughout the year, as specified in this specification and Job Specification/Data Sheet.

5.0 PROTECTION AND PAINTING

5.1 All exposed carbon steel parts to be painted shall be thoroughly cleaned from inside and outside to remove scale rust, dirt and other foreign materials by wire brushing and shot/grit blasting as applicable.

5.2 Non-ferrous materials, austenitic stainless steels, plastic or plastic coated materials, insulated surfaces of equipment and pre-painted items need no painting.

5.3 Stainless steel surfaces, both inside and outside, shall be pickled and passivated.

5.4 Machined and bearing surfaces shall be protected with varnish or thick coat of grease.

5.5 Painting shall be done as per manufacturer's standard painting suitable for corrosive industrial/ marine environment unless otherwise specified in the Job Specification.

5.6 The colour of finish coat shall be intimated to vendor, after placement of order.

6.0 PACKAGING AND IDENTIFICATION

6.1 All packaging shall be done in such a manner as to reduce the volume. The equipment shall be dismantled into major components, suitable for shipment and shall be properly packed to provide adequate protection during shipment. All assemblies shall be properly match marked for site erection.

6.2 Attachments, spare parts of the equipment and small items shall be packed separately in wooden-cases. Each item shall be appropriately tagged with identification of main equipment, item denomination and reference number of the respective assembly drawing.

6.3 Detailed packing list in water-proof envelope shall be inserted in the package together with equipment.

6.4 Each equipment shall have an identification plate giving salient equipment data, make, year of manufacture, equipment number, name of manufacturer etc.

6.5 Vendor shall furnish procedure for prolonged site storage of supplied equipment/material.

7.0 SPARE PARTS

7.1 Vendor shall submit list of spare parts with recommended quantities and itemised prices for first two years of operation of the equipment. Proper coding and referencing of spare parts shall be done so that later identification with appropriate equipment is facilitated.

7.2 Recommended spares and their quantities should take into account related factors of equipment reliability, effect of equipment downtime upon production or safety, cost of parts and availability of vendor's service facilities around the proposed location of equipment.

7.3 Vendor shall supply adequate quantity of commissioning spares. The commissioning spares shall be sufficient for trouble free commissioning of the system at site. Any commissioning spares required during commissioning, over and above, the commissioning spares supplied, shall be made available by the vendor without any cost and time implication to purchaser. If for any reason, during commissioning, vendor needs to utilise spares from 2 years' operation spares (if already available at site), the same shall be replenished by vendor within a reasonable time without any cost implication to purchaser. Any unused commissioning spares shall be handed over to owner.

7.4 Vendor shall supply the Mandatory spares as listed in Job Specification.

8.0 SPECIAL TOOLS & TACKLES

Vendor shall provide one set of following special tools & tackles as a minimum for operation & maintenance along-with each Air-conditioning plant.

S.NO.	DESCRIPTION	QTY.
1.	Flaring Tools up to 3/4" (19 mm) Size	One Set
2.	Gas Charging manifold with Cylinder Adopter	One Set
3.	Halide Leak Detector	One
4.	Digital Psychrometer	One
5.	Pressure Gauge 0-300 PSI and Compound Gauge 30" Vacuum-150 PSI for Refrigerant Line	One Set
6.	Digital Anemometer	One

APPENDIX 1

INSULATION MATERIAL AND THICKNESS

S. No.	Application	Insulation Material (Density)	Form	Thickness
1	Supply Air Duct	Closed Cell Flexible Elastomeric Nitrile Rubber (40-60 kg/m^3)	Sheets	32 mm
2	Return Air Duct	-Do-	-Do-	13 mm
3	Supply Duct exposed to Return Air (i.e. Return Non-Ducted)	-Do-	-Do-	19 mm
4	Outdoor Exposed Supply Duct	-Do-	-Do-	50 mm
5	Outdoor Exposed Return Duct	-Do-	-Do-	25 mm
6	Refrigeration Piping	-Do-	Tubes upto 100 mm and Sheets for above 100 mm	a) **32 mm** (For NB Dia upto 25 mm) b) **38 mm** (For Pipes above 25 mm NB Dia upto 65 mm NB Dia) c) **44 mm** (For Pipes above 65 mm NB Dia upto 150 mm NB Dia) d) **50 mm** (For Pipes above 150 mm NB Dia)
7	Chiller Water Piping, Valves			
8	Chilled water pumps	-Do-	-Do-	Same as connecting Pipes
9	Expansion tank	-Do-	Sheets	32 mm
10	Chiller	-Do-	-Do-	32 mm
11	AHU Drain pipe	-Do-	Pipe Section	a) **13 mm** (For Pipes Upto 50 mm NB Dia) b) **19 mm** (For Pipes above 50 mm NB Dia)
12	AHU Drain pan	-Do-	Sheets	9 mm
13	Acoustic treatment	Open Cell Nitrile Rubber Foam (140-240 kg/m^3)	Sheets	15 mm
14	Hot Water / Steam piping	Flexible Silica Aerogel (mineral fibre) Blanket (160-240 kg/m^3)	Sheets	30 mm
15	Line / Pipe from Pan Humidifier to Duct	-Do-	-Do-	20 mm

APPENDIX 2

HOT INSULATION INSTALLATION PROCEDURE FOR PIPES

1) Measure circumference of pipe using a strip of insulation material sheets to ensure accurate tight longitudinal butt or overlap seam (25-50 mm overlap). Either jointing method is acceptable.

2) Wrap insulation material sheets tightly around pipe to avoid gaps or voids.

3) Longitudinal seams shall be tightly closed. Bring first part of edges together and secure with wire.

4) Continue to bring longitudinal edge together and secure with wire every 200 mm so that the seam is tight, without gaps and evenly secured.

5) Each layer of sheets (or the final layer of a continuous wrap) must always be secured to the substrate using 19 mm stainless-steel bands. However for smaller diameters upto 100 mm, 1 mm diameter stainless steel wires may also be used

6) Maximum separation of wires shall be 200 mm and maximum separation of band centres shall be 300 mm

7) Always rotate the longitudinal seam to the side, never at the top.

8) Circumferential butt joints shall be pushed tightly together to avoid gaps. Joints and seams shall be staggered minimum 100 mm circumferentially, longitudinally and between layers.

9) Aerogel sheets may also be applied in multiple layers as a continuous wrap.

10) Aerogel Sheets shall always be protected by a jacketing / cladding when installed outdoors. This is also recommended for indoor applications.

APPENDIX 3

COLD INSULATION INSTALLATION PROCEDURE FOR PIPES

1) Before applying insulation, all pipes shall be brushed and cleaned. All Pipe surfaces shall be free from dirt, dust, mortar, grease, oil, etc.

2) One coat of primer shall be applied over the entire surface of pipe and fitting and accessories like valves etc.

3) Insulating material in tube form shall be sleeved on the pipes upto 100 mm NB Dia.

4) On existing piping, slit opened tube of the insulating material (slit with a very sharp knife in a straight line) shall be placed over the pipe and adhesive shall be applied on the slit ends.

5) Adhesive must be allowed to tack dry and then press surface firmly together starting from butt ends and working towards centre.

6) Wherever flat sheets shall be used it shall be cut out in correct dimension. All longitudinal and transverse joints shall be sealed as per insulation manufacturer recommendations.

7) The insulation shall be continuous over the entire run of piping, fittings and valves.

8) Ensure all seam joints have adhesive applied on both surfaces as detailed in the Installation Manual.

9) Direct contact between pipe and hanger shall be avoided. Hangers shall pass at the outer ends of the saddle support.

10) There shall be proper thermal isolation of pipe from pipe support. Additional layer of suitable packing material/cover of adequate strength shall be provided between the insulated pipe and the Pipe support (i.e. bracket, saddle etc.) to avoid any damage to the pipe insulation at pipe support locations.

11) In locations that have many bends and fittings, first install the bend fitting and then install the straight lengths of insulation material, following the application procedures.

12) All valves, fittings, joints, strainers, etc. in chilled water piping shall be insulated to the same thickness as specified for the main run of piping and procedure of installation shall be same as above. Valves bonnet, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced.

13) For all irregular shape of fittings, valves etc., procedure as per manufacturer manual shall be followed.

14) Ensure all exposed metal parts of the fittings including the "neck spindle" are insulated to prevent condensation/ice formation. In areas and locations that have exposed electrical equipment nearby, it is advised that the Valve Handle itself is also insulated with removable insulation fabrications.

APPENDIX 4

DUCT INSULATION INSTALLATION PROCEDURE

1) Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work.

2) Measurement of surface dimensions shall be taken properly to cut insulation material sheets to size with sufficient allowance in dimension.

3) Install the insulation material to the top surface of the ductwork. After installing the insulation material to the top sections, proceed to install insulation sheets to the two (2) vertical sides and finally to the bottoms of the ductwork.

4) Direct contact between duct and hanger shall be avoided. Hangers shall pass at the outer ends of the duct support.

5) There shall be proper thermal isolation of duct from duct support. Additional layer of suitable packing material/cover of adequate strength shall be provided between the insulated duct and duct support to avoid any damage to the duct insulation at duct supporting locations.

6) Material shall be fitted under compression and no stretching of material should be allowed.

7) A thin film of adhesive recommended by insulation manufacturer, shall be applied on the back of the insulating material sheet and on to the metal surface. Adhesive shall be in compliance with Indian Green Building requirement, having VOC content less than 850 g/l.

8) When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond.

9) All longitudinal and transverse joints shall be sealed by self-adhesive tapes supplied by insulation manufacturer.

APPENDIX 5

ACOUSTIC LINING (INSIDE THE DUCT) INSTALLATION PROCEDURE

1) The inside surface for the ducts shall be covered with adhesive recommended by the manufacturer.

2) Cut Foamed sheets into required sizes apply adhesive on the foam and stick it to the duct surfaces.

3) Install the insulation material sheet (acoustic lining) to the top inside surface of the ductwork.

4) After installing the insulation material to the top section, proceed to install insulation material sheet on the inside of the two vertical sides of the duct.

5) Finally install the insulation material sheet to the inside bottoms of the ductwork.

उपकेन्द्रीय पम्प के लिए मानक विनिर्देश (जल सेवा)

STANDARD SPECIFICATION FOR CENTRIFUGAL PUMPS (WATER SERVICE)

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	02/12/24	REVISED & ISSUED AS STANDARD SPECIFICATION	MK	JSD/TK	NK	MN
5	09/01/20	REVISED & ISSUED AS STANDARD SPECIFICATION	BBS	JSD	SM	RKT
4	06/04/11	REVISED & ISSUED AS STANDARD SPECIFICATION	SPS	DB	AKN	DM
3	20/03/08	REVISED & ISSUED AS STANDARD SPECIFICATION	NK	AKN	VKM	VC
2	04/09/02	REVISED & ISSUED AS STANDARD SPECIFICATION	NK	KDS	VJN	GRR

Abbreviations:

ANSI	:	American National Standards Institute
ASTM	:	American Society for Testing and Materials
BIS	:	Bureau of Indian Standards
CG	:	Centre of Gravity
DCI	:	Document Control Index
EC	:	Experience Criteria
engDMS	:	Engineering Electronic Document Management System
GA	:	General Arrangement
IC	:	Internal Combustion
ISA	:	Instruments Society of America
MAWP	:	Maximum Allowable Working Pressure
MCF	:	Minimum Continuous Flow
MCR	:	Maximum Continuous Rating
MCS	:	Maximum Continuous Speed
NFPA	:	National Fire Protection Association
NPSH	:	Net Positive Suction Head
NPSHA	:	Net Positive Suction Head Available
NPSHR	:	Net Positive Suction Head Required
OD	:	Outside Diameter
P&ID	:	Piping and Instrumentation Diagram
PTR	:	Proven Track Record
VDM	:	Vendor Document Management
VDR	:	Vendor Data Requirements

Rotating Equipment Standards Committee

Convenor: Mr. Nalin Kumar

Members:
Mr. Tarun Kumar
Mr. J S Duggal
Mr. Abhay Kumar
Mr. Mahesh Easwaran
Mr. Mahesh Gupta
Mr. Pintu Lal
Mr. Aasheesh K Handa (Projects)

CONTENTS

SECTION 1 - GENERAL

1.1 SCOPE

i. This specification together with the attendant Data Sheets and other specifications/attachments to inquiry/order defines the minimum requirements for vertical and horizontal centrifugal pumps and their accessories/auxiliaries for use in clean, cold water service. Water injection pump, boiler feed water pumps and pumps for sea water services are not covered by this specification.

ii. Vendor shall comply with the requirement of this specification and other specifications/attachments to inquiry/order. No deviation or exception shall be permitted without the written approval of the purchaser.

iii. Compliance with this specification shall not relieve the vendor of the responsibility of furnishing equipment and accessories/auxiliaries of proper design, materials and workmanship to meet the specified start up and operating conditions.

In case the vendor considers requirement of additional instrumentation, controls, safety devices and any other accessories/auxiliaries essential for safe and satisfactory operation of the equipment, they shall recommend the same along with reasons in a separate section along with their proposal and include the same in their scope of supply.

1.2 CONFLICTING REQUIREMENTS

In case of conflict between this specification and the attendant data sheets, job specifications (if any) and other attached specification the following order of precedence shall govern:

1. Process Data Sheet / P&IDs / Process Package
2. Mechanical Data Sheets.
3. Job Specifications / Scope of Work (if any)
4. This specification
5. Other standards & specifications
6. Other referred codes and standards

The editions of referenced publication that are in effect at the time of inquiry or at a date specified in the inquiry documents shall be applicable.

In case of any ambiguity in the above documents, the vendor/supplier shall seek clarification from the owner/purchaser and the decision of the owner/purchaser shall be final and binding.

1.3 DEFINITION OF TERMS

1.3.1 The **Normal operating point** is the point at which usual operation is expected.

1.3.2 The **Rated operating point** is the point at which the vendor certifies that performance is within the tolerances stated in this specification.

1.3.3 **Maximum allowable working pressure (MAWP)** is the maximum continuous pressure for which the manufacturer has designed the equipment (or any part to which the term is referred) when the equipment is operating at the maximum allowable temperature.

1.3.4 **Maximum allowable temperature** is the maximum continuous temperature for which the manufacturer has designed the equipment (or any part to which the term is referred) when handling the specified liquid at the specified pressure.

1.3.5 **Minimum continuous stable flow** is the lowest flow at which the pump can operate continuously without exceeding the noise and vibration limits imposed by this specification.

1.3.6 The **Pressure casing** is the composite of all stationary pressure containing parts of the unit, including all nozzles, glands and other attached parts.

1.3.7 Unless otherwise specified, **Supplier / Vendor** shall be a manufacturer of centrifugal pumps (water service) having adequate design, engineering, manufacturing, packaging and testing facilities and shall have supplied complete centrifugal pumps (water service) package as a single point responsibility vendor. The vendor shall also be the manufacturer of the proposed centrifugal pumps (water service).

1.3.8 **Net positive suction head** (NPSH) is the total absolute suction head, in meters of liquid, determined at the suction nozzle and referred to the datum elevation minus the vapour pressure of the liquid in meters absolute. The datum elevation is the shaft centreline for horizontal pumps, the suction nozzle centreline for vertical in-line pumps and the top of foundation for other vertical pumps.

1.3.9 **Net positive suction head available** (NPSHA) is the NPSH in meters of liquid, determined by purchaser for pumping system with the liquid at the rated flow and normal pumping temperature.

1.3.10 **Net positive suction head required** (NPSHR) is the NPSH in meters, determined by vendor testing with water. NPSHR is measured at the suction flange and corrected to the datum elevation. NPSHR at rated and other capacities is equal to the NPSH that produces a 3 percent head drop (first stage head in multistage pumps) due to cavitation within the pump.

1.3.11 **Minimum Submergence required** is the liquid level with respect to pump suction flange face, in millimeters, determined by the vendor when testing with water for vertical pumps. This is the level required to prevent vortex formation/ingress of air/vapour into the pump suction resulting in loss of flow/head.

1.4 EXPERIENCE CRITERIA

1.4.1 The pump model offered shall be from the existing pump model series and shall be from the regular manufacturing range of the vendor (Prototypes are not acceptable).

The mechanical design as well as the hydraulic performance (including NPSHR) for the complete range of operation of the offered model shall have been established in the shop test. (Details to be furnished, if required).

The offered pump model with identical hydraulics and design shall be field proven (at least ONE unit) with minimum operating experience of one year for similar operating/design conditions, bearing span/column length, pumping liquid and material of construction supplied in the last Ten (10) years, from the proposed manufacturing plant, as on bid due date.
(Note: Similar operating/design conditions, bearing span/column length would mean approx. 80% or higher)

Multiple references can be furnished to justify the above.

1.4.2 The vendor shall complete the Experience Record Proforma enclosed with the inquiry document to amply prove that the offered pump meets the above criteria by furnishing references of flow, head, pressure & temperature, driver rating & speed, number of stages, bearing span / column length (as applicable), efficiencies, material of construction, bearing

design & lubrication. In addition, manufacturer's catalogue and general reference list for centrifugal pump (water service) to be furnished along with the proposal.

SECTION 2 - BASIC DESIGN

2.1 GENERAL

2.1.1 The vendor shall have UNIT RESPONSIBILITY of complete centrifugal pump package & shall be responsible for complete design, engineering, manufacturing, packaging, testing, supply & supervision of erection & commissioning of total package as per specification requirements. Vendor's scope shall include but not limited to the responsibility for execution, coordination of all technical aspects of equipment and its auxiliary systems, their selection & integration into a complete package constituting total order. All drawings/documents pertaining to the order shall be duly approved by the vendor before onward submission.

2.1.2 Pumps with constant speed drivers shall be capable of at-least 5 percent head increase at rated condition and pump rated speed by replacing with a new impeller or impellers. Offered impeller shall in no case be less than the minimum diameter impeller.

2.1.3 Horizontal pumps of the close-coupled, the two stage overhung, or the single stage double suction overhung, type shall not be furnished.

2.1.4 Unless otherwise specified, Pumps where difference between NPSHA and NPSHR is 0.6 meter or less are not acceptable. The said NPSHR value shall correspond to the maximum value of NPSHR from rated flow down to the recommended minimum continuous stable flow specified by the vendor. However, for pumps having pump rated BKW up to 55 kW, pumps with margin between NPSHA & NPSHR less than or equal to 1 m are not acceptable.
For Pumps with open discharge valve/auto-start condition, the NPSHR at the 120% of Best Efficiency Point (BEP) flow shall not exceed the NPSHA.
Note: Actual datum for NPSHA (i.e. grade level, top of foundation level or any other level as defined in enquiry) shall be referred from the data sheets forming part of enquiry document.

Pumps fitted with inducers for reducing NPSHR are not acceptable.

2.1.5 Pumps shall have stable head/capacity curves (continuous head rise to shut-off). When parallel operation is specified, head rise shall be at least 10 percent of the head at the rated capacity. The shut off head shall not be more than 120 percent of the rated head in horizontal pumps and 140 percent in the case of vertical turbine pumps. In no case shutoff pressure shall exceed downstream design pressure. Unless otherwise specified, discharge orifice shall not be used to achieve required head rise to shut off, even in the case of parallel operation.

2.1.6 The best efficiency point for the furnished impeller is preferred between the rated point and the normal point. However the rated point shall be between 70 to 110 percent of the best efficiency point of the rated impeller except for intermittent duty applications and for pumps having rated BKW upto 22 kW.

2.1.7 Unless otherwise specified, the maximum permissible sound pressure level of the complete equipment (pump + driver) train shall not exceed 85 dBA measured at 1 meter from pump surface in any direction for the recommended range of operation at site.

2.1.8 For vertical pumps, not provided with non-reverse ratchet, vendor shall describe the precaution taken, to prevent damage due to reverse rotation.
Vertical pumps shall be provided with their own thrust bearing designed to carry rotor

weight and pump generated axial forces and shall not transmit any thrust to the bearings of driver.

2.1.9 Pump-Driver train shall be designed to be suitable for outdoor installation without a roof.

2.1.10 Lifting lugs/eye hooks shall be provided for ease of lifting of complete pump as well as the heavy maintenance components of the pump (e.g. Top half casing cover of axially split pump).

2.1.11 The guaranteed parameters shall be demonstrated during shop test without any coating on impellers or casings.

LCWP (Horizontal/vertical) shall be internally coated after pump performance test to improve the pump efficiency to the extent possible. One pump per tag will be performance tested (testing procedure similar to pump tested without coating) after coating to witness the actual improvement in efficiency.

2.1.12 Pumps with variable speed drivers shall be capable of operating continuously upto 105 percent of rated speed as well as operating briefly upto driver trip speed.

2.1.13 Casing vents alongwith vent valves, as per manufacturer standards, for all pumps shall be provided. For all horizontal pumps, casing drain with isolation valve and flanged piping terminated at the skid edge shall be provided. Baseplate shall also be provided with flanged drain connection.

2.1.14 Horizontal between bearing pumps, pumps with rated flow above 500 m3/hr (horizontal) and pumps with rated flow above 100 m3/hr (vertical) shall be considered as Large Capacity Water Service (LCWS).

2.2 PRESSURE CASING DESIGN

2.2.1 Maximum allowable working pressure (MAWP) for all pressure containing parts e.g. casing, bowl, discharge head, discharge pipe, column pipe (in case of vertical turbine type pump), stuffing box etc. shall in no case be less than the maximum discharge pressure produced by the pump at shut-off (including tolerances), at the maximum suction pressure, for the rated impeller diameter and the maximum continuous speed.
Note: Shut-off pressure for vertical pumps shall be calculated at the delivery flange at the top of mounting plate in the same way bowl head is calculated, since the shut-off head corresponds to the rated impeller, at the Pump casing discharge flange.

MAWP shall also not be less than the specified downstream design pressure.

These pressure containing parts shall be suitable for hydrostatic test pressure of 1.5 times the MAWP.

Note: MAWP shall not be less than 10 kg/cm²g for pumps with 125# flanges (i.e. with Cast Iron casing) & 16 kg/cm²g for pumps with 150# flanges (i.e. with Carbon Steel or Alloy Steel casing).

2.2.2 Pumps shall have suction and discharge flanges designed for same rating. Unless otherwise stated, flanges shall be machined and drilled conforming to ASME B16.5 (up to NPS 24) and ASME B16.47 Series B (for above NPS 24).

2.2.3 Pumps shall be provided with Flanged nozzles.

2.2.4 Unless otherwise specified, all pumps shall be supplied with companion flanges with rating conforming to applicable specification of ASME B16.5 (up to NPS 24) and ASME B16.47 Series B (for above NPS 24), drilled and faced in accordance with pump suction

and discharge flanges alongwith gaskets and fasteners.

For pumps with casing material as cast iron (CI), the companion flanges shall be of slip-on (SO) type [for flange sizes 50 mm (2 inches) & above] or socket welded (SW) type [for flanges of size 15 mm (0.5 inches) to 40 mm (1.5 inches)] with flat face (FF) & of carbon steel material. The gasket shall be of full face type.

For pumps with casing material other than cast iron, the companion flanges for pump suction and discharge connections shall be of weld neck (WN) type with raised face (RF) & of the material compatible with piping material.

2.3 IMPELLER, SHAFTS AND SHAFT SLEEVES

2.3.1 Impellers shall be cast as one piece.

2.3.2 Shaft shall be provided with sleeves under the packing/seal and shall be locked to the shaft. The material of sleeve shall be 12 percent chrome steel (hardened). Where the size of pump makes the use of shaft sleeve impracticable, the shaft shall be constructed of 12 percent chrome steel (hardened). For vertical pumps, shaft material shall be 12 percent chrome steel.

2.4 WEAR RINGS

Unless otherwise specified, renewable wear ring shall be furnished at least on the casings. Mating wear surfaces of hardenable materials shall have a difference in Brinell hardness number of at least 50. Integral impeller wear surfaces shall have higher hardness than that of the casing wear rings, when only casing wear rings are provided.

2.5 DYNAMICS

The following vibration limits shall be applied at rated speed and at flow of ±10 percent of rated flow.

2.5.1 **Horizontal Pumps**

Unfiltered vibration velocity (peak) for horizontal pumps upto 3000 rpm with antifriction bearing or sleeve bearings when measured at the bearing housing in horizontal or vertical direction shall not exceed 4.0 mm/sec (0.16 inch/sec).

Bearing housings shall be suitable to permit measurement of vibration.

2.5.2 **Vertical Pumps**

Unfiltered vibration velocity (peak) for vertical pumps with antifriction and or sleeve bearings when measured at the top bearing housing of pump or top bearing housing of motor or mounting flange for measuring points upto 3 meters above the mounting base shall not exceed the following limit:

Pumps greater than 1500 rpm	=	7.0 mm/sec (0.28 inch/sec)
Pumps upto & including 1500 rpm	=	5.1 mm/sec (0.2 inch/sec)

2.5.3 The vibration limits (peak) specified vide clause. 2.5.1 and 2.5.2 above shall be applied for pumps only. The vibration limits for the drivers shall be as per their respective applicable standards. Where respective applicable standards do not specify such limits for the associated drivers, the driver manufacturer's recommendation shall be applied for acceptance of the driver. Such acceptable limits shall be indicated by the vendor in their proposal.

2.6 MECHANICAL SEAL/PACKING

2.6.1 Unless otherwise specified, the pump shall be supplied with packings. Stuffing box shall

have minimum five packing rings plus lantern ring. Packing ring size shall be 3/8" or larger.

2.6.2 The mechanical seal shall be of a make, duly approved by the purchaser.

2.6.3 Seal manufacturers specific recommendation shall be obtained and submitted alongwith the proposal.

2.6.4 All auxiliaries for flushing of mechanical seal shall be in vendor's scope of supply.

2.6.5 Large Capacity Water Service (LCWS) Pumps shall be provided with Non-API, balanced & horizontal split mechanical seals.

2.7 BEARINGS

2.7.1 Antifriction bearings shall be of standard type and shall meet minimum L-10 rating life of either 25000 hours with continuous operation at rated conditions or 16000 hours at maximum axial and radial loads and rated speed.

2.7.2 The rise in bearing grease/oil temperature with continuous running of the pump shall be within the allowable limits which shall not exceed 30°C for grease and 39°C for oil lubricated bearings above ambient. Cooling arrangements shall be provided if required. Bearings shall be equipped with constant level oilers, vent breather & drain point for oil lubricated arrangements.

2.7.3 Unless otherwise specified, for vertical pumps with open shaft, the intermediate bearings / bushings shall be suitable for operation without any lubrication during start / shut-down or during normal operation (i.e. bearing bush material shall be of self lubricating type). Details of line shaft bearings shall be furnished with the proposal.

2.7.4 Unless otherwise specified, for vertical pumps, thrust from the pump shall not be transferred to the electric motor.

2.8 MATERIALS

2.8.1 The material of construction of parts shall be as specified. Vendor shall furnish the equivalent material as per ASTM.

For impellers in cast iron or bronze construction, the tip speed shall be limited to 40 meters/sec. Unless otherwise specified, for tip speeds exceeding 40 meters/sec, the material of impellers shall be stainless steel.

2.8.2 Unless otherwise specified in the data sheet, material test certificates (chemical and mechanical properties) shall be supplied for impeller, shaft, shaft sleeve, wearing rings and casings.

2.8.3 The repair of pressure castings by peening, plugging, impregnating or by the use of plastic or cement compound is prohibited. The Inspector's prior approval shall be obtained for the repair of castings. When authorised, repair shall be carried out in accordance with applicable ASTM Specification. Weld repair of pressure containing parts of Cast Iron construction is not permitted.

2.9 PUMPS FOR FIRE WATER APPLICATION

Pumps for Fire Water Application shall also meet the following additional requirements:

2.9.1 Unless otherwise specified, Pumps shall meet the requirements of NFPA (National Fire

Protection Association). Technical requirements specified in the data sheet are also to be met. The vendor shall also be responsible for obtaining the necessary approvals as specified in inquiry.

2.9.2 Pumps shall be direct-coupled except in the case of engine-driven vertical turbine pumps wherein gear drives through universal joint and cardan shaft shall be used. Belt driven pumps are not acceptable.

2.9.3 Parts of pumps like impeller, shaft sleeve, wearing ring etc. shall be of non-corrosive metal preferably brass or bronze unless the quality of water dictates the use of special metals/alloys which shall be insisted upon.

2.9.4 Pumps shall be capable of discharging not less than 150 percent of rated capacity at a head not less than 65 percent of the rated head.

2.9.5 Difference between NPSHA and NPSHR at 150 percent of the duty point shall not be less than 0.6 meters.

2.9.6 The electrical motor shall be of continuous rating type and the rating shall be 110 percent of the power at rated point or equal to maximum BKW rated impeller whichever is higher.

2.9.7 For Diesel engine drivers, the net continuous site power available after considering the deration due to site condition and power losses, due to other parasitic loads and engine driven auxiliaries shall be higher of the following two values:

(a) 20 percent in excess of the BKW required to drive the pump at rated condition.
(b) Maximum BKW rated impeller as indicated by the manufacturer in the pump data sheets.

SECTION 3 - ACCESSORIES

3.1 DRIVERS

3.1.1 Electric motor drivers shall have a maximum continuous rating (MCR) (i.e. service factor equal to 1) not lower than the following unless higher rating is dictated by the Note 1.

Pump Rated BKW *		**Motor MCR (% of Pump Rated BKW)**
Less than 22 kW	:	To suit maximum BKW indicated on pump data sheet or 125% of rated pump BKW, whichever is higher.
22 kW - 55 kW	:	115% of rated pump BKW.
Higher than 55 kW	:	110% of rated pump BKW.

Remark: * including all mechanical & transmission losses & with 0% +ve tolerance.

Note :

1. The motor nameplate rating for pumps under parallel operation shall not be less than the max. BKW indicated on pump data sheet (the power at End of the curve for the rated impeller) or shall have the specified margin as per this clause whichever is greater. The pump motors shall also be suitable for start-up under open discharge valve condition.

3.2 GEARS

The type of gears shall be as specified in the inquiry document.

Unless otherwise specified, gear box shall be selected with a minimum of AGMA service factor of 1.75 over the driver rating.

Wherever right angle gear box are required the same shall be supplied non-reversible

ratchet and shall allow for vertical adjustment of the impeller. Further the gearbox shall be suitable for absorbing the maximum thrust under any case of operation.

3.3 COUPLING & GUARDS

3.3.1 Unless otherwise specified, connection between pump and driver shall be made by a flexible metallic coupling.

A spacer (127 mm minimum normal length), shall be used to permit the removal of coupling, bearings, seal and/or rotor as applicable without disturbing the driver, the suction and discharge piping, or the casing top cover, for all horizontal pumps.

It shall be the responsibility of the pump vendor to obtain purchaser's approval for the selected coupling, its make and rating.

3.3.2 Whether or not pump vendor is required to supply the driver, he shall still deliver the fully machined coupling assembly alongwith the pump. The driver shaft dimensions and tolerances shall be furnished by the Purchaser to the pump vendor.

3.3.3 Removable coupling guard shall be provided which shall be fabricated from non-sparking material, and shall be open at the bottom to permit manual shaft rotation. The guard shall be sufficiently rigid to withstand deflections as a result of bodily contact of nominally 100 kgs. Coupling guard shall have a hinge to open and Inspection window to see the healthiness of the coupling shims.

3.3.4 Coupling service factor shall not be less than 1.5 over driver rating. However, while selecting the coupling, it shall be ensured by pump vendor that the allowable shaft stresses of the pump train are not exceeded under any circumstances including any offset condition or conditions of maximum torque. For pump trains having gear-box, the coupling service factor shall not exceed the gear-box service factor.

3.4 BASEPLATE

3.4.1 Baseplates for Horizontal Pumps

3.4.1.1 Baseplate shall extend under the pump, gear box and motor/turbine driver and shall be fully machined for mounting the above equipment. All other projections of the equipment supplied shall fall within the maximum perimeter of the baseplate. Baseplate shall be steel fabricated and shall have sufficient rigidity to avoid vibration and distortion. Baseplate shall be so designed as to facilitate proper grouting (Vent holes where required shall be provided).Type of grout material and technical details shall be furnished by vendor in his proposal. Baseplate shall be cleaned (sand blasted) inside and outside and coated with suitable anticorrosion paint.

Drain Pan Type Baseplate surrounding the entire baseplate to be provided. Baseplate to be provided with minimum 2" flanged drain connection.

3.4.1.2 The baseplate shall be provided with lifting lugs for at-least a four point lift. Lifting the baseplate complete with all equipment mounted shall not permanently distort or otherwise damage the baseplate or machinery mounted on it.

3.4.1.3 For driver trains over 75 kW, alignment positioning screws shall be provided for each drive element to facilitate longitudinal and transverse horizontal adjustments. The lugs holding these positioning screws shall be attached to the baseplate so that they do not interfere with the installation or removal of the drive element.

3.4.1.4 Vertical leveling screws, spaced for stability shall be provided on the outside perimeter of

the baseplate. These shall be numerous enough to carry the weight of the baseplate, pump, gear-box (if any) and driver without excessive deflection.

3.4.2 **Baseplate / Mounting Plate for Vertical Pumps**

3.4.2.1 Vertical pumps shall have the manufacturer's standard mounting arrangement.

3.4.2.2 Alignment positioning screws shall be provided for 18.5 kW and above and as per manufacturer's standard practice for lower ratings.

3.4.2.3 Unless otherwise specified, mounting plate for vertical pumps shall be having a minimum thickness of 48 mm and is to be made from IS:2062/IS:2002 plate material or can be of the same material as that of vessel / tank. Mounting plate shall be supplied with gaskets (as applicable) & fasteners.

3.4.2.4 Alignment positioning screws shall be provided for all motors.

3.5 STRAINERS

Unless otherwise specified, all vertical pumps shall be provided with suction strainers of SS-316 material.

SECTION 4 - INSPECTION, TESTING AND PREPARATION FOR SHIPMENT

4.1 GENERAL

4.1.1 Unless otherwise specified, all pumps shall be inspected and all tests shall be witnessed by the Purchaser or by the Purchaser's authorised representative.

4.1.2 Purchaser's or their authorised representative shall have access to the plant including sub vendors plants where work on or testing of equipment is being performed.

4.1.3 No surfaces of parts of pumps are to be painted until the inspection is completed.

4.1.4 Vendor shall give to the purchaser at-least 15 days notice prior to commencement of testing. Vendor shall carry out all running tests and mechanical checks and satisfy himself prior to purchaser's arrival for inspection and shall maintain desired log of tests.

4.1.5 Acceptance of shop test shall not constitute a waiver of requirement to supply equipment as per specification and/or to meet field test under operating condition, nor does inspection relieve the manufacturer of his responsibility in any way whatsoever.

4.2 TESTS

As a minimum following tests shall be performed. The basic reference standard shall be the latest edition of Hydraulic Institute Standard or IS:5120.

4.2.1 **Hydrostatic Test**

4.2.1.1 Pressure casings including column pipe and discharge head shall be hydrostatically tested with water at ambient temperature at 1½ times the maximum allowable working pressure specified in the data sheet.

4.2.1.2 Jackets for bearing, stuffing box, coolers, etc, shall be tested at 1½ times the maximum allowable jacket working pressure.

4.2.1.3 Hydrostatic test shall be maintained for a minimum period of 30 minutes. Shop test certificate is required.

4.2.2 **Performance Test**

4.2.2.1 Unless otherwise specified, performance test for Horizontal Pumps for General Water Service (GWS) shall be carried out as per the following:

Pumps with drivers upto 55 kW	Non witnessed. Only review of manufacturer's shop test reports are required.
Pumps with drivers from 55 kW to 160 kW	One pump per tag/Item no. to be witnessed
Pumps with drivers above 160 kW	All pump units in an item to be witnessed

However in case of vertical pumps and for pumps for Large Capacity Water Service (LCWS), all pumps in a tag needs to undergo witnessed performance test.

4.2.2.2 Unless specifically agreed upon, pump shall be tested at the rated speed specified in the data sheet with calibrated motors, at least for four hours. During the four hour run test, complete data including pressure, capacity, power, vibration levels, bearing temperatures and noise levels shall be recorded and guaranteed parameters verified.

Prior to start of test, manufacturer shall furnish the certificate of latest calibration / re-calibration of driver and measuring instruments. Unless electrical or mechanical failure occurs, driver used for shop testing need not be recalibrated and original calibration certificate shall remain valid. Duration of recalibration for all measuring instruments shall be as per the recommendations of HI Standards and/or relevant standards of the country of origin of the pump manufacturer.

4.2.2.3 The pump shall be tested with water at ambient temperature. Suitable rust inhibitor shall be added in the water used during any internal testing / performance testing of the pumps, to prevent rusting of pump internals.

4.2.2.4 The performance test for the pumps shall be in accordance with Indian Standard IS:5120 latest edition and the tolerance of the guaranteed parameters shall be as follows:

Rated head	:	Zero negative tolerance.
Shut-off head	:	Positive tolerance permitted as long as it does not exceed downstream design pressure. Negative tolerance permitted so long as the curve is continuously rising to shutoff without any drooping and minimum 110% head rise to shutoff shall be available for pumps in parallel operation.
Min. Submergence required (for vertical pumps)/ NPSH(R)	:	Zero Positive Tolerance.
Rated BKW	:	Zero positive tolerance (However pumps may be accepted upto 104 percent of Guaranteed BKW subject to Penalties as defined elsewhere)

As a minimum, data at Shut-off (no vibration data required), minimum continuous stable flow, midway between minimum and rated flow, rated flow and maximum allowable flow (as a minimum, 120% of best efficiency flow), shall be measured and recorded during tests. All the instruments used for conducting the tests shall be calibrated before tests and calibration certificates furnished from a recognised testing institution to the Inspector.

4.2.2.5 For fire water application all engine driven horizontal and vertical pumps shall be subjected to a 4 hour complete unit string test at the pump vendor's works during which mechanical performance of the train shall be verified, in terms of vibration, bearing/oil temperature, engine parameters and controls.

In case multiple units are ordered, only one number of diesel engine and gear box unit (if used) may be brought to the pump vendor shop for complete unit (string) test for the fire water pump unit. For the remaining pumps, complete unit (string) need not be done. However, any modification required to be done on the first unit shall be uniformly done on the remaining units also for proper unitization of the same at site.

4.2.3 **NPSH Test / Min. Submergence Test**

Unless otherwise specified, NPSH test for Horizontal Pumps for General Water Services (GWS) shall be carried out as per following:

For pumps with driver rating upto 55 kW	Not Applicable
For Pumps with driver rating between 55 kW to 160 KW	One pump tag/item to be witnessed
For Pump with driver rating above 160 KW	All pump units to undergo witness test

Additionally, in case of vertical pumps, all pumps in tag needs to undergo minimum submergence test Testing for NPSH is not required for Vertical pumps.

Also for all pumps in LCWS, all pumps in a tag needs to undergo NPSH test if required as per specification.

Unless otherwise specified NPSH test shall be carried out where difference between NPSH available and NPSH required is 1 meter or less at the rated point, for pumps beyond 55 kW.

Test points shall be similar to those of Performance test.

4.2.4 **Vibration Measurement**

During performance test vibration shall be measured on the bearing housing for the capacity range from pump MCF to 110% of rated capacity. For checking the vibration, flat surface shall be provided on bearing housing by pump manufacturer. The vibrations shall be within the limits as specified in clause no. 2.5.

4.2.5 **Dismantling Inspection**

Dismantle inspection of pump after performance test shall be applicable only in case of abnormality in mechanical behaviour (such as excessive noise and vibration, bearing temperature rise etc.) during performance test.

If it is necessary to dismantle a pump after the performance test for the sole purpose of machining impellers to meet the tolerances for differential head, no re-test will be required unless the reduction in diameter exceeds 5 percent of the original diameter. The diameter of the impeller at the time of shop test, as well as the final diameter of the impeller, shall be recorded on a certified shop test curve that shows the operating characteristics after the diameter of the impeller has been reduced.

If it is necessary to dismantle a pump for some other correction, such as improvement of power, NPSH or mechanical operation, the initial test will not be acceptable and final performance test shall be run, after the correction is made.

4.2.6 **Final Inspection**

After the performance/dismantle test the pump and the job driver shall be unitised on the

job base plate, aligned and coupled to make a complete unit except for engine driven vertical pumps. The pump will then be checked for visual inspection to confirm compliance to the GA drawings, nozzle dimension, elevations, anchor bold position, direction of rotation etc.

4.2.7 Prior to start of tests, vendor shall furnish the following:

1. Certificate of calibration of driver, which should be recalibrated after a period of every three years.
2. Certificate of calibration of measuring instruments, which should be recalibrated after a period of every one year. Magnetic flowmeters shall be recalibrated once in two years. Pressure gauges shall be calibrated prior to start of test and after completion of test.
3. Record of all running test and mechanical checks (including test curves and data) completed prior to purchaser's inspection.

4.3 PREPARATION FOR SHIPMENT

4.3.1 After all tests are completed and after inspection is made, all exposed mechanical surfaces and all internal parts shall be thoroughly coated with a rust preventive. All exterior parts of the unit except machined surfaces shall receive one prime coat and one coat of vendor's standard enamel.

4.3.2 All flanges, nozzles shall be blanked off. All untapped openings shall be provided with substantial wood or metal closure. The ends of small piping may be sealed with tape.

4.3.3 The pump shall be supplied with a nameplate containing the following information:

- Purchaser's Item No.
- Manufacturer's Name
- Type and Serial No
- Rated capacity in m3/hr.
- Differential head at rated capacity in m.
- Casing hydrostatic test pressure in kg/cm^2.
- Speed in rpm.

The nameplate shall be of stainless steel and relevant information shall be punched into the same.

4.3.4 All auxiliary, dismantled and packed separately shall be properly marked with the Item No. for which it is intended by means of metal tag.

4.3.5 Pump with auxiliary shall be suitably packed, fastened to avoid damage during transit and crated for shipment and storage for a period of 12 months. Lifting, unpacking and handling instructions shall be securely attached to the exterior of the largest packing in a well marked weather proof container. The upright position of lifting points, gross weights and dimensions be clearly marked on each package. Each package shall clearly identify the equipment contained therein. If any extra precaution is to be taken by the Purchaser for storage beyond 12 months the same shall be explicitly indicated in the operation and maintenance manuals.

SECTION 5 - VENDOR'S DATA

5.1 PROPOSALS

The vendor's proposals shall as a minimum include the following:

a) All data sheets, drawings and documents listed under "PRINTS WITH QUOTE" in the enclosed Vendor Data Requirement Form.
b) Vendor's confirmation/comments on post-order Vendor Data Requirements (Type of

Documents, no. of prints and date needed) indicated in Vendor Data Requirement forms data sheets and specs.

c) List of recommended commissioning spares included in the offer.
d) List of mandatory spares (where specified by the purchaser) included in the offer.
e) List of Vendor's standard Spare Parts for Two Years Normal Operation
This list shall be made separately for each items including auxiliaries and drivers in the form of a table & shall show :
   i) Part name, description and number.
   ii) Quantity installed in one unit.
   iii) Quantity recommended per unit for 2 years normal operation.
   iv) Quantity recommended for number of units of an item as specified in the inquiry.
   v) Quantity recommended as insurance for the number of units of an item specified in the inquiry.
f) An itemised list of special tools included in the offer.
g) Any start-up, shutdown or operating restrictions required to protect the integrity of the equipment.
h) Any limitations of vendor's test-facility to carryout the specified tests.
i) A specific statement that the scope of supply, the offered equipment/systems and all its components are in strict accordance with the data sheets, job specifications, this specifications and all other attachments, except for specific deviations as listed in the proposal.

5.2 CONTRACT DATA

5.2.1 General

5.2.1.1 Drawings and data as required after purchase order has been specified in Vendor Data Requirement. Vendor to note that the drawing/document descriptions/titles as given in the Vendor Data Requirement are generic in nature. It is possible that against one drawing/document specified there are several drawings to be furnished by the vendor or vice versa.
Vendor shall complete & forward a document "DOCUMENT CONTROL INDEX (DCI)" to the purchaser (Destination & contact person as per order).

This document shall list out in consolidated form all drawings and documents required by purchaser (As specified in Data Sheets, Specifications and Vendor Data Requirement forms enclosed with the order).

Against each drawing/document vendor shall indicate the vendor's drawing numbers, titles, Rev. No., category (whether for information or approval) and schedule of submission.

This shall be the first document to be submitted by vendor within two weeks of order. **No drawing shall be taken up for review till the DCI for inquiry/order is finalized by vendor**. If specified, drawing review may be through VDM in soft as per the details provided elsewhere in the inquiry document.

5.2.1.2 All transmittal letters (covers), drawings and data shall have a title block (in addition to vendor's standard title block) which shall as a minimum contain the following contract information:
i) Purchaser's and Consultant's Corporate Name
ii) Project Name.
iii) Client / Customer's Name.
iv) Equipment Name and Item No.
v) Purchase Order No.
vi) Purchase Requisition No.
Title Block on drawings shall be placed on the lower right hand corner.

5.2.1.3 All vendor data/drawings/documents shall be in English Language and in Metric Systems.

5.2.1.4 Data specified in the VDR is the minimum requirements of Purchaser. Any additional document/data required or requested by Purchaser for engineering or construction shall also be made available by the vendor.

5.2.1.5 Whether or not specified the vendor shall furnish the following, before shipment:

- As built running clearances and when applicable; thrust bearing, radial bearing and seal running clearances.
- A supplementary list of spare parts other than those included in his original proposal. The supplementary list shall include recommended spare parts, cross-sectional or assembly type drawings, parts numbers, materials, prices and delivery period. The vendor shall forward this supplementary list to the purchaser promptly after receipt of the reviewed drawings and in time to permit order and delivery of parts before field start-up.
- A parts list for all equipment supplied. The list shall include pattern, stock, or production drawing numbers and materials of construction. The list shall completely identify each part so that the purchaser may determine the interchangeability of the parts with other equipment furnished by the same manufacturer. Standard purchased items shall be identified by the original manufacturer's name and part number.
- At least 8 weeks before shipment, the vendor shall submit his preservation, packaging and shipping procedures to the purchaser's for his review.

5.2.2 **Co-ordination Meeting**

When specified, a co-ordination meeting shall be held at Purchaser's office, preferably within 4 weeks of order.
An agenda shall be prepared for this meeting and would include the following points related to technical aspects.

a. Any clarifications required by the vendor on purchaser's order.
b. Vendor Data Index & Schedule.
c. Vendor Data Review/approval modalities.
d. Sub-vendor lists proposed by vendor.
e. Utility requirements.
f. Preliminary General Arrangement & layout drawings & purchaser's interface drawings.

5.2.3 **Drawings**

5.2.3.1 The number of prints and/or reproducible required and the times within which these are to be submitted by vendor are specified in Purchaser's inquiry/order.

5.2.3.2 The purchaser's review of the vendor's drawings shall not constitute permission to deviate from any requirements in the purchase order/specifications unless specifically agreed upon in writing. After the drawings have been reviewed, the vendor shall furnish certified copies in the quantity specified. All drawings must be clearly legible and shall be folded to 216 mm x 279 mm (8½" x 11") size.

5.2.3.3 Drawings/documents with following titles shall contain as a minimum the following information:

a) **General Arrangement Drawing**
A general arrangement drawing shall indicate:
i) Outline dimensions (minimum three views) (All principal dimensions).
ii) Allowable forces and moments on suction and discharge nozzles.
iii) Location (in all three planes), size, type, rating and identification of all purchaser's interface connections including those of vents, drains lubricating oil, sealing fluid, cooling water, steam & Electrical/Instrumentation.
iv) Direction of rotation viewing from the driving end.
v) Weight of each assembly/component.
vi) The weight & location of center of gravity of the heaviest

assembly/components that must be handled for erection.

vii) Identification and weight, dimensions of the heaviest assembly / subassembly / component required to be handled for maintenance.

viii) Maintenance clearances and dismantling clearances.

ix) Speeds of Driven Equipment and driver and driver rating. Location of driver terminal box (in case of Electric Driver)

x) Layout of auxiliary equipment and operating platform.

xi) Make, Type and Size of couplings and the location of guards and their coverage.

xii) A list of reference drawings if any.

xiii) A list of any special weather-protection and climatic features.

b) **Foundation Drawings**

A foundation drawing shall indicate complete information required for foundation design by purchase including the following:

i) Foundation bolt sizes, pipe sleeve details, pocket sizes and locations and also distance between the first/ nearest anchor bolt and pump suction and discharge nozzle centrelines.

ii) Grouting thickness and other necessary technical details.

iii) Static weight of each skid/independently grouted item and location of center of gravity of each of such skid/items in all three planes.

iv) Weight distribution for each bolt/subsole plate location and total static weight.

v) Dynamic loading caused due to various items grouted independently.

vi) The direction and magnitude of unbalance forces and moments generated by each such item at the worst operating condition and short circuit moments of motor drivers at the C.G. of the pump-motor baseplate.

vii) GD^2 value of each item resolved to driver speed.

viii) Maximum permissible amplitude of vibration on the foundation at base level.

ix) Total mass of rotating parts.

x) Total mass of reciprocating parts.

xi) Suggested dynamic factor and ratio of foundation weight to weight of skid/equipment as per vendor experience.

c) **Layout Drawing** (For multi-skid packages)

This drawing shall include atleast the following:

i) Layout of all skid/equipment and their auxiliaries, vessels, control panels, exchangers etc. Vendor shall furnish an optimised layout (considering the space allocated, site wind conditions, area classification, the type of equipment located in the vicinity etc.) indicating elevation and dimension of skids/equipment.

ii) Minimum spacing required between the various skids/equipment and between the skids and the walls/columns/roof for an easy accessibility and maintenance.

iii) Layout for water piping, trenches for water piping, cable tray/trenches layout.

iv) Piping arrangement and piping support arrangement/location for piping in vendor's scope.

v) Layout for auxiliary equipment and operating platform details.

vi) Specification for crane/mono rail (including suggested mono rail layout) recommended for maintenance and height of the lifting hook from the centerline of equipment.

d) **Field Alignment Diagram**

The diagram shall indicate the relative displacement to be kept between the centrelines of various equipments at the time of installation, so that under normal running conditions the equipments get fully aligned. This relative displacement should be decided on the basis of centerline temperature rise data of driver, gear box/transmission system, driven equipment.

e) **Heat Exchanger Drawings**
Heat exchanger drawing and data shall include heat and mass balance data, details of provisions for separating and withdrawing the condensate, construction details, cross sections & general arrangement drawings of heat exchangers, vendors recommendations regarding provision for support and piping expansion.

5.2.3.4 **P&I Diagrams** (with Bill of Materials)
Vendor shall supply P&I Diagrams along with Bill of Materials of each system in the vendor's scope of supply or specified in the order. P&I Diagram shall indicate the system details, location of various auxiliaries, instruments, controls and safety devices as required. Line sizes, piping class, valve sizes and class shall be clearly marked on the P&ID. Vendor's scope and purchaser's scope shall be clearly demarcated. Each item shall be identified by an item No./item tag no., which shall correspond to the item no. shown on the bill of materials. The bill of materials shall include items number, normal value, set value, range, quantity per unit, make and other specifications as applicable.
Legends adopted shall be indicated either at the bottom of drawing or on a separate drawing. The legends shall be as per ISA.

5.2.3.5 **Cross-sectional Drawing** (with Bill of Materials)
The vendor shall supply cross-sectional or assembly type drawings for all equipment furnished showing all parts, design assembly and running clearances, and balancing data required for erection and maintenance. Each part shall be numbered which shall correspond to the part number on the bill of materials. The bill of materials shall include the part no., name of component, materials quantity installed per unit & sizes where applicable (say for bolts, nuts, rings, gaskets etc.). All boughtout items shall also be indicated with make and brief specifications.
A separate cross-sectional drawing showing installation and setting dimensions for the seals shall be furnished.

5.2.4 **Performance Characteristic Curves**

5.2.4.1 The vendor shall provide complete performance curves to encompass the map of operations, with any limitations indicated thereon.

5.2.4.2 All curves submitted prior to final performance testing shall be marked "PREDICTED". Any set of curves resulting from a test shall be marked "TESTED".

5.2.4.3 Certified test curves and data shall be submitted within 15 days after testing and shall include head, power recalculated to the proper specific gravity and efficiency plotted against capacity. If applicable, viscosity corrections shall be indicated. If NPSHR test is specified, the water NPSHR curve (drawn upto minimum continuous flow) shall also be included. The curve sheet shall include the maximum and minimum diameters of the impeller design supplied, the eye area of the first stage impeller, the identification number of the impeller or impellers and the pump serial number.

5.2.5 **Data Sheet**

5.2.5.1 The Vendor shall provide completely filled in data sheets, first for "as purchased" and then for "as built". This shall be done by the vendor correcting and filling out the data sheets and submitting copies to the purchaser.

5.2.6 **Technical Data Manual/Mechanical Catalogues**

5.2.6.1 Technical Data Manual/Mechanical Catalogue is a compilation of "as built" drawings and data, manufacturing and test records, installation, operating and maintenance instructions.

5.2.6.2 Not later than two weeks after successful completion of all specified tests, the vendor shall

furnish the required number of Technical Data Manual/Mechanical Catalogues for the equipment, any auxiliaries and instruments that the vendor is providing. The Technical Data Manual/Mechanical Catalogue shall include the following documents as a minimum:

i) All drawings and data as listed in the vendor data index & schedule. (For drawings, where purchaser's approval is required, the final certified drawings shall be attached.) Sections shall be organised in a manner that data & drawings related to one subject is grouped together such as Mechanical, Electrical, Instrumentation etc.

ii) All manufacturing, inspection and test data and records.

iii) Installation and Instruction Manual

The vendor shall provide sufficient written instructions, including a cross-reference list of all drawings, to enable the purchaser to correctly install the equipment and prepare the equipment for start-up. It shall include any special information required for proper installation that is not on the drawings, special alignment or grouting procedures, utility specifications (including quantity) and all installation data. It shall also contain the following information:

(a) Instructions for erecting, piping, aligning (including the expected thermally induced shaft centerline shift between normal site ambient temperature position and that at normal equipment operating temperature).

(b) A description of rigging procedures, including the lifting of the assembled equipment, and methods of disassembly, repair, adjustment, inspection and reassembly of the equipment and auxiliaries.

(c) Pre-commissioning/commissioning/functional test procedures and acceptance criterion.

iv) Operation and Maintenance Manual

This manual shall provide sufficient written instructions and data to enable purchaser to correctly operate and maintain the equipment ordered. It shall include a section to cover special instructions for operation at extreme environmental and/or extreme operating conditions. The following shall be included in this manual:

(a) Instructions covering start-up, normal shutdown, emergency shutdown, operating limits and routine operational procedures.

(b) A description of equipment construction features and the functioning of component parts or systems (such as control, lubrication, sealing systems etc.).

(c) Outline and sectional drawings, schematics and illustrative sketches in sufficient details to identify all parts and clearly show the operation of all equipment and components and the methods of inspection and repair. Standardised sectional drawings are acceptable only if they represent the actual construction of the equipment.

(d) The following maintenance information:

i. Maximum and minimum bearing, labyrinth and seal clearances including any other clearance between moving and stationary parts of the equipment affecting proper running and maintenance of the equipment.

ii. Instructions for measuring and adjusting cold clearances, shaft runout, concentricity etc.

iii. Rotor float allowance.

iv. Interference fits on parts that are required to be removed or replaced for maintenance of normally consumable spares.

v. Balancing data with permissible tolerances.

vi. Lubricating schedules indicating recommended grades of oil, their properties, replacement period etc.

vii. Normal maintenance procedure.

viii. Preventive maintenance schedules and criterion for replacement of parts.

ix. Trouble - shooting procedures.

(e) The following reassembly information:

i. Bolting sequence and torque values for all bolts affecting equipment

performance/integrity/safety.

ii. Reassembly sequences together with required inspection checks.

iii. Adjustment procedures to achieve required positions, clearances, float and so forth.

iv. Detailed procedures for pre-operational checks, including settings and adjustments.

v. Seals and coupling installation procedures.

vi. Parts list indicating cross-sectional drawings of various assemblies and sub-assemblies, part numbers, materials of construction (ASTM) etc.to facilitate identification of parts and for procurement of spares.

v) Following information shall also be included in the Technical Data Manual/Mechanical Catalogue:

a) Storage instructions for storing and preserving the equipment (including driver and all the auxiliary units) at the plant site before installation of the same.

b) Instructions for preserving the equipment after it has been installed. This is particularly required in cases where a long time gap is expected between equipment installation and commissioning.

c) Field performance test procedures and acceptance criterion.

5.2.6.3 Technical Data Manual/Mechanical Catalogue shall be in Hard board folder(s) of size 265 mm x 315 mm (10½" x 12½") and shall not be more than 90 mm thickness; it may be of several volumes and each volume shall have a volume number, index of volumes & index of contents of that particular volume.

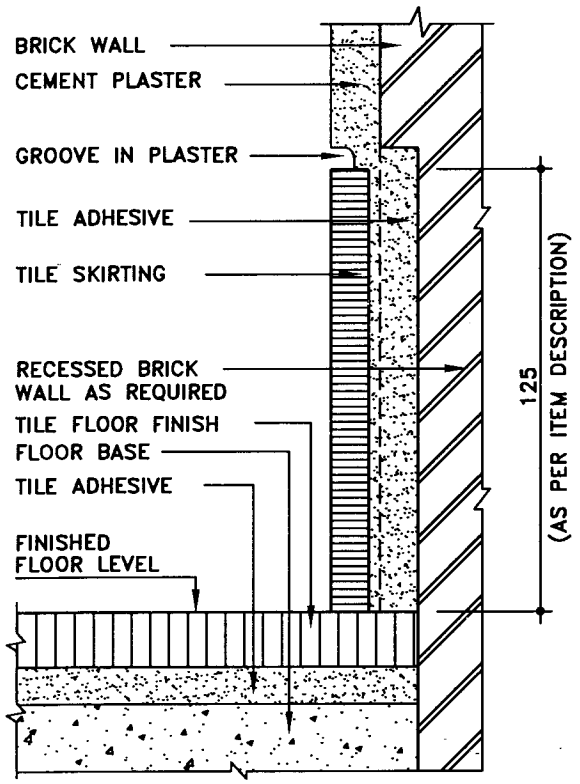
5.2.6.4 Title sheet (Top sheet) of each volume of Technical Data Manual/Mechanical Catalogue shall contain the contract information as defined under 5.2.1.2 besides the volume number.

5.2.6.5 In case order contains more than one item, separate dedicated mechanical catalogues shall be submitted for each item.

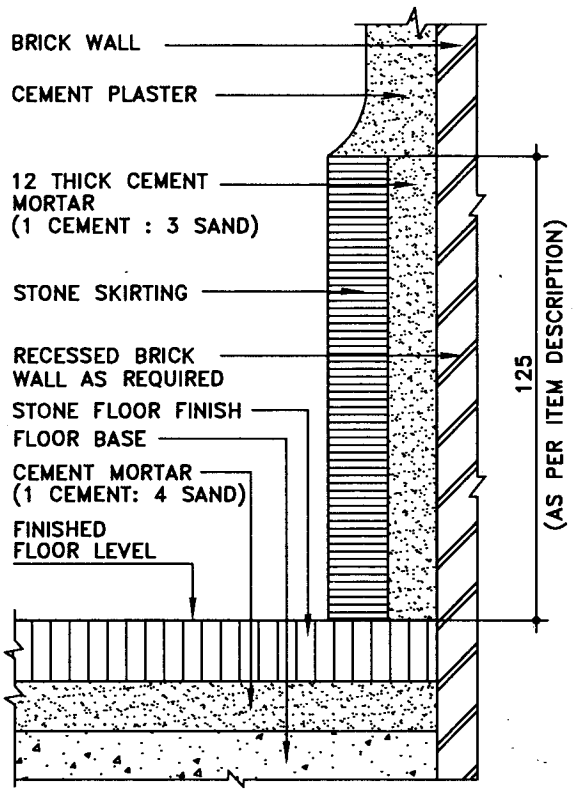
5.2.6.6 Final documentation shall be submitted in hard copy and soft (CDs/ DVDs) in addition to submission through EIL VDM portal. The number of prints and/or reproducible required to be submitted by vendor are specified in Purchaser's inquiry/order.

5.2.6.7 All post order documents shall be submitted / approved through EIL VDM portal.

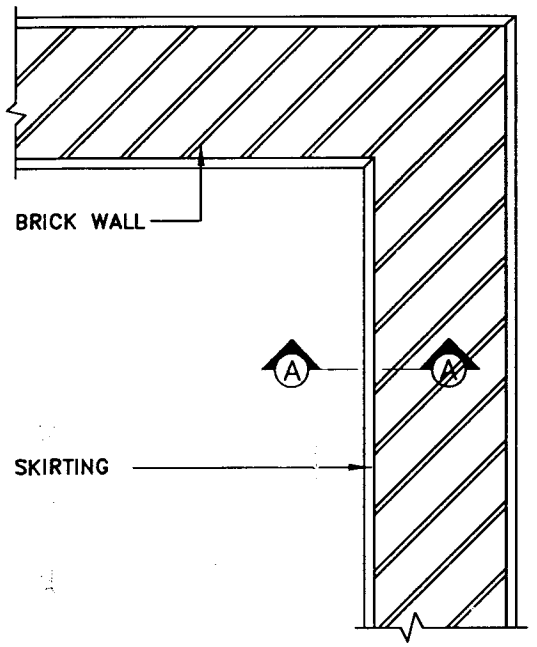
SKIRTING DETAIL (WITH BRICK WALL)



SECTION A–A
(TILE FLOORING–FLUSH SKIRTING)

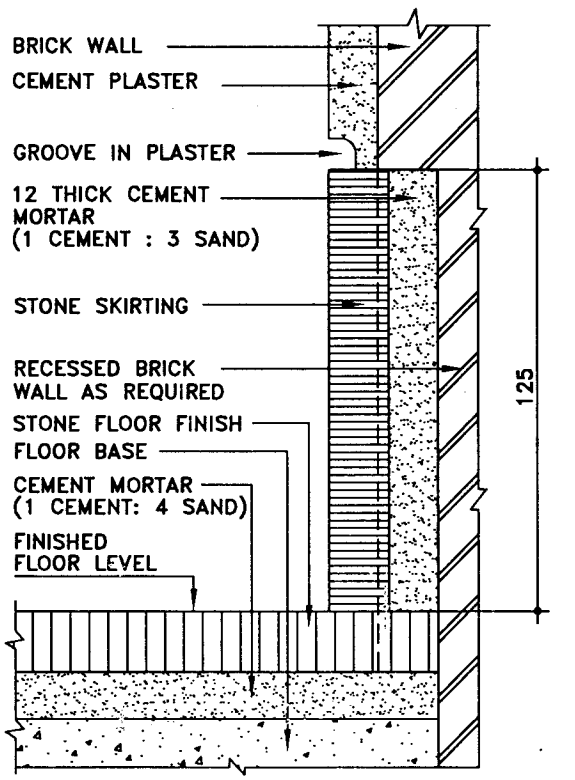


SECTION A–A
(STONE FLOORING–RAISED SKIRTING)



PLAN

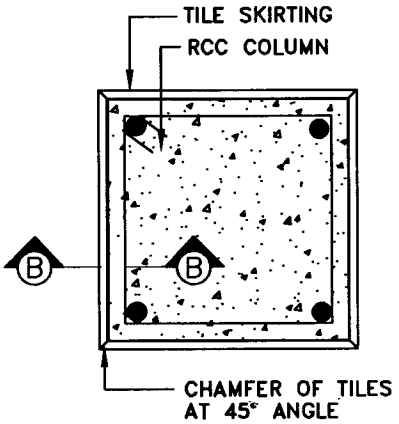
NOTE: ALL DIMENSIONS ARE IN MM



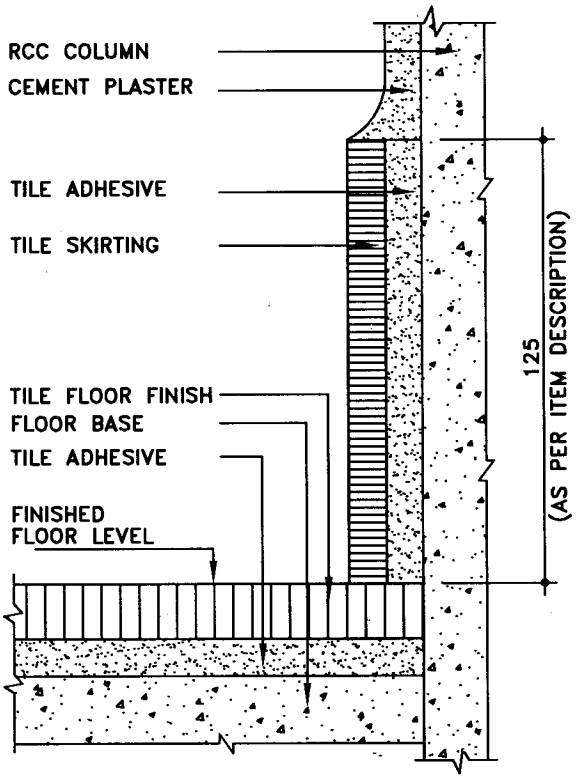
SECTION A–A
(STONE FLOORING–FLUSH SKIRTING)

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	11.02.22	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	ANISH MAHALA	SAMIR DAS	SANJAY MAZUMDAR
5	07.11.16	REAFFIRMED & ISSUED AS STANDARD	DK	JS/JKB	RAJANJI SRIVASTAVA	R. NANDA

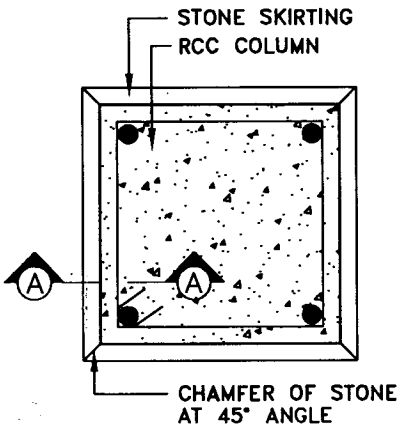
Approved by



PLAN
(TILE SKIRTING)



SECTION B–B



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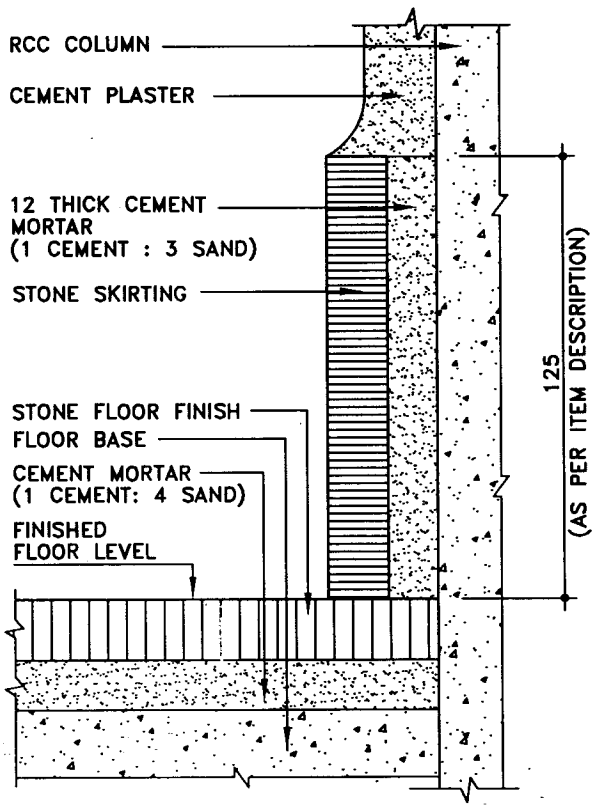
(STONE SKIRTING)



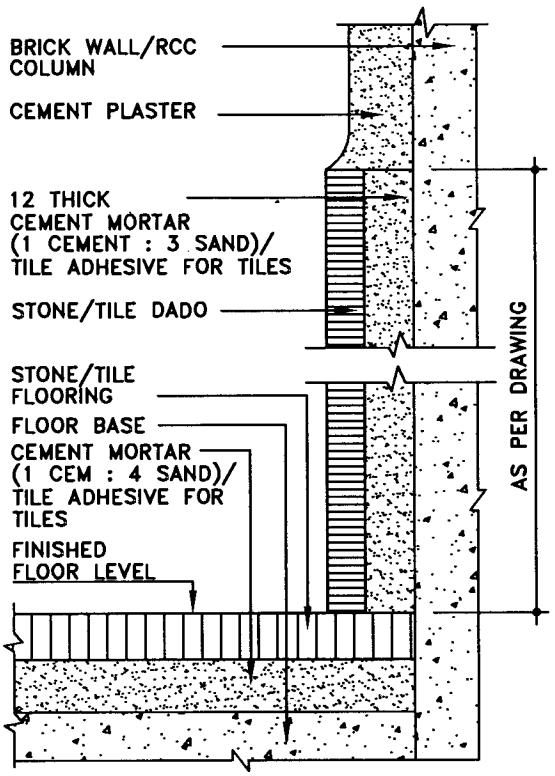
SECTION A–A

NOTE: ALL DIMENSIONS ARE IN MM

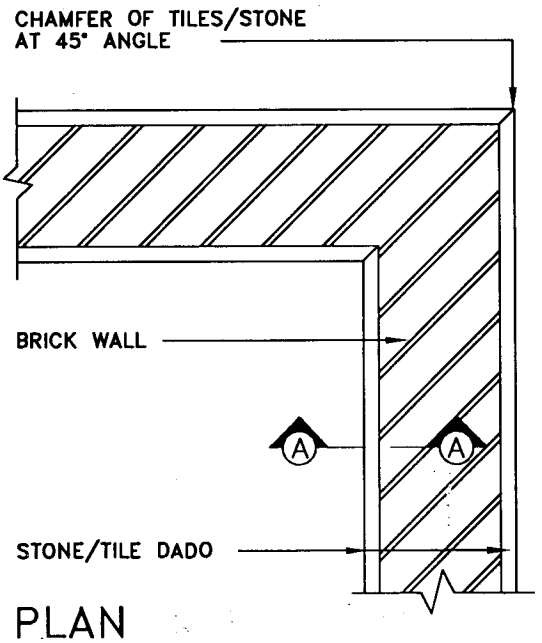
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	11.02.22	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	ANISH MAHALA	SAMIR DAS	SANJAY MAZUMDAR
5	07.11.16	REAFFIRMED & ISSUED AS STANDARD	DK	JS/JKB	RAJANJI SRIVASTAVA	R. NANDA

Approved by

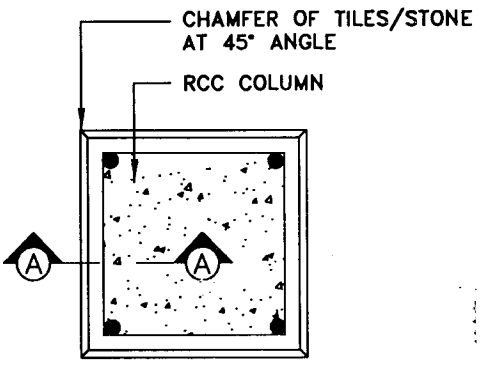
DADO DETAIL
(WITH BRICK WALL AND RCC COLUMN)



SECTION A–A



PLAN
(DADO ON BRICK WALL)

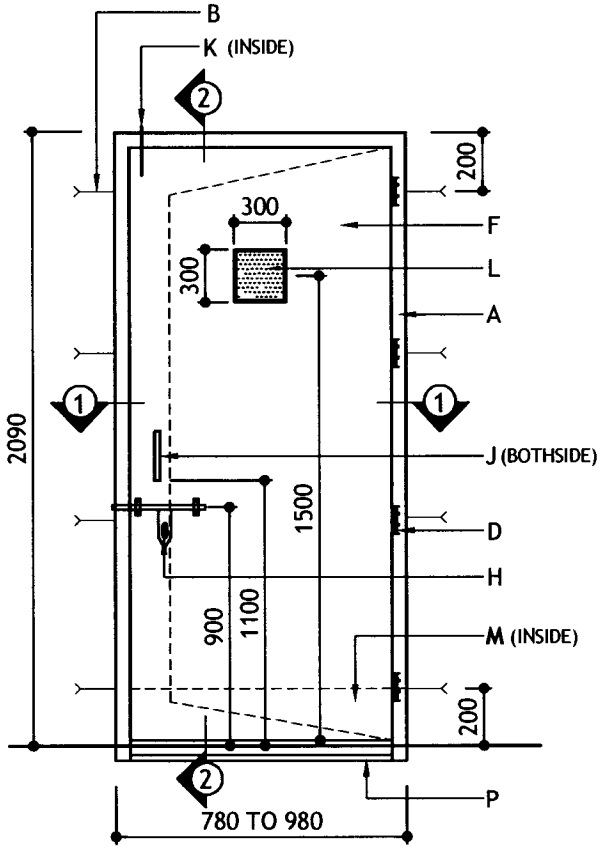


PLAN
(DADO ON RCC COLUMN)

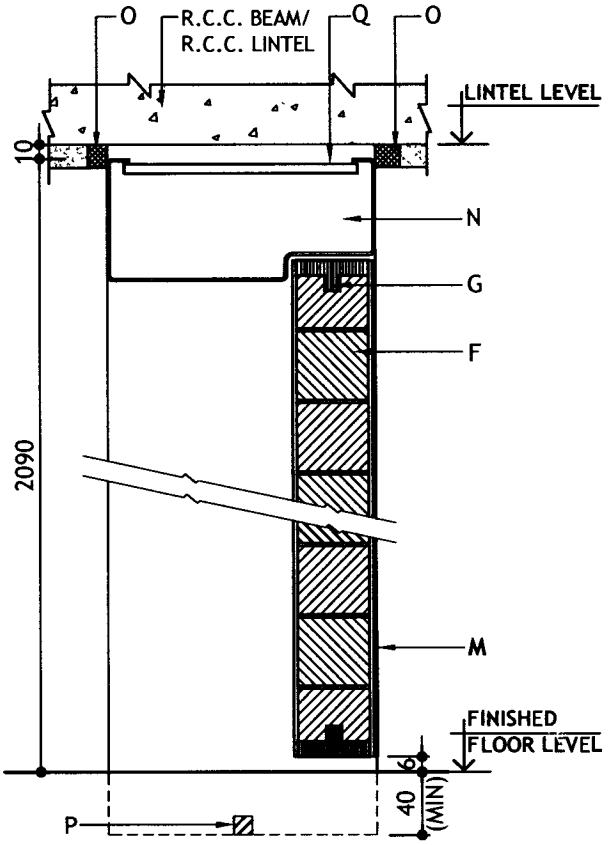
NOTE: ALL DIMENSIONS ARE IN MM

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
6	11.02.22	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	ANISH MAHALA	SAMIR DAS	SANJAY MAZUMDAR
5	07.11.16	REAFFIRMED & ISSUED AS STANDARD	DK	JS/JKB	RAJANJI SRIVASTAVA	R. NANDA

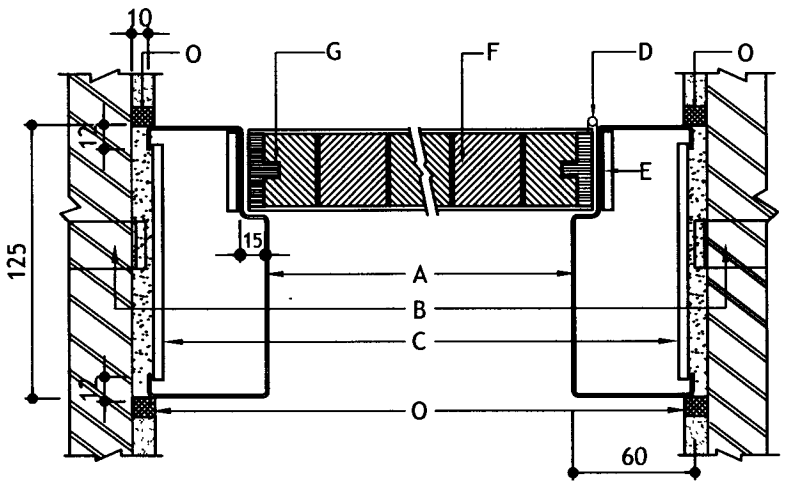
WOODEN FLUSH DOOR
(WITH PRESSED STEEL FRAME)



ELEVATION



SECTION 2-2



SECTION 1-1

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. FOR SHUTTER FINISH REFER TO DRAWINGS AS/TENDER ITEM.
3. DOOR CLOSER & DOOR STOPPER SHALL BE PROVIDED AS PER TENDER ITEM.

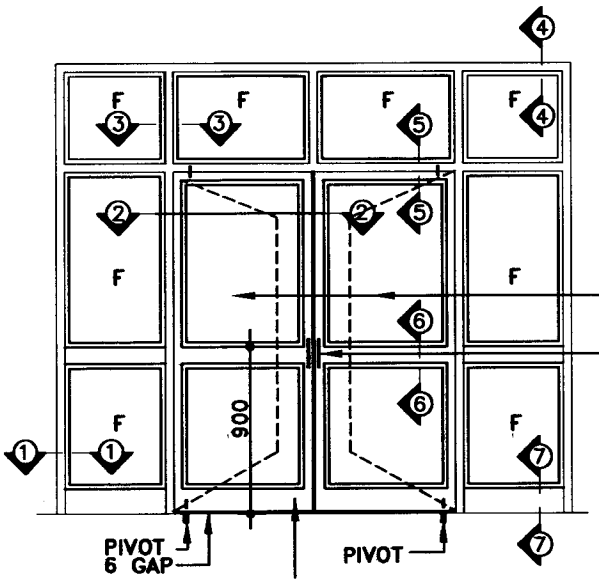
LEGEND :

A : 16 SWG PRESSED STEEL FRAME FINISHED AS PER TENDER ITEMS.
B : 25x6-300 LONG M.S. HOLDFAST/FASTENER @ MAXIMUM 600 C/C WELDED TO FRAME SPACER.
C : 50x6 THICK M.S. FLAT SPACER WELDED TO FRAME AT HOLD FAST LOCATIONS.
D : 150 LONG M.S. BUTT HINGE @ MAXIMUM 600 C/C SCREWED TO FRAME AND SHUTTER.
E : 40x3-150 LONG M.S PAD WELDED TO FRAME AT ALL HINGE & LOCK LOCATIONS.
F : 35 THICK FLUSH DOOR SHUTTER (AS PER ITEM / SPECIFICATION).
G : TEAK WOOD LIPPING
H : ALDROP/MORTICE LOCK (AS PER REQUIREMENT)
J : HANDLE BOTHSIDE (AS PER REQUIREMENT).
K : 10 DIA x 250 LONG ALUMINIUM TOWER BOLT INSIDE.
L : VISION PANEL WITH 4mm THK GLASS WITH 15x15 TEAK WOOD BEADING (AS PER REQUIREMENT).
M : 200x3 PLASTIC KICK PLATES FIXED WITH STEEL SCREWS (AS REQUIRED).
N : CAVITY FILLED WITH CONCRETE OR PHENOLIC FOAM.
O : 12X10 GROOVE IN PLASTER FILLED WITH POLYSULPHIDE SEALANT.
P : 12mm M.S. SQUARE BAR (TIE) WELDED TO BOTH ENDS OF VERTICAL MEMBER OF FRAME.
Q : 25x3 THICK M.S. FLAT SPACER @500 C/C MAXIMUM.

Rev. No	Date	Purpose	Prepared by	Checked by	Stds Committee Convenor	Stds. Bureau Chairman
6	12.04.21	REVISED & ISSUED AS STANDARD	M L THAKUR	SAMIR DAS	ANURAG SINHA	SANJAY MAZUMDAR
5	19.10.15	REVISED & ISSUED AS STANDARD	BABITA/GJK	SD/JKB	RAJANJI SRIVASTAVA	S. CHANDA

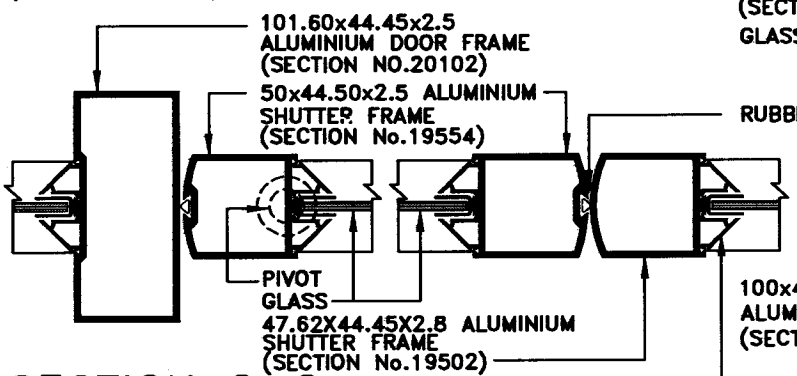
Approved by

GLAZED ALUMINIUM DOOR

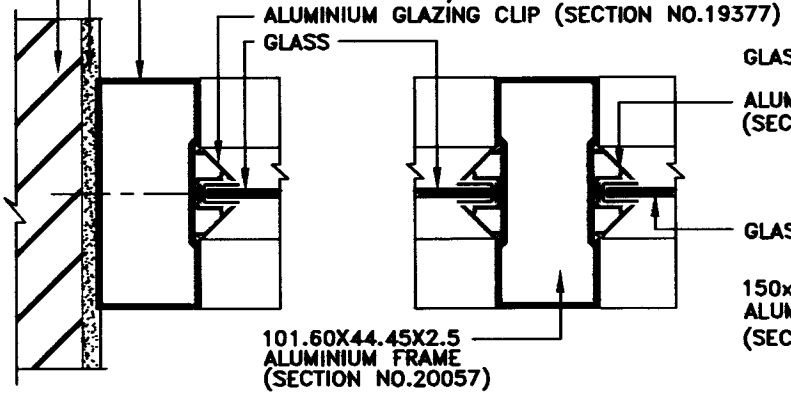


ELEVATION
(F-FIXED GLAZING)

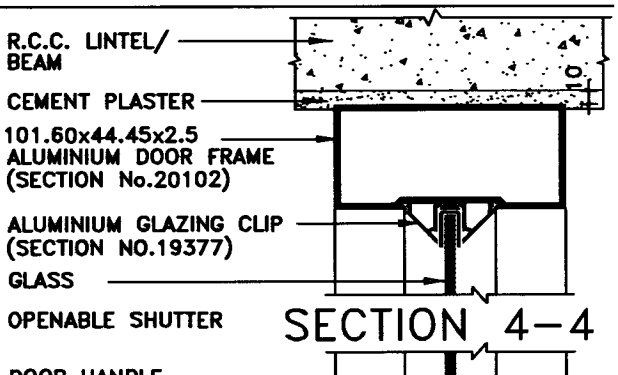
ALUMINIUM BOTTOM RAIL
(SECTION NO.19584)



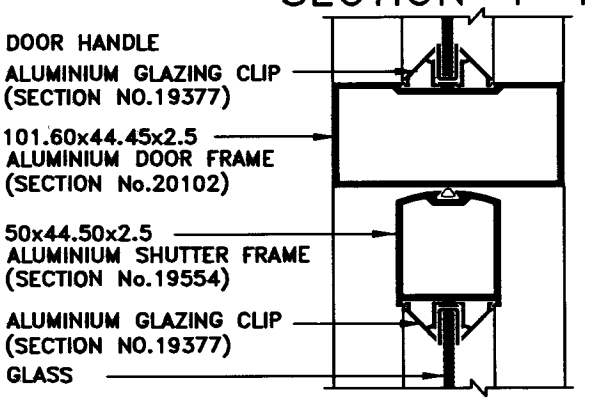
SECTION 2-2



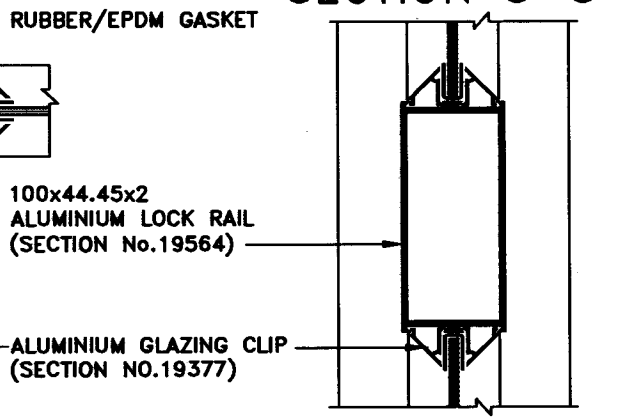
SECTION 1-1 SECTION 3-3



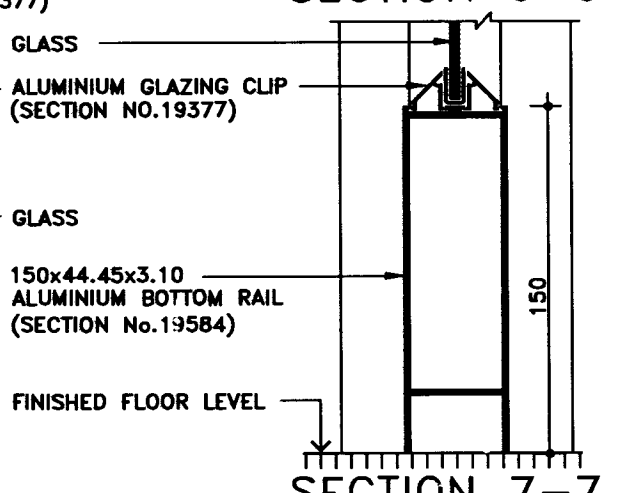
SECTION 4-4



SECTION 5-5



SECTION 6-6



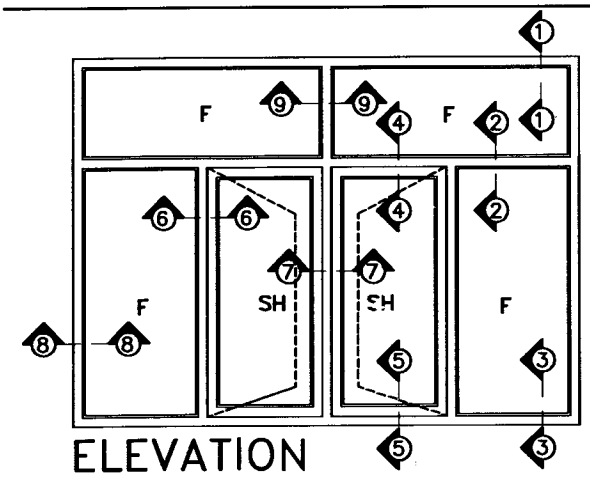
SECTION 7-7

NOTES:

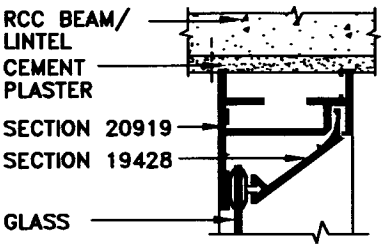
1. ALL DIMENSIONS ARE IN MM.
2. THE SECTION DESIGNATION NOS. PERTAIN TO EXTRUDED ALUMINIUM SECTIONS OF "JINDAL ALUMINIUM LTD." AND ARE INDICATED FOR REFERENCE. EQUIVALANT SECTIONS OF OTHER APPROVED MANUFACTURERS CAN ALSO BE USED.
3. FOR FINISHING OF ALUMINIUM SECTION (ANODISED/POWDER COATING) REFER BID/TENDER.
4. RUBBER/EPDM GASKET SHALL BE USED FOR FIXING OF GLASS.
5. HARDWARE SHALL BE AS PER BID/TENDER.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	02.02.22	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	ANISH MAHALA	SAMIR DAS	SANJAY MAZUMDAR
5	21.03.17	REAFFIRMED & ISSUED AS STANDARD	DK	JS/JKB	RAJANJI SRIVASTAVA	R. NANDA

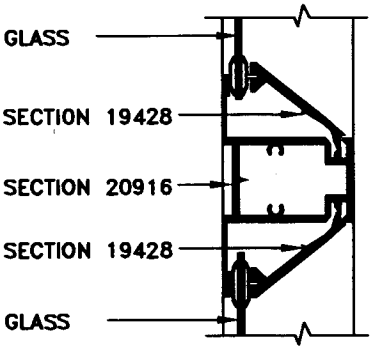
Approved by



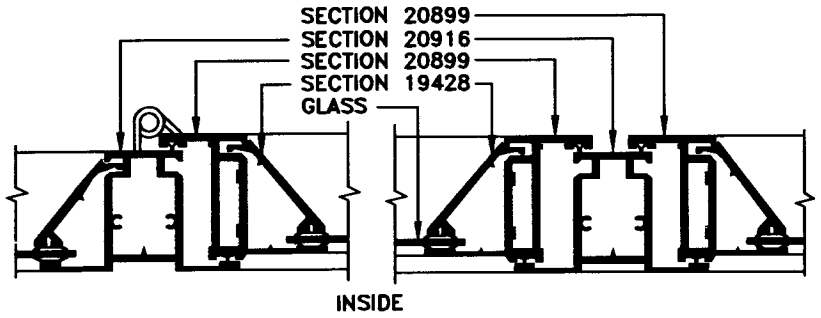
ELEVATION
(F–FIXED GLAZING)
(SH–SIDE HUNG SHUTTER)



SECTION 1–1

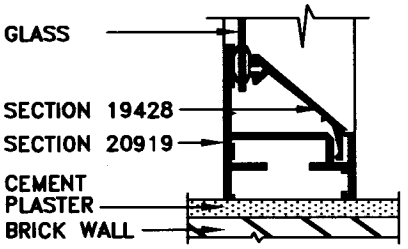


SECTION 2–2

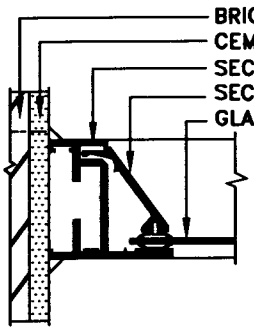


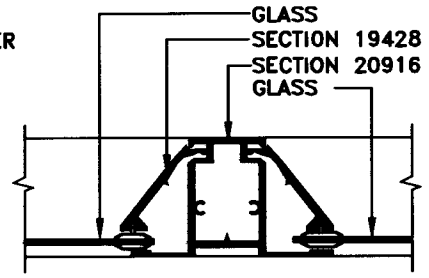
SECTION 6–6

SECTION 7–7



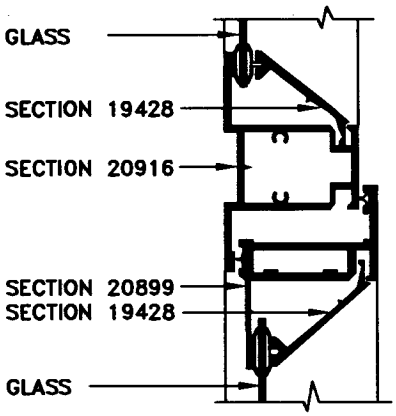
SECTION 3–3



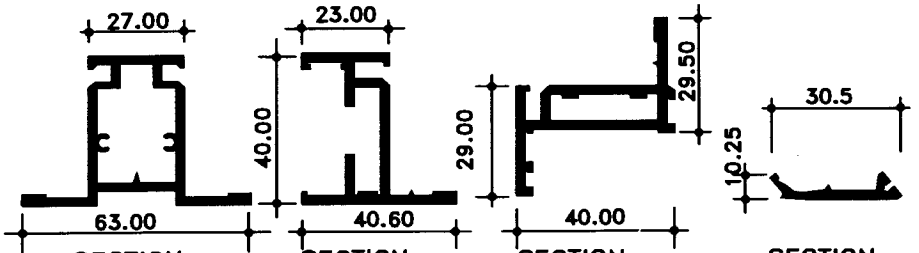


SECTION 8–8

SECTION 9–9



SECTION 4–4



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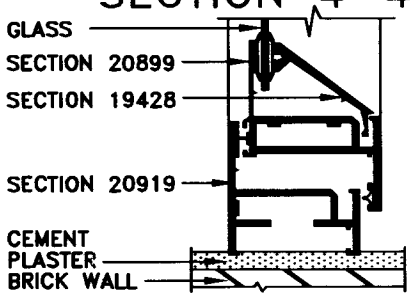
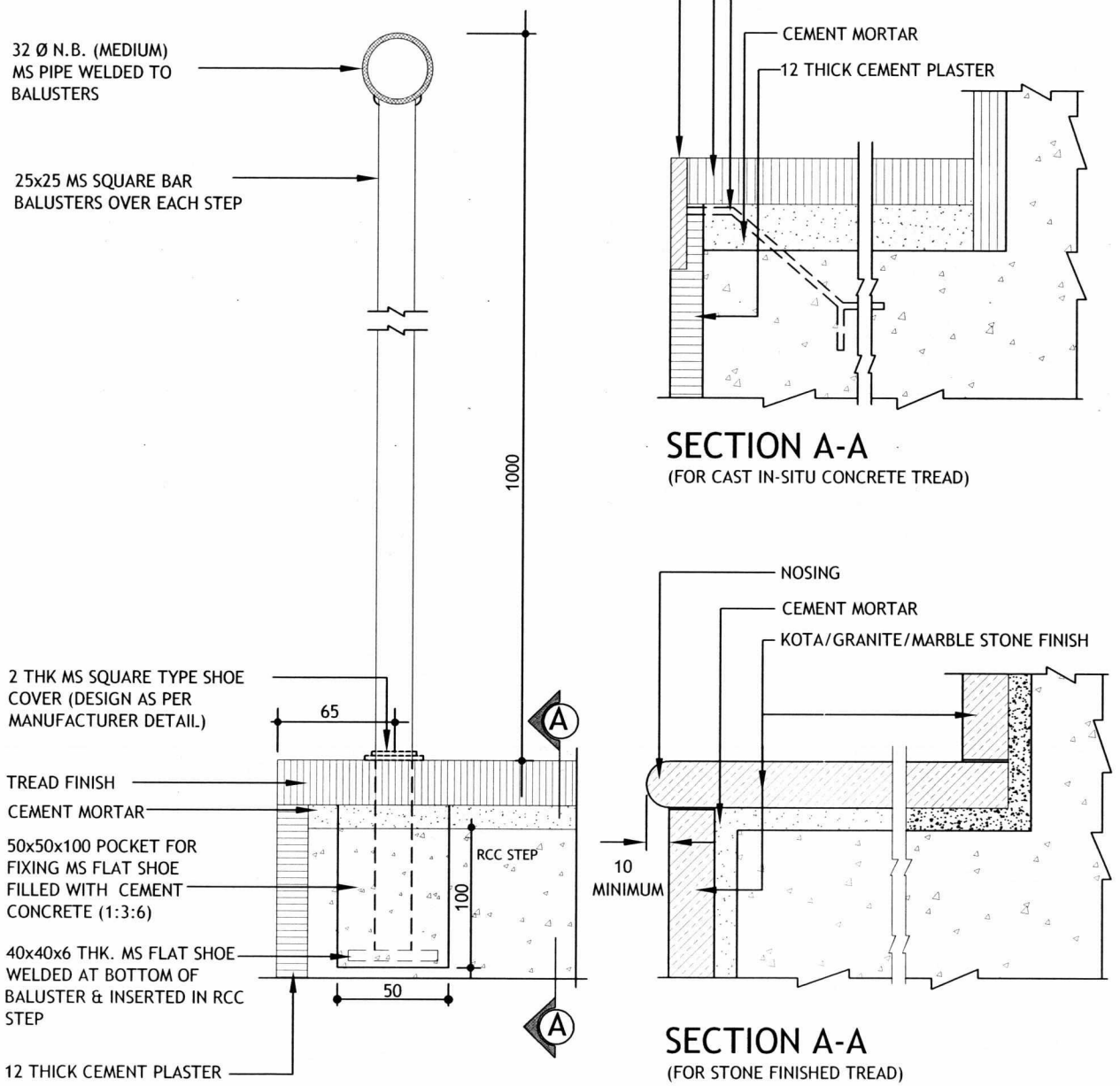


SECTION 5–5

NOTE:
1. ALL DIMENSIONS ARE IN MM.
2. THE SECTION DESIGNATION NOS. PERTAIN TO EXTRUDED ALUMINIUM SECTIONS OF "JINDAL ALUMINIUM LTD." AND ARE INDICATED FOR REFERENCE. EQUIVALANT SECTIONS OF OTHER APPROVED MANUFACTURERS CAN ALSO BE USED.
3. FOR FINISHING OF ALUMINIUM SECTION (ANODISED/POWDER COATING REFER BID/TENDER.
4. RUBBER/EPDM GASKET SHALL BE USED FOR FIXING OF GLASS.
5. HARDWARE AND GLASS SHALL BE AS PER BID/TENDER.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	02.02.22	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	ANISH MAHALA	SAMIR DAS	SANJAY MAZUMDAR
5	21.03.17	REAFFIRMED & ISSUED AS STANDARD	DK	JS/JRB	RAJANJI SRIVASTAVA	R. NANDA

Approved by

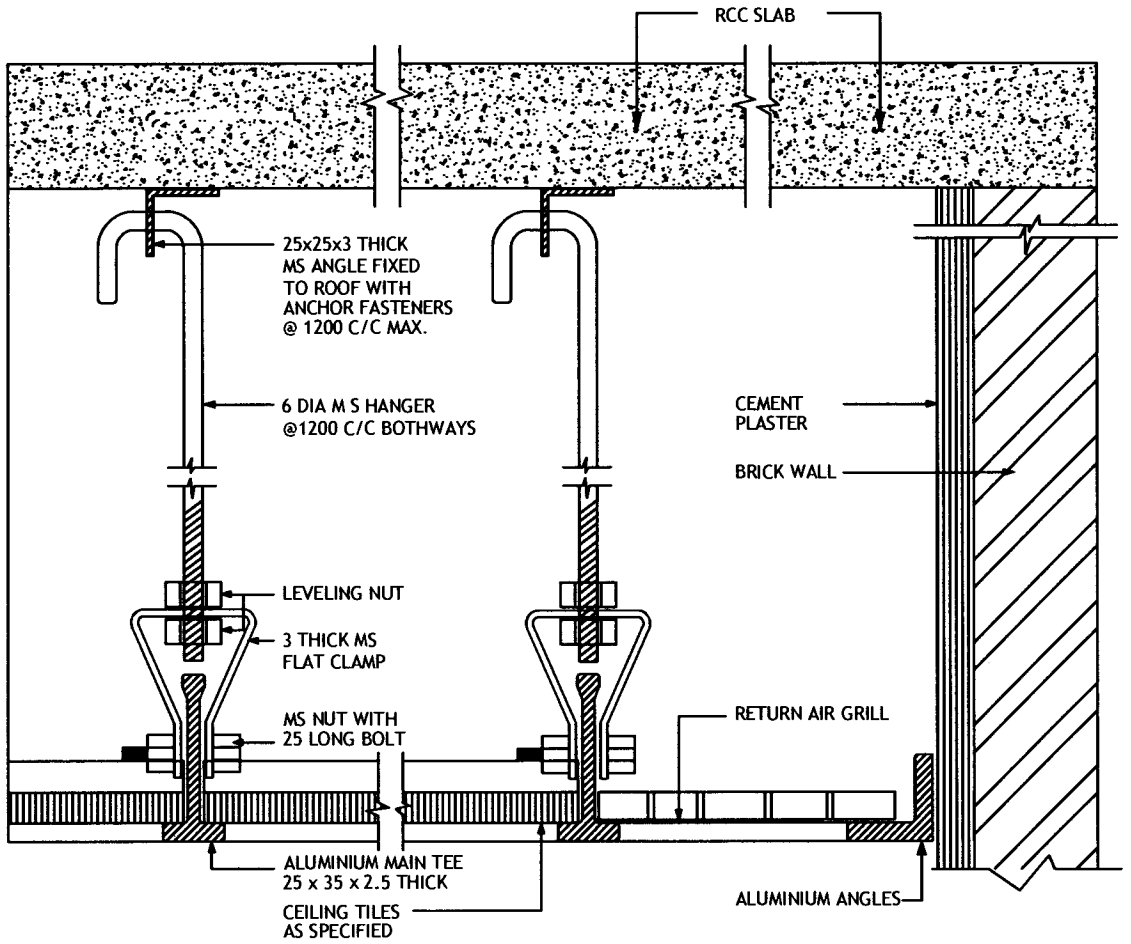


DETAIL OF HANDRAIL

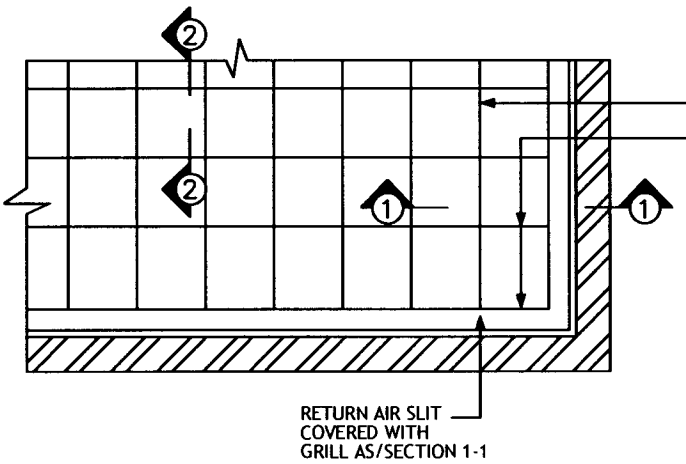
NOTE: 1. ALL DIMENSIONS ARE IN MM.
2. RISER, TREAD AND SKIRTING SHALL BE OF SAME FINISH

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
7	16.10.23	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	SANDEEP	SAMIR DAS	SANJAY MAZUMDAR
6	02.01.19	ISSUED AS STANDARD	SG	SD	RS	R K TRIVEDI

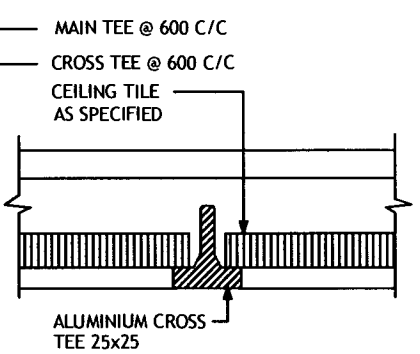
Approved by



SECTION AT 1-1



PLAN (PART)

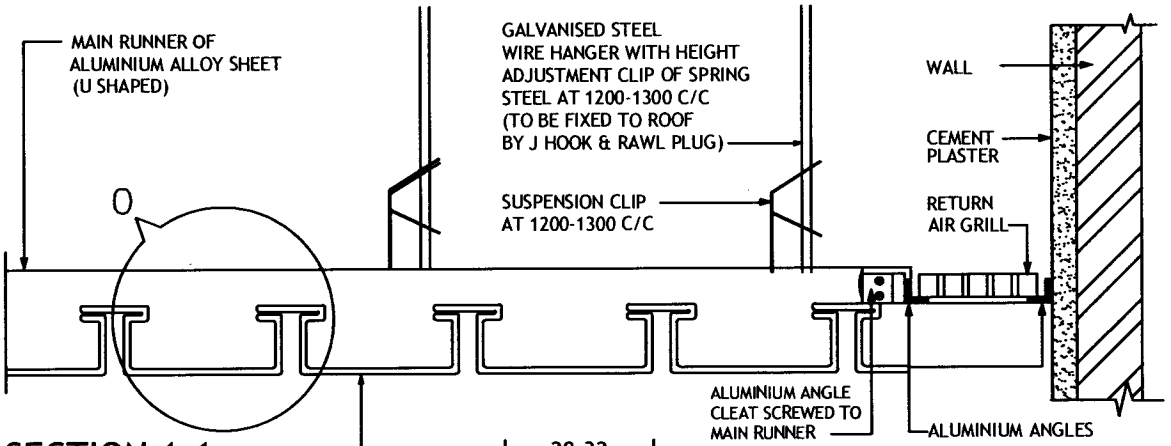


SECTION AT 2-2

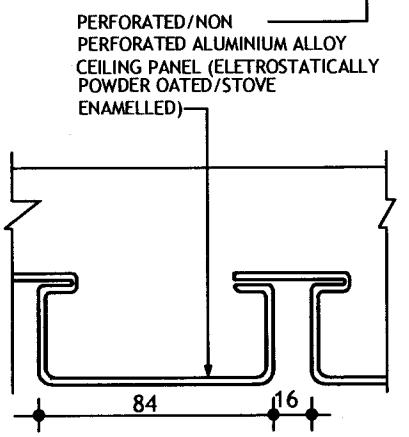
(ELECTRICAL, A/C FIXTURE LOCATIONS SHALL BE AS PER DETAIL DRAWING)
NOTE: ALL DIMENSIONS ARE IN MILLIMETRES.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	30.03.21	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	SAMIR DAS	ANURAG SINHA	SANJAY MAZUMDAR
5	02.03.16	REVISED & ISSUED AS STANDARD	DK	SD/JKB	RAJANJI SRIVASTAVA	S. CHANDA

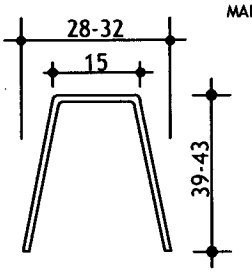
Approved by



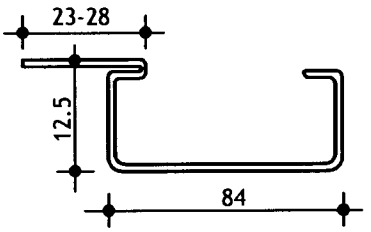
SECTION 1-1



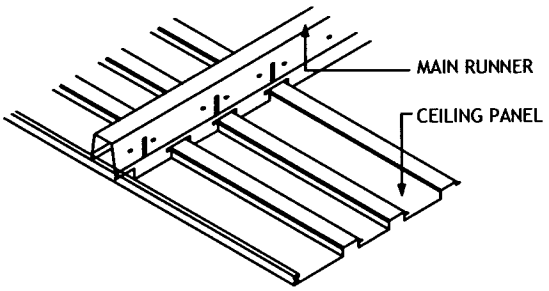
DETAIL AT 'O'



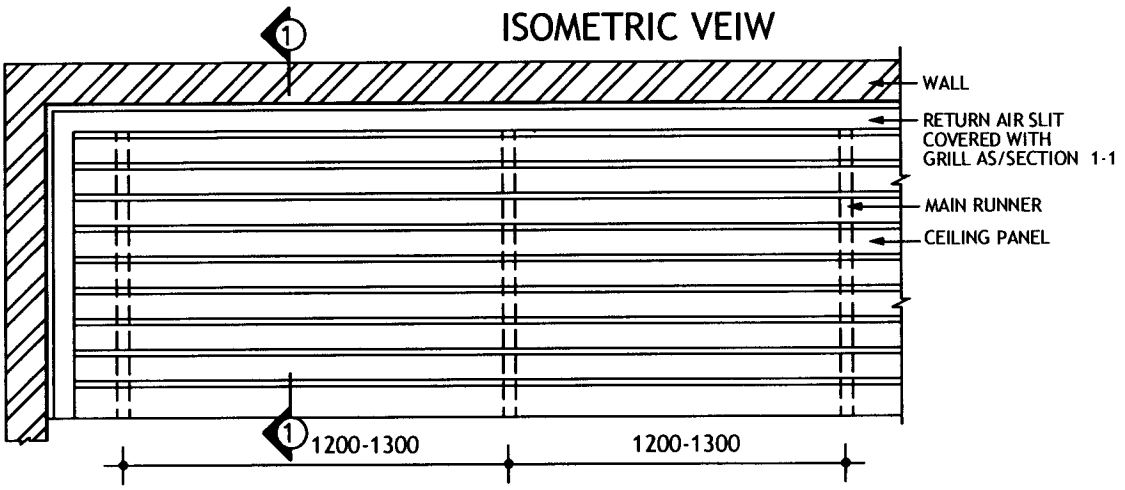
SECTION
(MAIN RUNNER)



SECTION
(PANEL)



ISOMETRIC VEIW

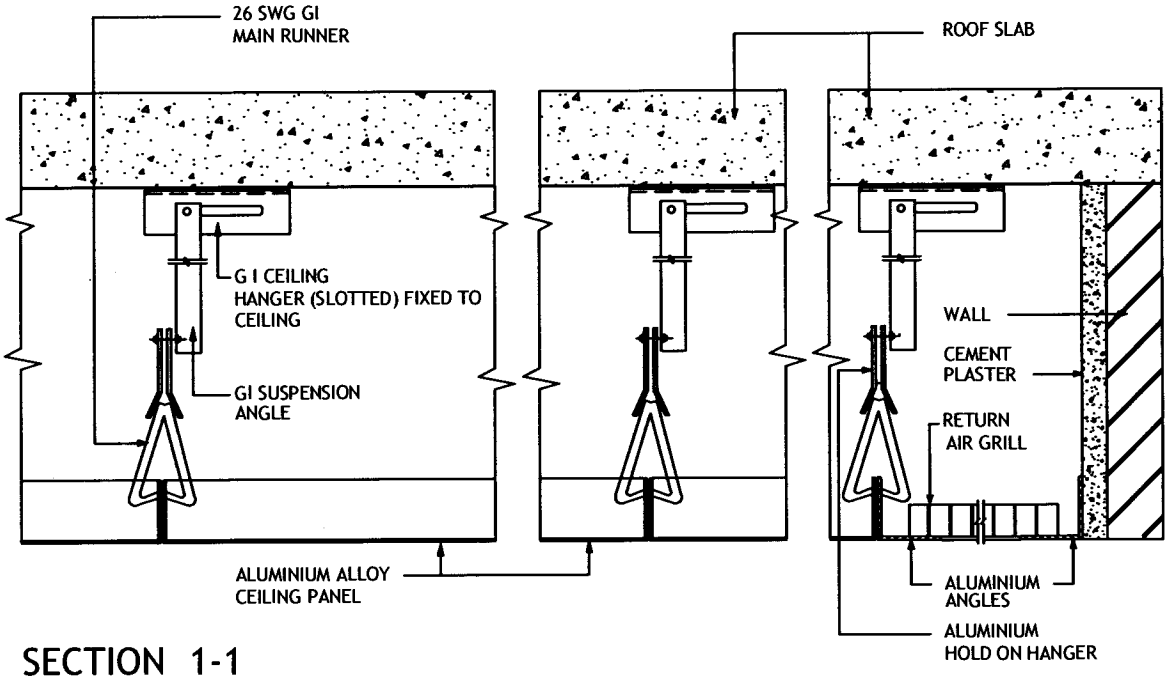


REFLECTED CEILING PLAN (PART)

(ELECTRICAL, A/C FIXTURE LOCATIONS SHALL BE AS PER DETAIL DRAWING)

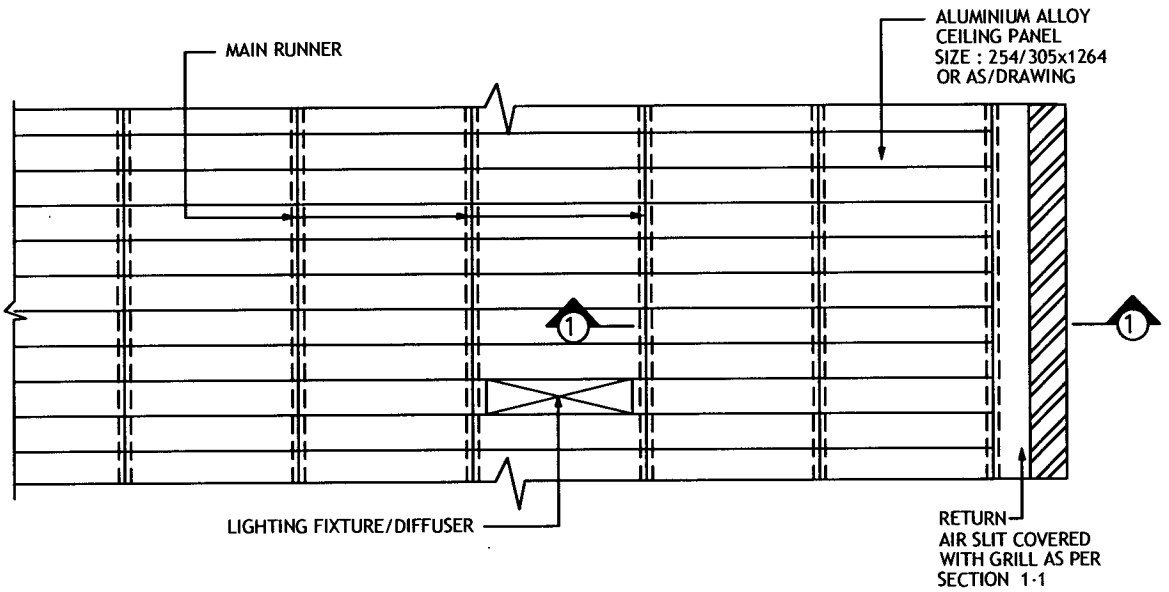
NOTE: ALL DIMENSIONS ARE IN MILLIMETRES.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
6	30.03.21	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	SAMIR DAS	ANURAG SINHA	SANJAY MAZUMDAR
5	02.03.16	REVISED & ISSUED AS STANDARD	DK	SD/JKB	RAJANJI SRIVASTAVA	S. CHANDA



SECTION 1-1

(HANGING/SUSPENSION ARRANGEMENT CAN VARY FROM VENDOR TO VENDOR)



REFLECTED CEILING PLAN (PART) (LINEAR PANEL)

(ELECTRICAL, A/C FIXTURE LOCATIONS SHALL BE AS PER DETAIL DRAWING)
NOTE: ALL DIMENSIONS ARE IN MILLIMETRES.

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					Approved by	
6	30.03.21	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	SAMIR DAS	ANURAG SINHA	SANJAY MAZUMDAR
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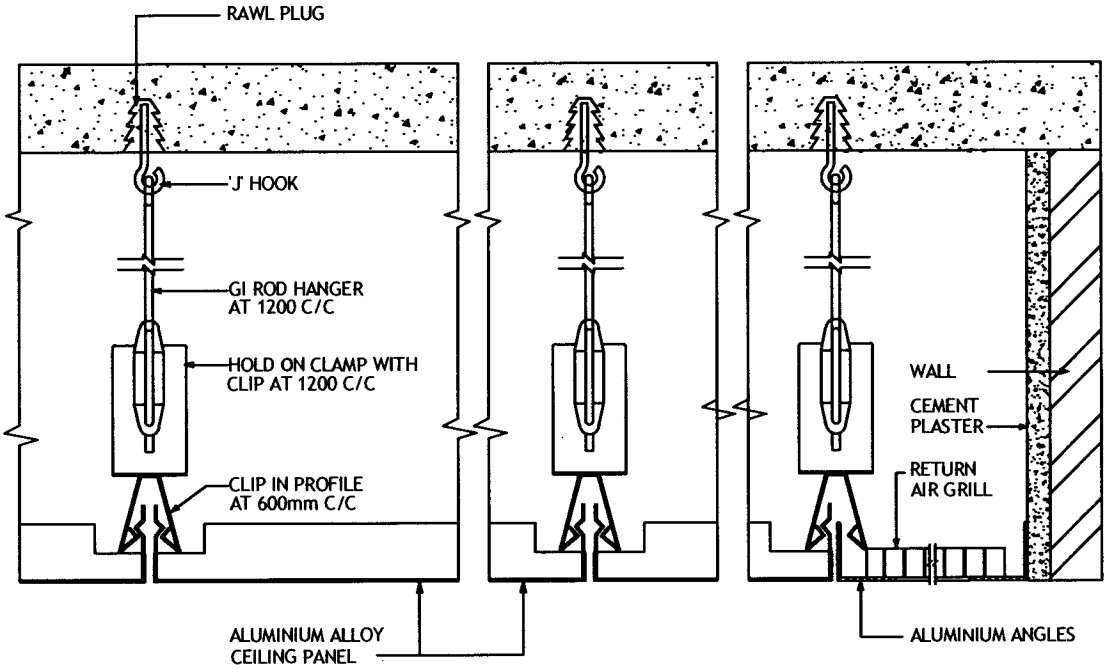
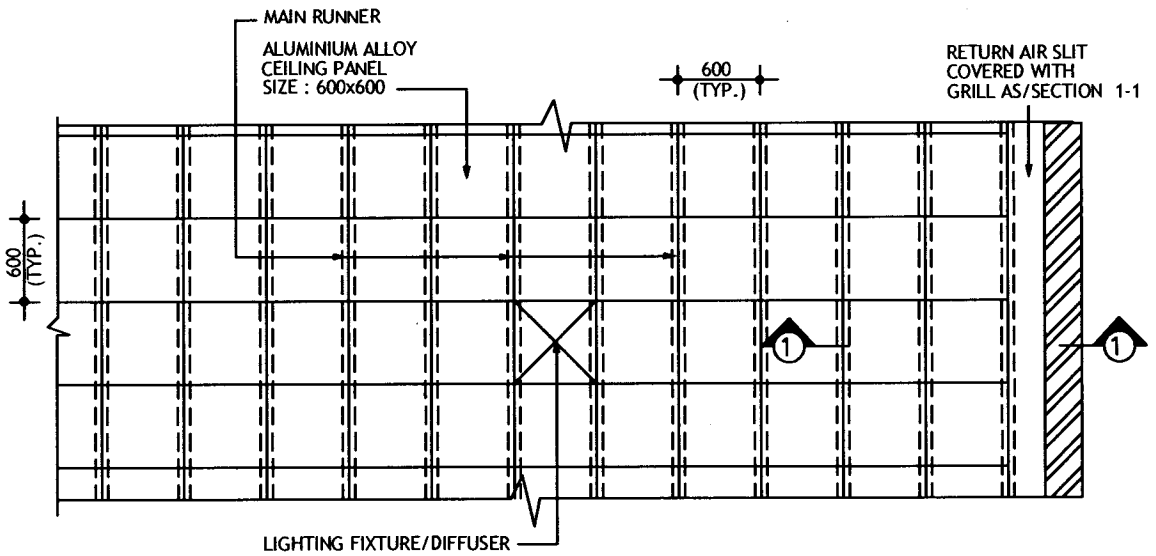


SECTION 1-1

(HANGING/SUSPENSION ARRANGEMENT CAN VARY FROM VENDOR TO VENDOR)



REFLECTED CEILING PLAN (PART) (600mm X 600mm PANELS)

(ELECTRICAL, A/C FIXTURE LOCATIONS SHALL BE AS PER DETAIL DRAWING)

NOTE: ALL DIMENSIONS ARE IN MILLIMETRES.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
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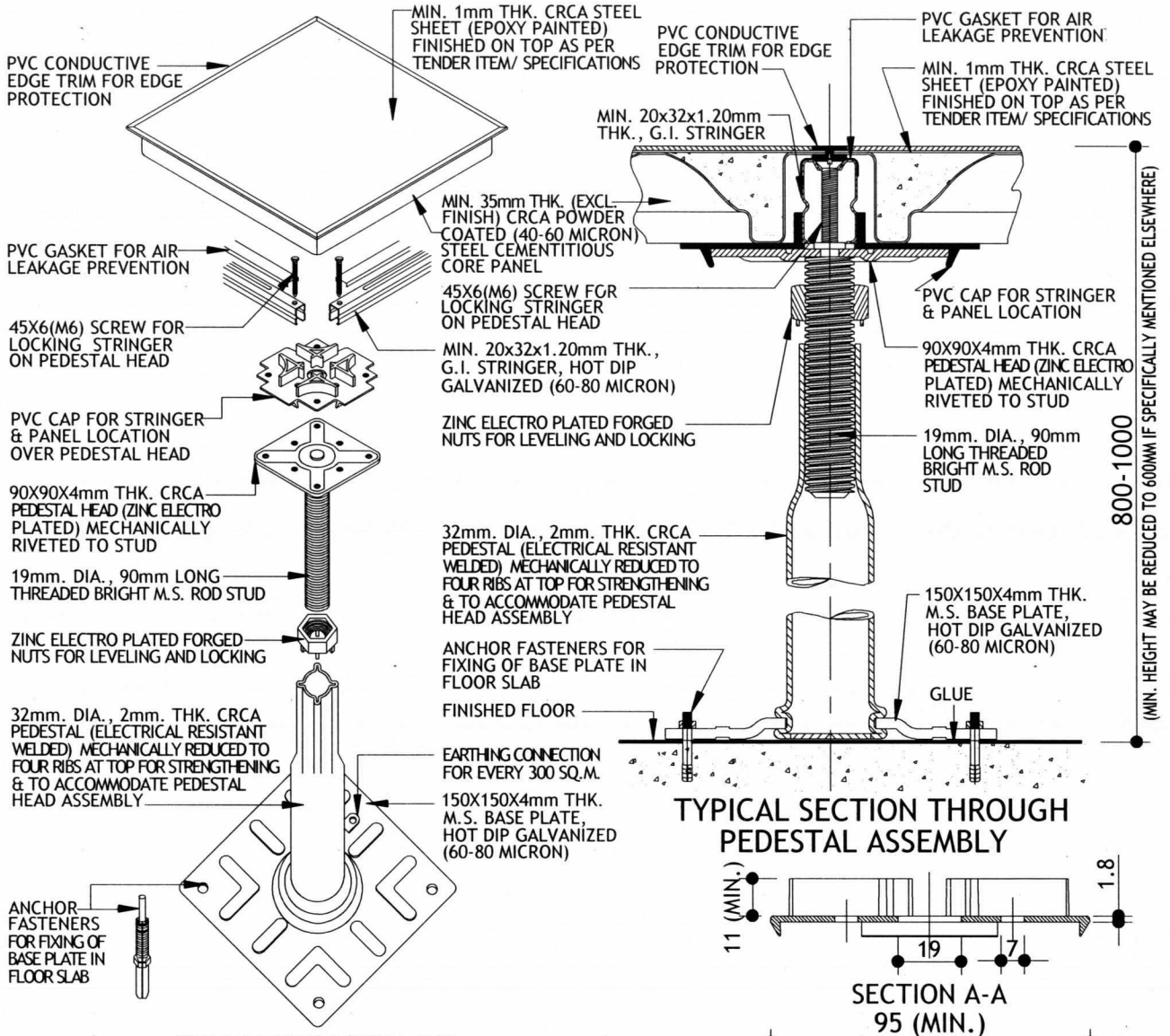
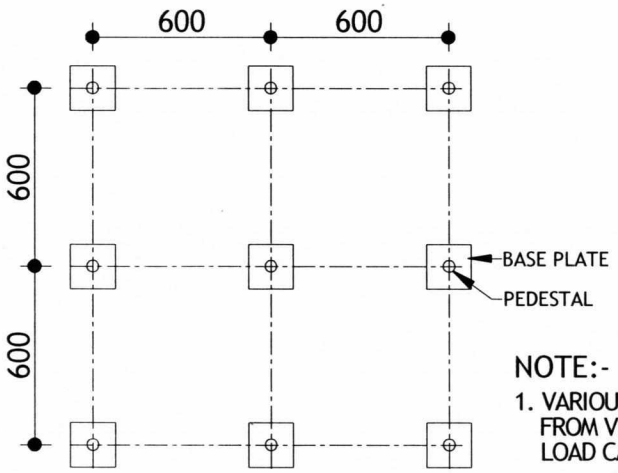


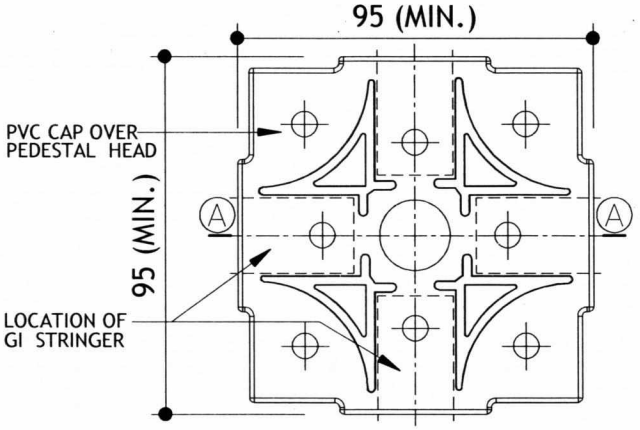
ISOMETRIC VIEW OF PEDESTAL ASSEMBLY

TYPICAL SECTION THROUGH PEDESTAL ASSEMBLY

SECTION A-A



PART GRID PLAN (PEDESTALS)



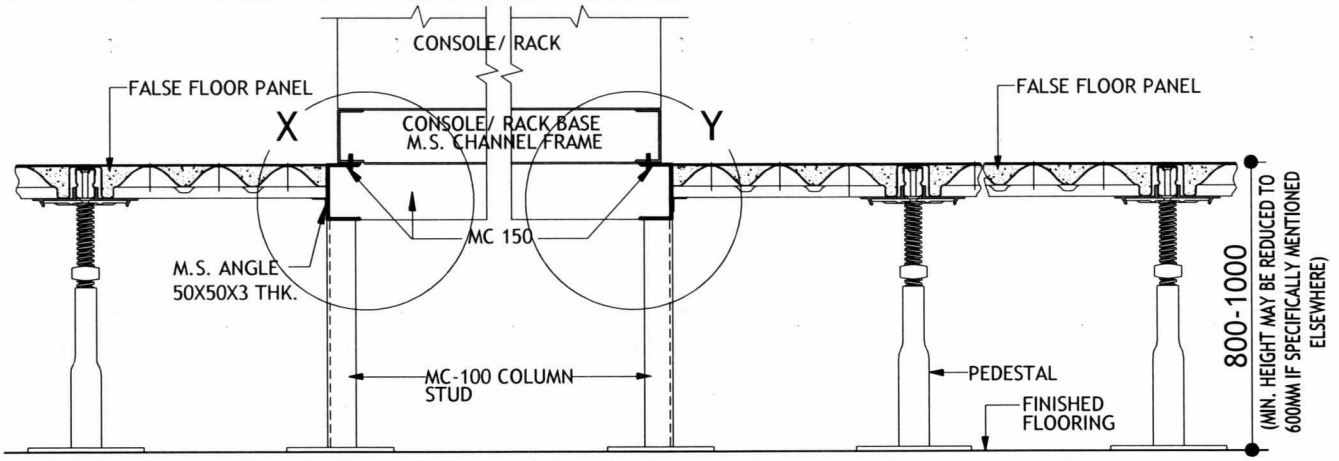
TOP VIEW OF CAP FOR PEDESTAL HEAD

NOTE:-

1. VARIOUS COMPONENTS' DIMENSIONS, SHAPES ETC. MAY VARY SLIGHTLY FROM VENDOR TO VENDOR. HOWEVER THE SYSTEM SHALL HAVE THE LOAD CARRYING CAPACITY AS PER ITEM DESCRIPTION & SPECIFICATIONS.
2. THE BASE FLOOR AND WALL PORTION UNDERNEATH THE FALSE FLOOR SHALL BE PROVIDED ONE COMPONENT POLYURETHANE COATING.

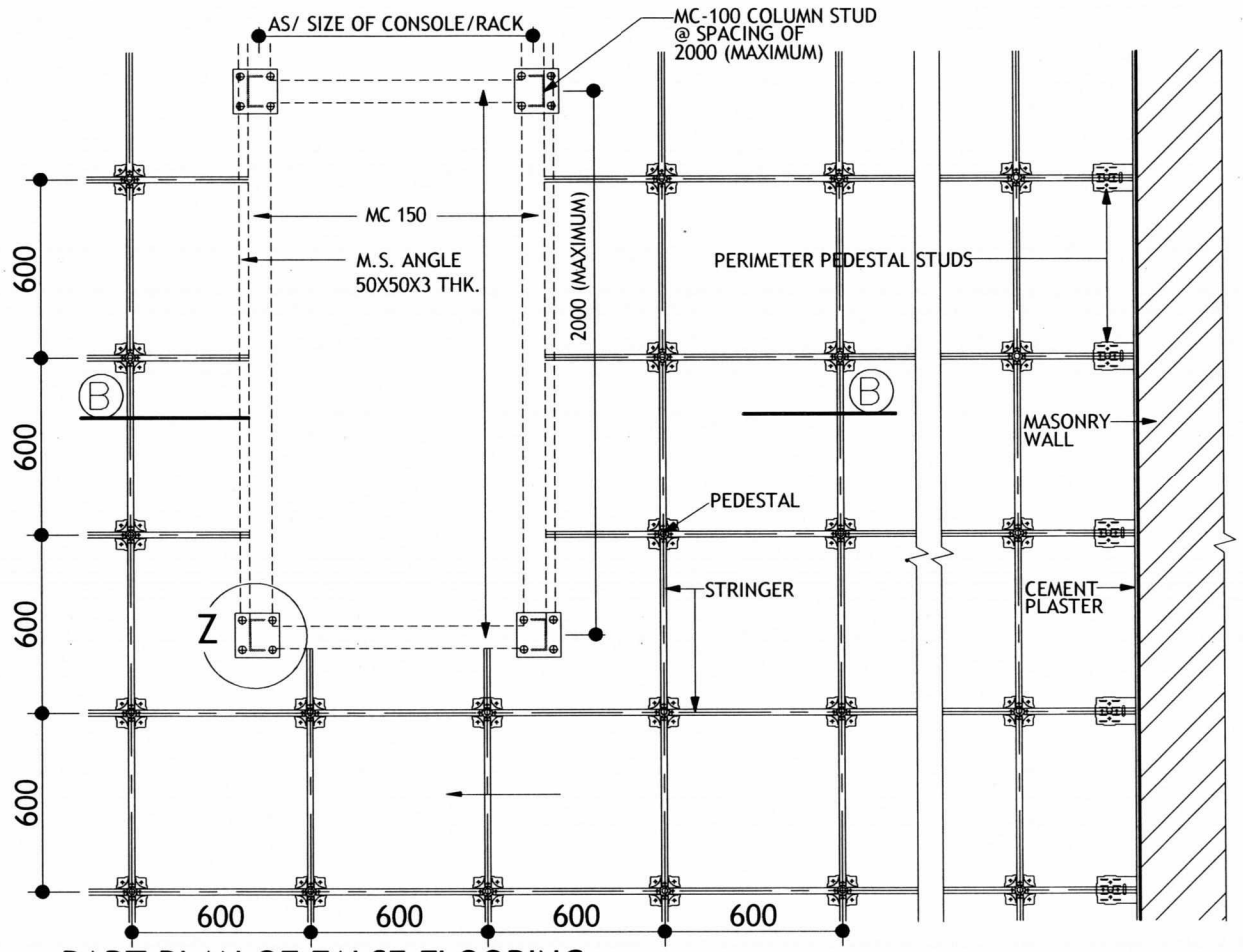
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
3	22.09.22	REVISED & ISSUED AS STANDARD	BABITA SHARMA	ATUL GUPTA	SAMIR DAS	SANJAY MAZUMDAR
2	11.02.22	REAFFIRMED & ISSUED AS STANDARD	ATUL GUPTA	SAMIR DAS	ANURAG SINHA	SANJAY MAZUMDAR

Approved by

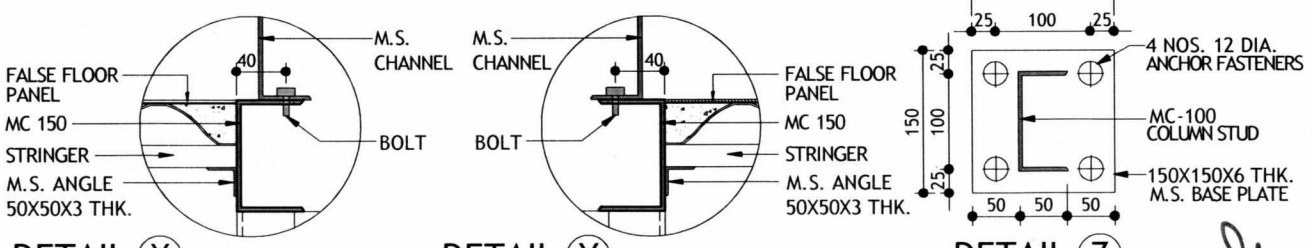


SECTION B-B

AS/ SIZE OF CONSOLE/ RACK

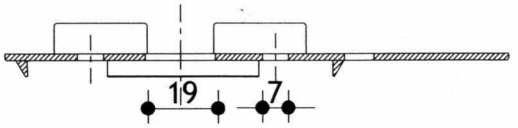


PART PLAN OF FALSE FLOORING

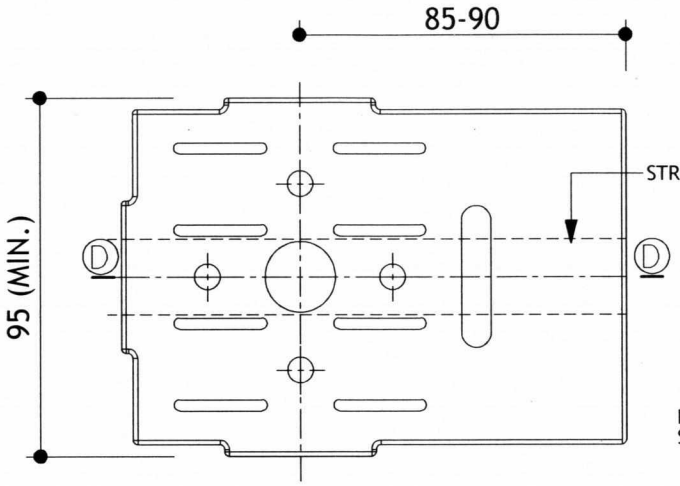


DETAIL (X) DETAIL (Y) DETAIL (Z)

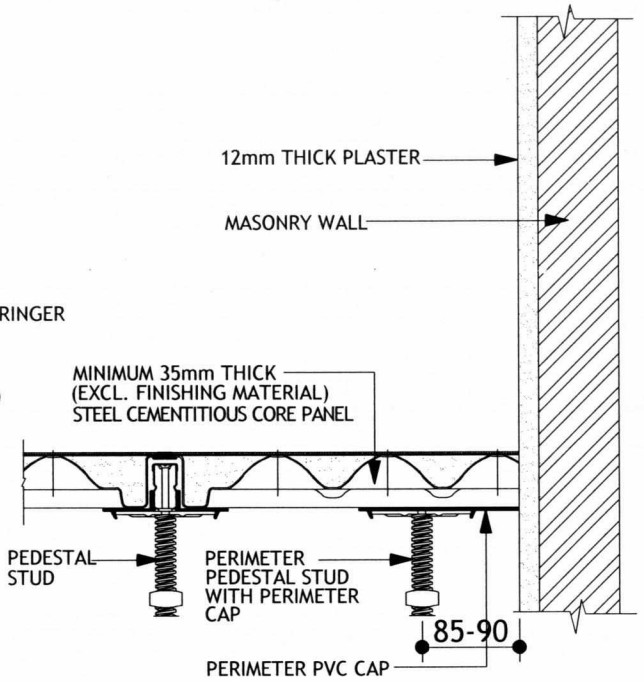
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
3	22.09.22	REVISED & ISSUED AS STANDARD	BABITA SHARMA	ATUL GUPTA	SAMIR DAS	SANJAY MAZUMDAR
2	11.02.22	REAFFIRMED & ISSUED AS STANDARD	BABITA SHARMA	ATUL GUPTA	SAMIR DAS	SANJAY MAZUMDAR



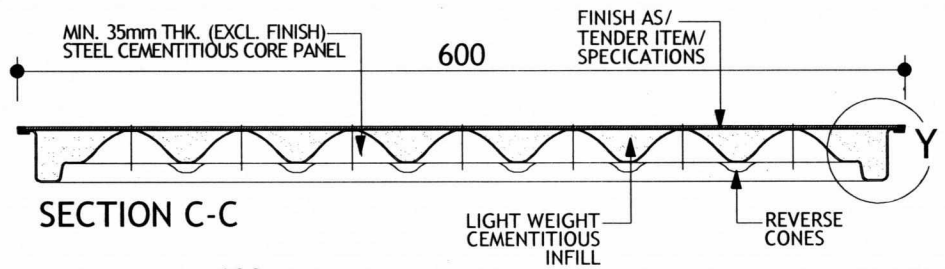
SECTION D-D



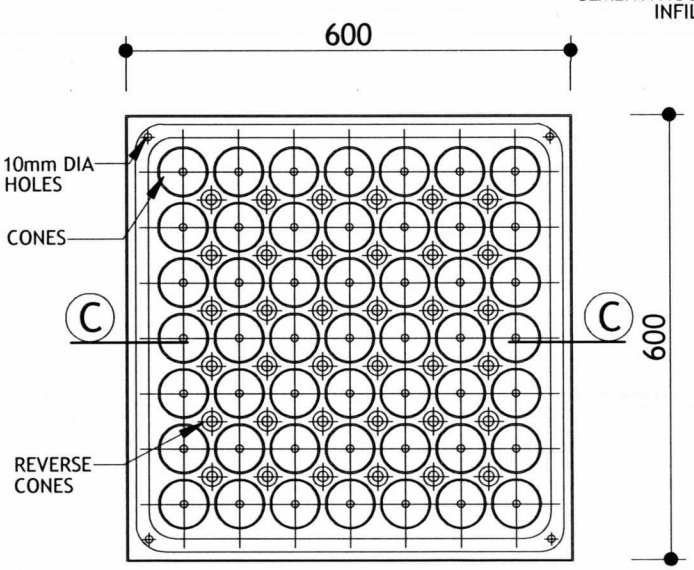
TOP VIEW OF PERIMETER PVC CAP



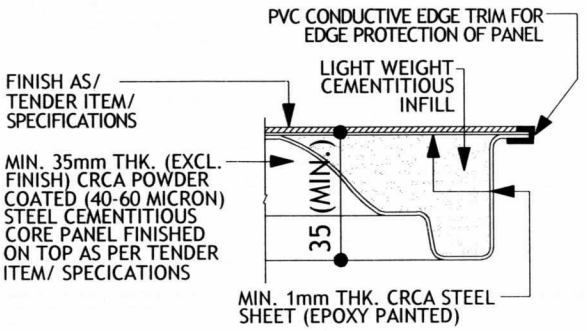
DETAIL OF JUNCTION WITH WALL



SECTION C-C



PLAN OF FALSE FLOOR PANEL
(UPSIDE DOWN)



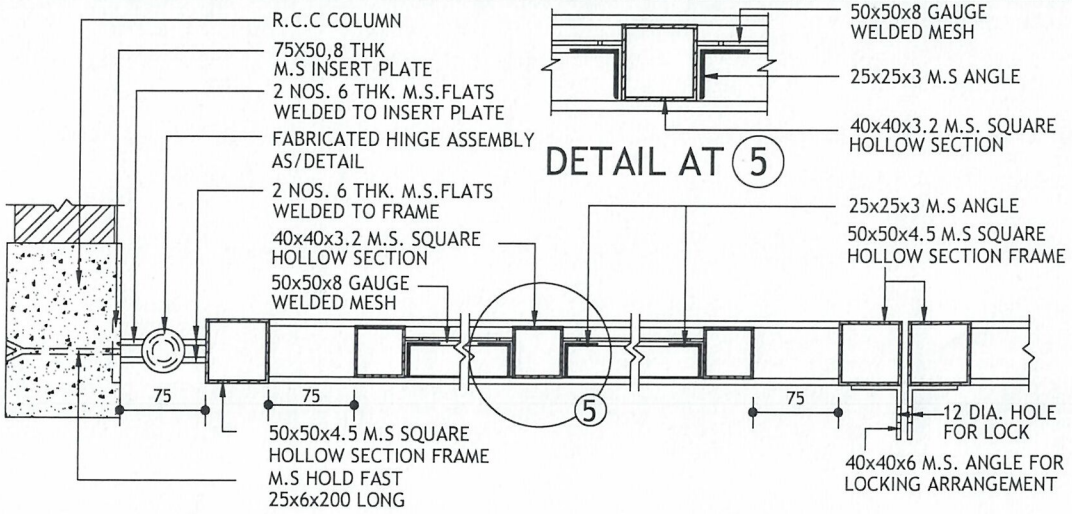
DETAIL (Y)

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
3	22.09.22	REVISED & ISSUED AS STANDARD	BABITA SHARMA	ATUL GUPTA	SAMIR DAS	SANJAY MAZUMDAR
2	11.02.22	REAFFIRMED & ISSUED AS STANDARD	ATUL GUPTA	SAMIR DAS	ANURAG SINHA	SANJAY MAZUMDAR

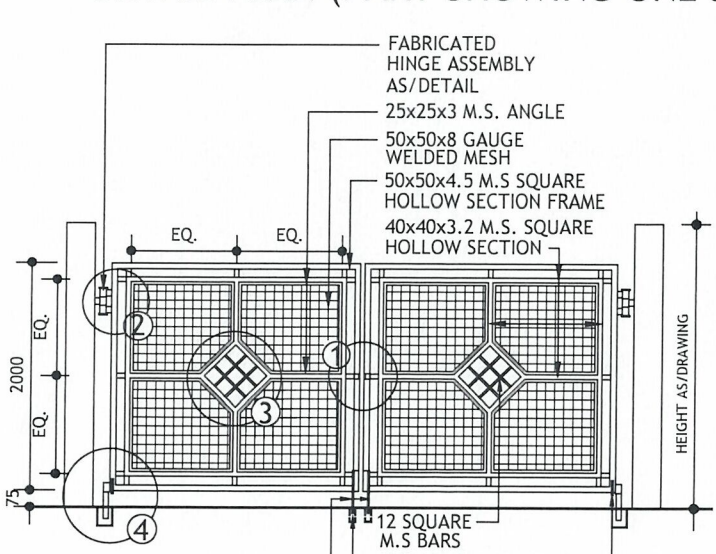
इंजीनियर्स इंडिया लिमिटेड (भारत सरकार का उपक्रम) ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

TRANSFORMER GATE DETAILS
(UPTO 6000mm. WIDTH)

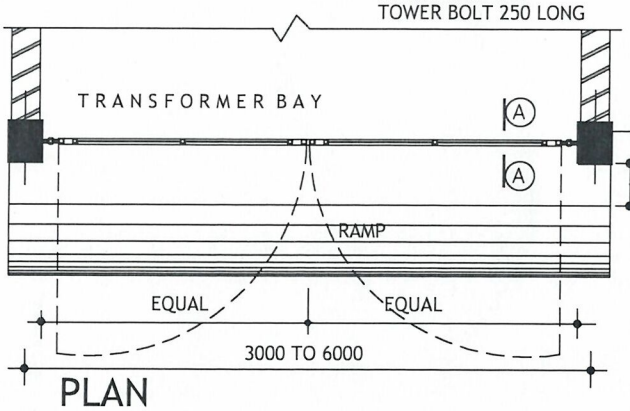
STANDARD No.
7-75-0051 Rev. 7



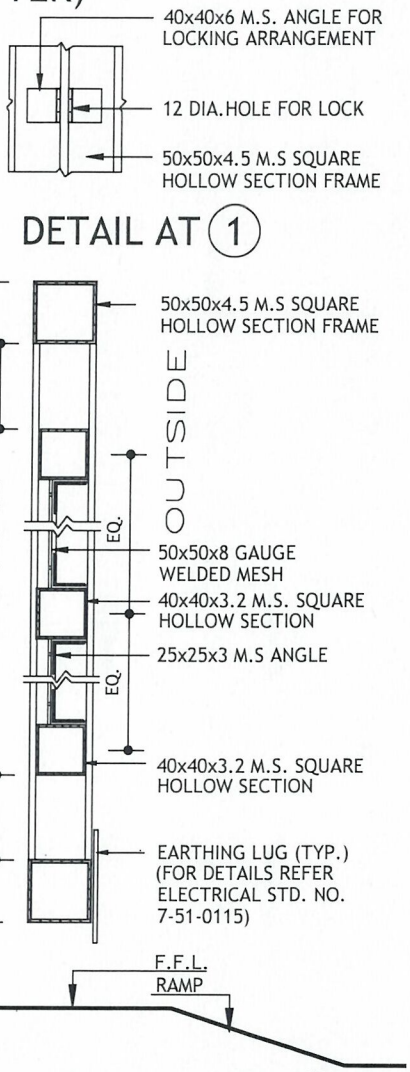
DETAIL PLAN (PART SHOWING ONE SHUTTER)



ELEVATION



PLAN

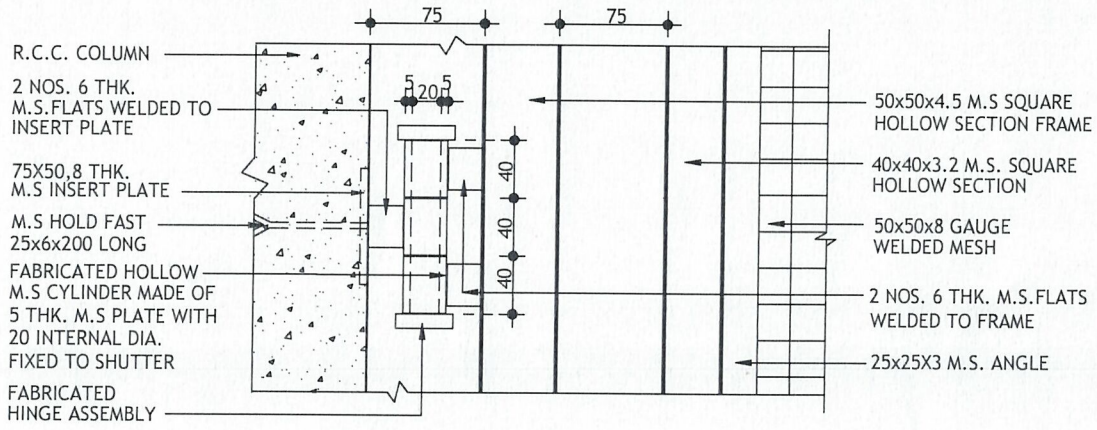


SECTION AT (A) - (A)

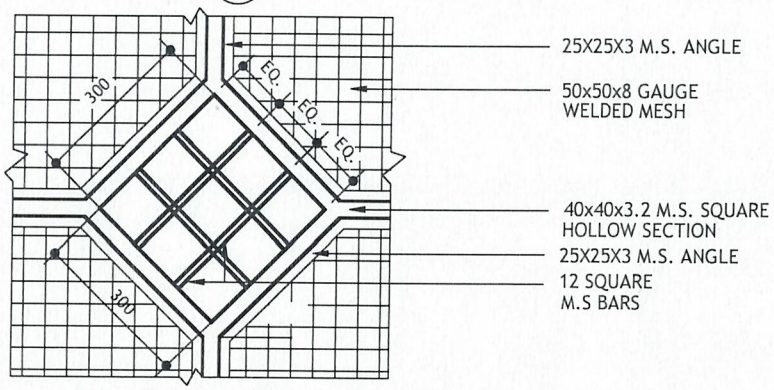
NOTE:
ALL STEEL MEMBERS SHALL CONFORM TO RELEVANT B.I.S. CODES AS APPLICABLE.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
7	18.03.26	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	ANISH MAHALA	ANISH KUNDU	NALIN KUMAR
6	30.03.21	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	SAMIR DAS	ANURAG SINHA	SANJAY MAZUMDAR

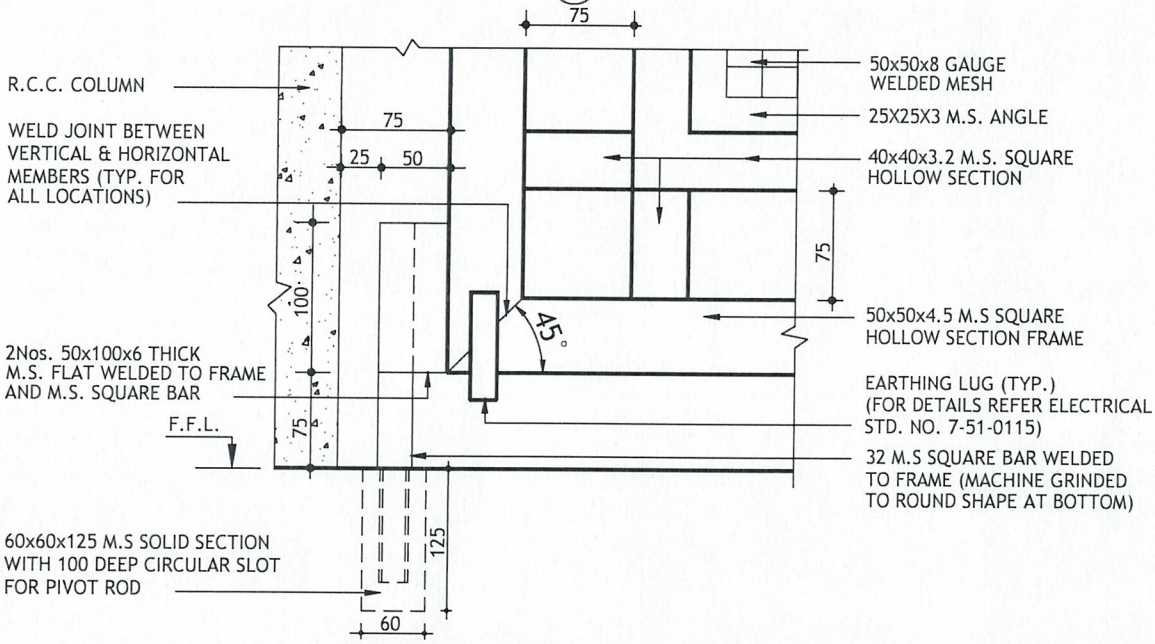
Approved by



DETAIL AT (2)



DETAIL AT (3)



DETAIL AT (4)

NOTE:
ALL STEEL MEMBERS SHALL CONFORM TO RELEVANT B.I.S. CODES AS APPLICABLE.

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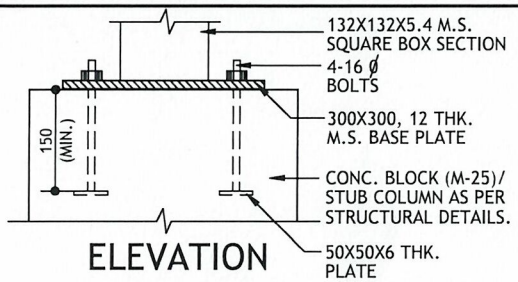
6	30.03.21	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	SAMIR DAS	ANURAG SINHA	SANJAY MAZUMDAR

Approved by

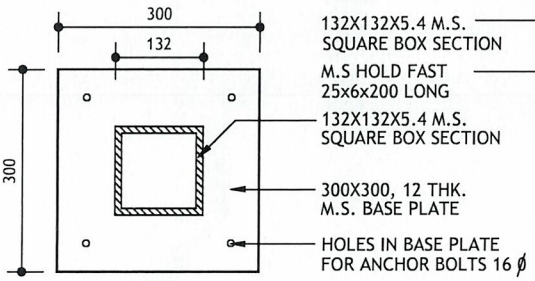
इंजीनियर्स इंडिया लिमिटेड (भारत सरकार का उपक्रम) ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

TRANSFORMER GATE DETAILS (BEYOND 6000mm. WIDTH)

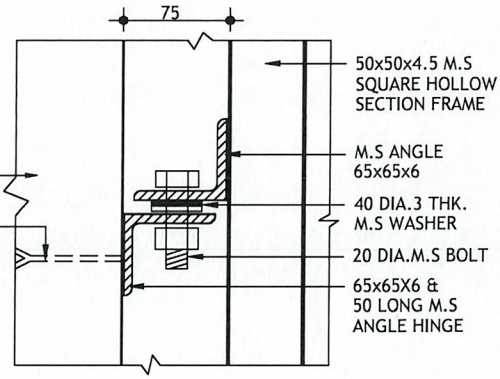
STANDARD No.
7-75-0052 Rev. 6



ELEVATION

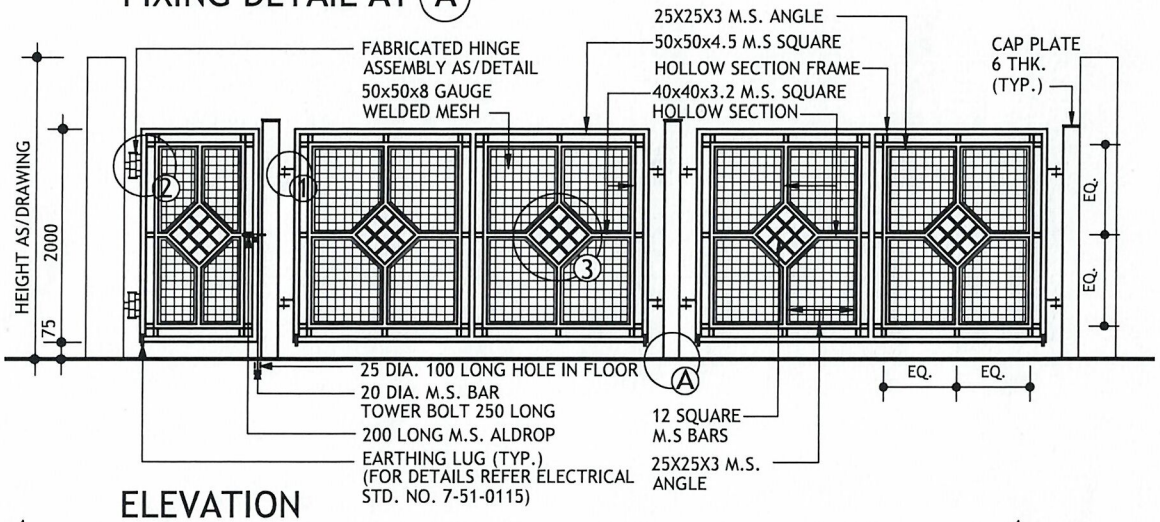


PLAN

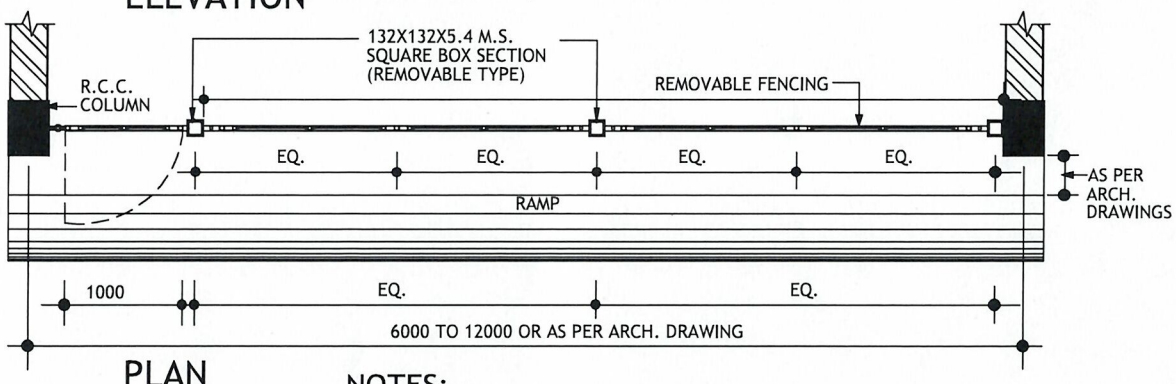


DETAIL AT (1)

FIXING DETAIL AT (A)



ELEVATION



PLAN

NOTES:

1. FOR DETAILS (2) & (3) REFER STANDARD NO. 7-75-0051
2. ALL STEEL MEMBERS SHALL CONFORM TO RELEVANT B.I.S. CODES AS APPLICABLE.

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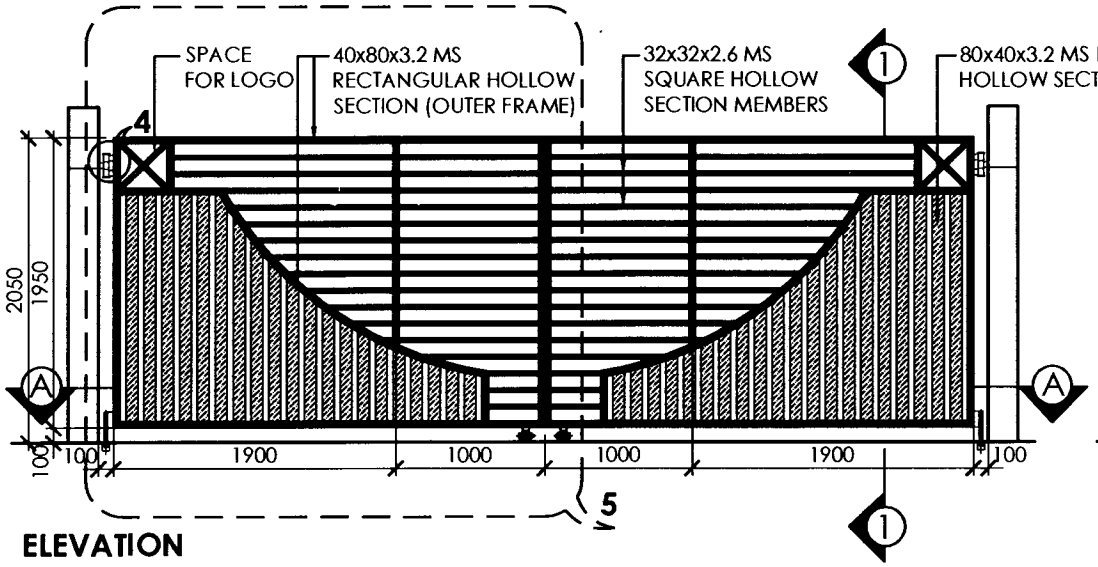
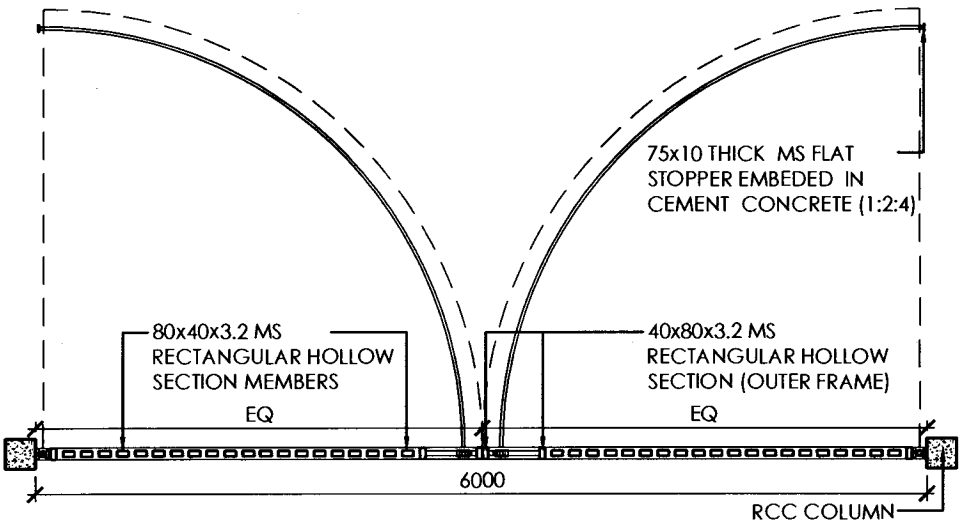
					Approved by	
6	18.03.26	RE-AFFIRMED & ISSUED AS STANDARD	M L THAKUR	ATUL GUPTA	ANISH KUNDU	NALIN KUMAR
5	30.03.21	REVISED & ISSUED AS STANDARD	M L THAKUR	SAMIR DAS	ANURAG SINHA	SANJAY MAJUMDAR
4	14.12.15	REVISED & ISSUED AS STANDARD	DK	SD/JKB	RAJANJI SRIVASTAVA	S. CHANDA

STEEL GATE
(FOR ENTRANCES UPTO 6.0M WIDTH)

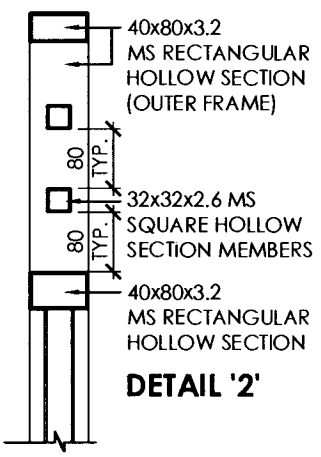


ELEVATION

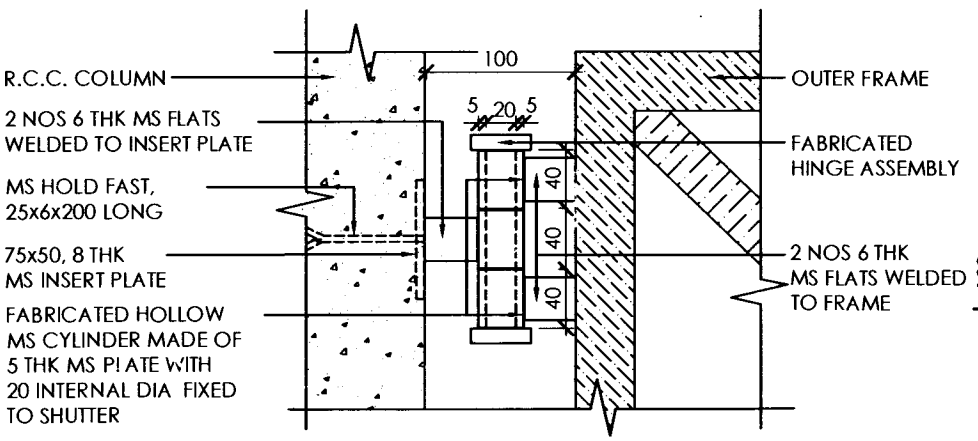
SECTION '1-1'



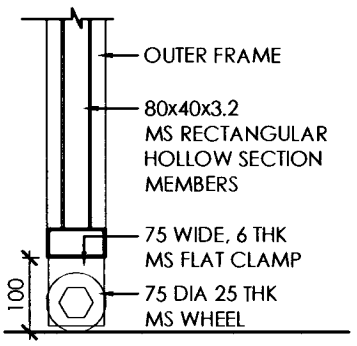
PLAN AT 'A'



DETAIL '2'



DETAIL AT '4'

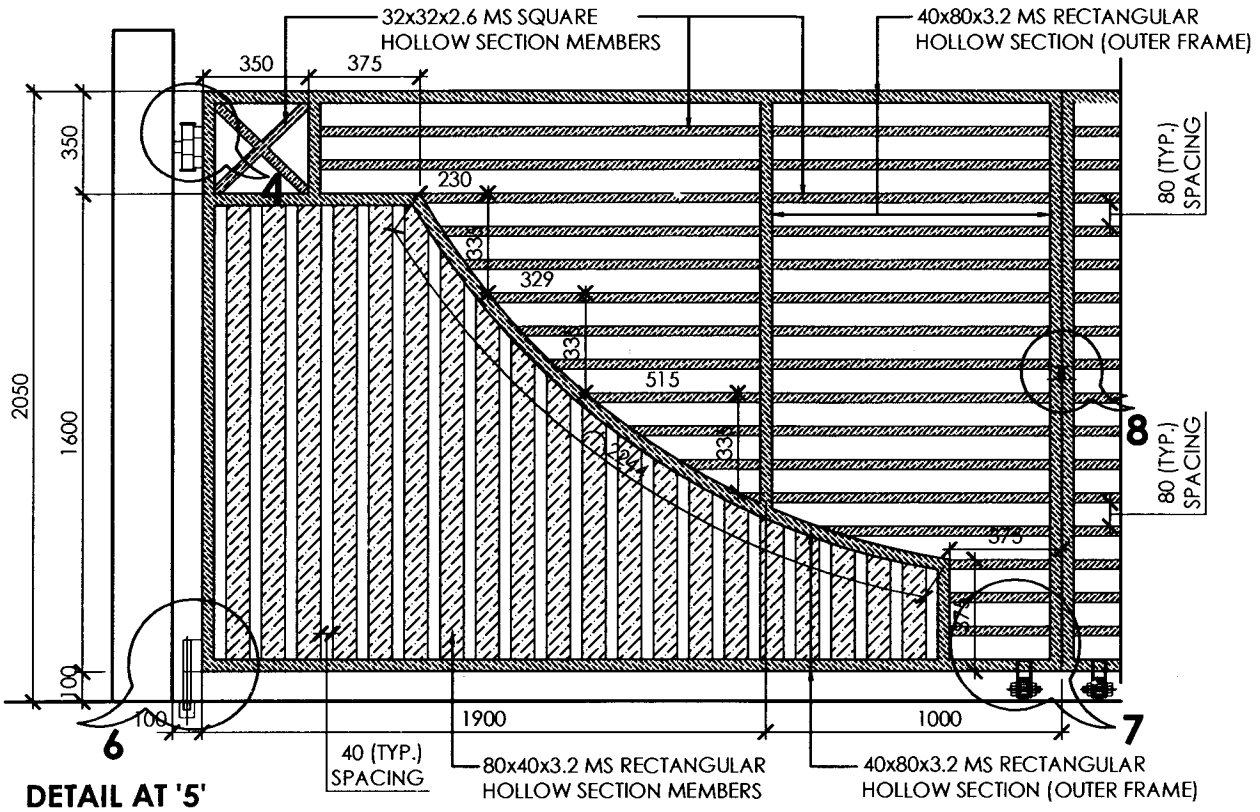


DETAIL '3'

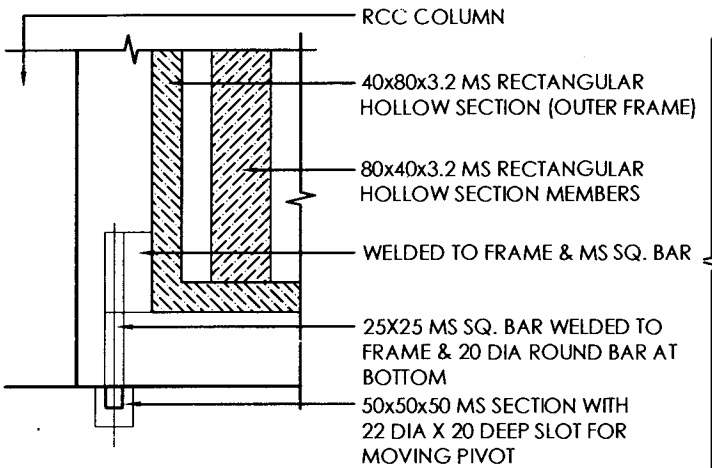
NOTE:
1. ALL DIMENSIONS ARE IN MM.
2. ALL STEEL MEMBERS SHALL CONFORM TO RELEVANT B.I.S. CODES AS APPLICABLE.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	02.02.22	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	SUMEDHA	SAMIR DAS	SANJAY MAZUMDAR
5	20.02.17	UPDATED & ISSUED AS STANDARD	DK	JS/JKB	RAJANJI SRIVASTAVA	R. NANDA

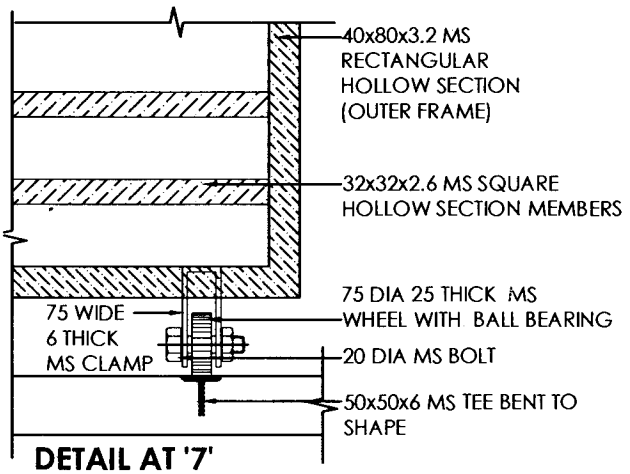
Approved by



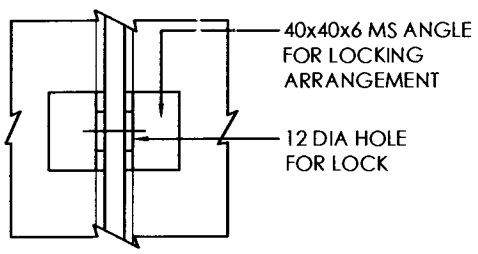
DETAIL AT '5'



DETAIL AT '6'



DETAIL AT '7'

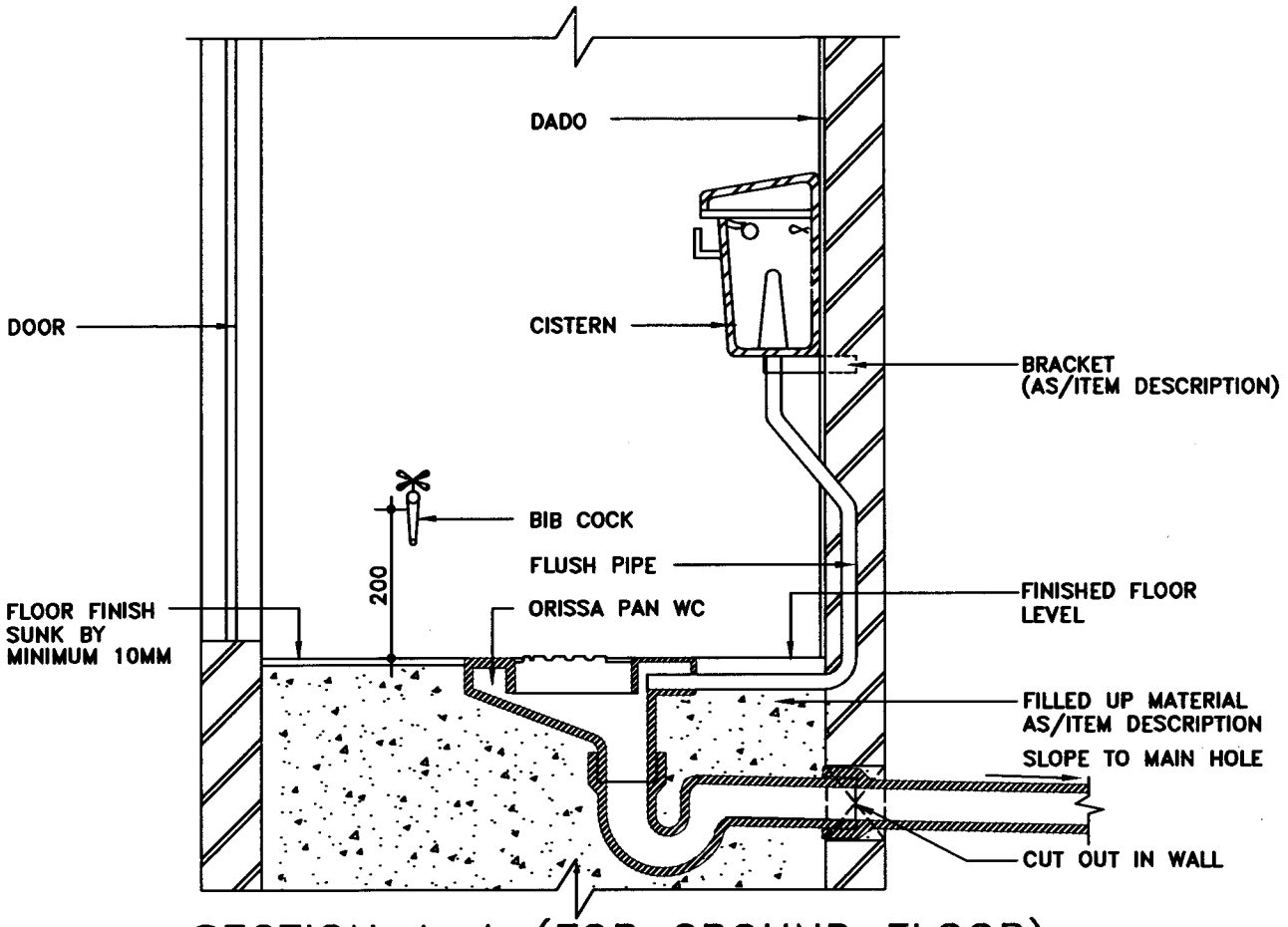


DETAIL AT '8'

NOTE:
1. ALL DIMENSIONS ARE IN MM.
2. ALL STEEL MEMBERS SHALL CONFORM TO RELEVANT B.I.S. CODES AS APPLICABLE.

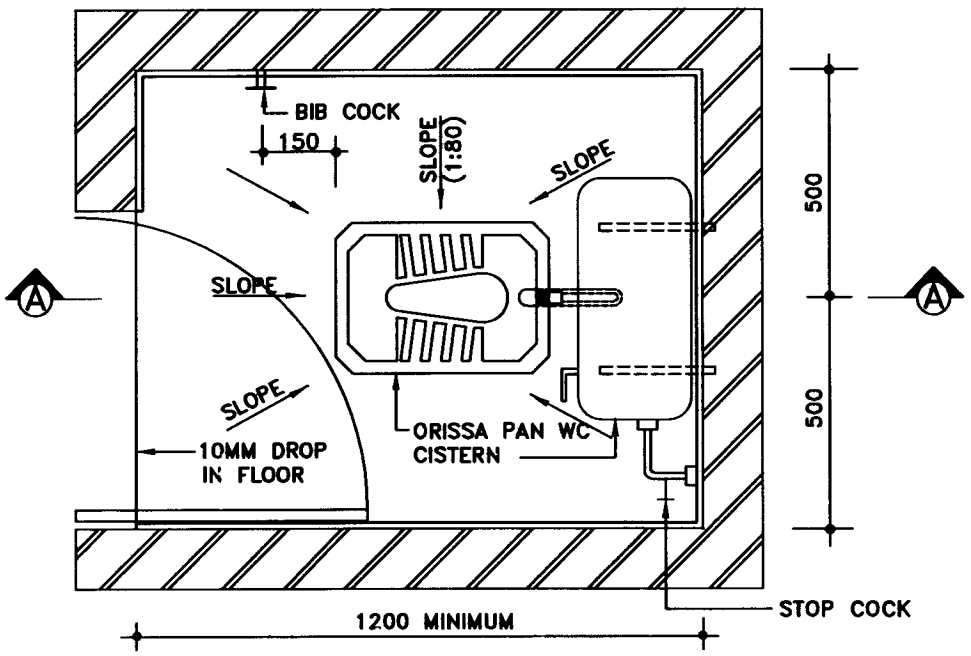
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	02.02.22	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	SUMEDHA	SAMIR DAS	SANJAY MAZUMDAR
5	20.02.17	UPDATED & ISSUED AS STANDARD	DK	JS/JKB	RAJANJI SRIVASTAVA	R. NANDA

Approved by



SECTION A–A (FOR GROUND FLOOR)

(REFER SHEET 2 OF 2 FOR SECTION A–A APPLICABLE TO UPPER FLOORS WITH SUNK SLAB)

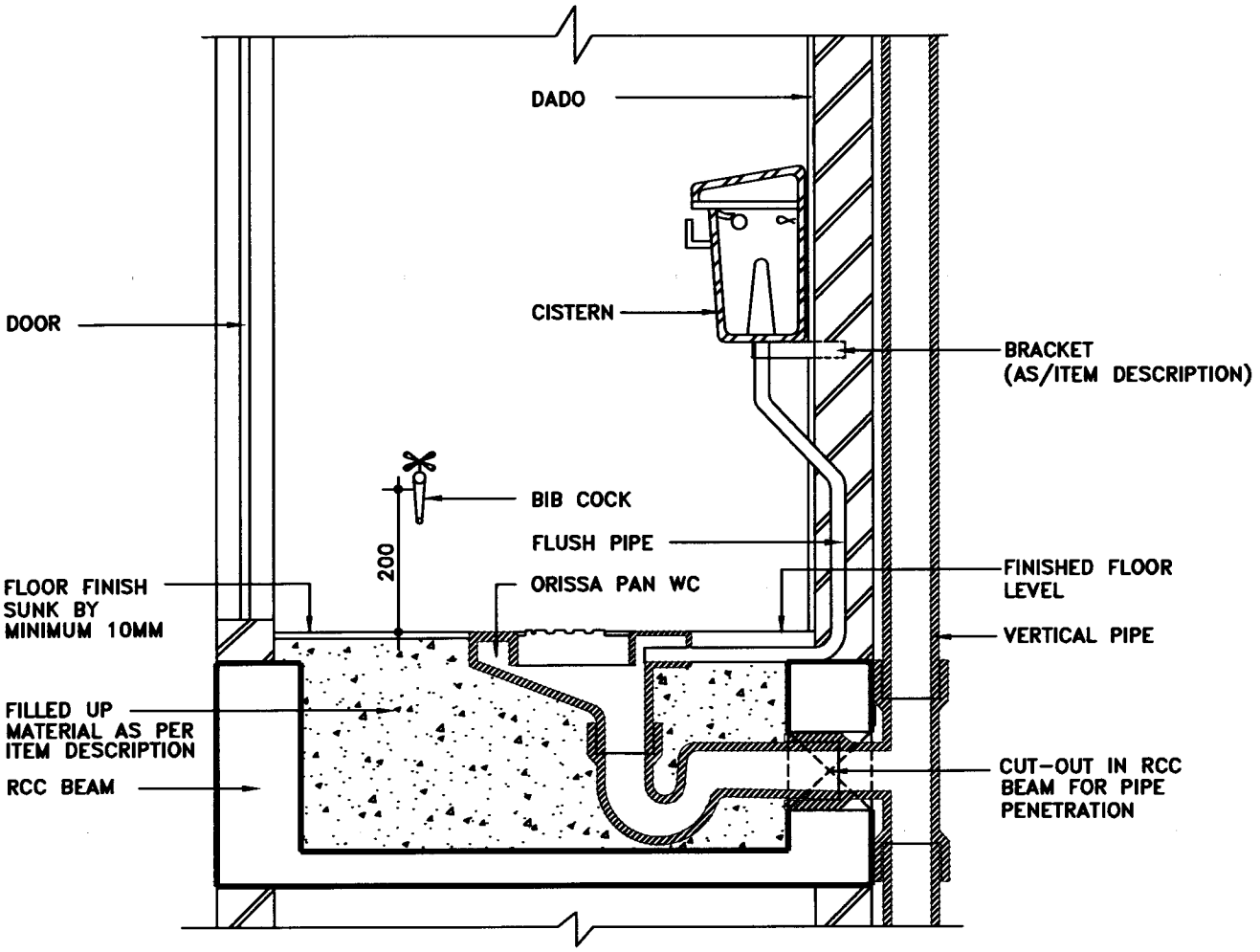


PLAN

NOTE: REFER SHEET 2 OF 2.

Rev. No.	Date	Description	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	02.02.22	REAFFIRMED & REISSUED AS STANDARD	NAVEEN	AKHILESH	SAMIR DAS	SANJAY MAZUMDAR
5	07.11.16	REVISED & REISSUED AS STANDARD	DK	SD/JKB	RAJANJI SRIVASTAVA	R. NANDA
4	09.11.11	REVISED & REISSUED	DK	SD	JKB	D.MALHOTRA

Approved by



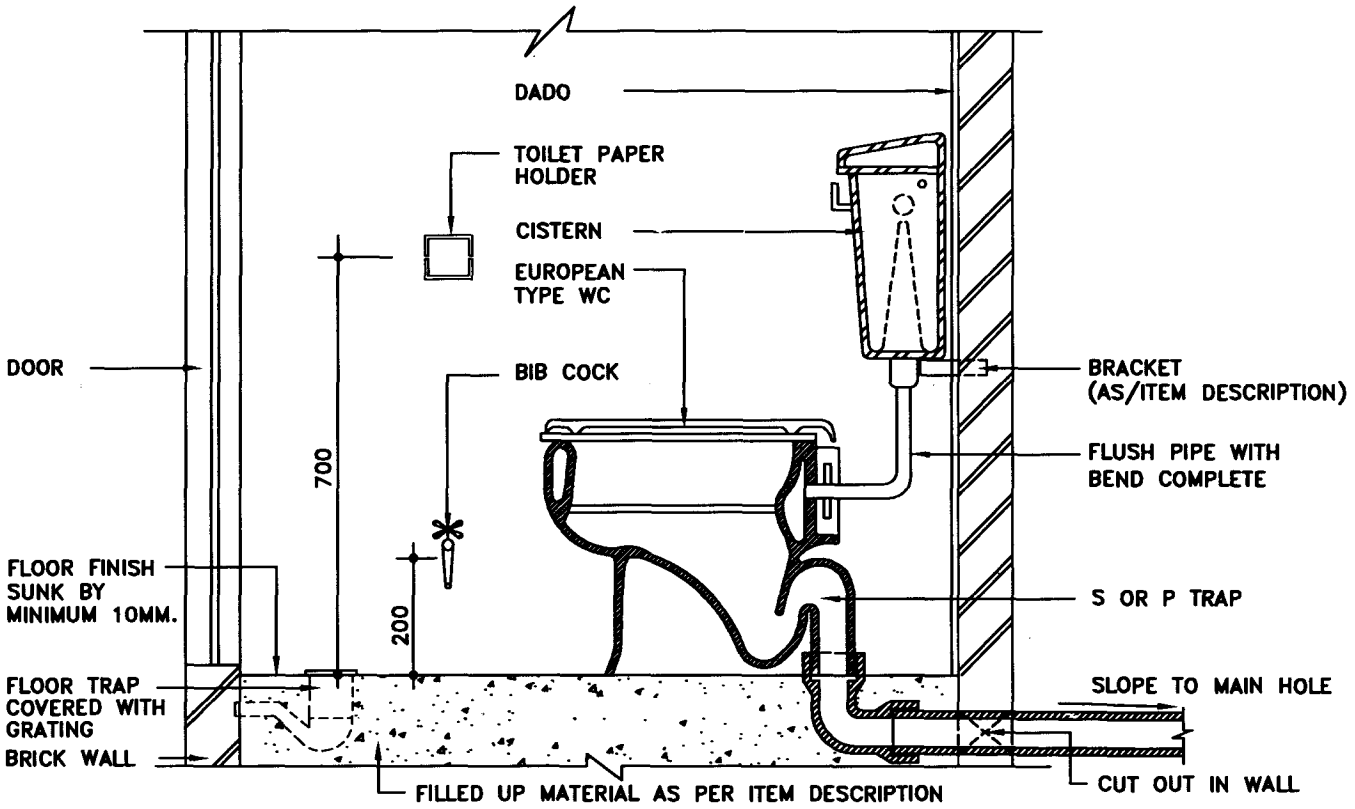
SECTION A-A
(FOR UPPER FLOOR WITH SUNK SLAB)

(REFER SHEET 1 OF 2 FOR SECTION A-A APPLICABLE TO GROUND FLOOR)

NOTES:

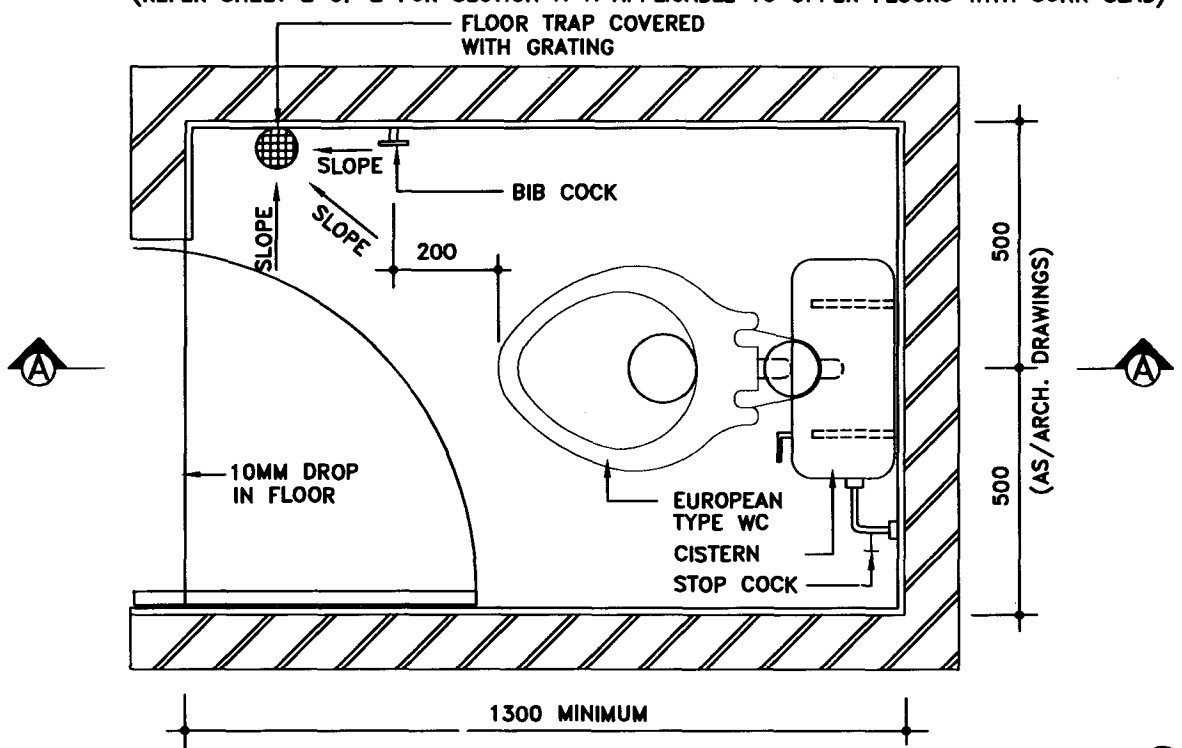
1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. ALL FLOOR FINISH LEVEL INSIDE THE W.C. CUBICLE SHALL BE 10 TO 15MM LOWER THAN OUTSIDE.
3. PROVISION FOR NECCESSARY CUT-OUT IN THE R.C.C. STRUCTURAL BEAM SHALL BE KEPT (FOR DISPOSAL PIPE PENETRATION). THE LOCATION ANGLE, GRADIENT ETC. OF THE CUT-OUT SHALL BE AS PER SITE REQUIREMENTS.
4. REFER RELEVANT ARCHITECTURAL DRAWINGS FOR ACTUAL SIZE OF THE CUBICLE.

Rev. No.			Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
6	02.02.22	REAFFIRMED & REISSUED AS STANDARD	NAVEEN	AKHILESH	SAMIR DAS	SANJAY MAZUMDAR
5	07.11.16	REVISED & REISSUED AS STANDARD	DK	SD/JKB	RAJANJI SRIVASTAVA	R. NANDA
4	09.11.11	REVISED & REISSUED	DK	SD	JKB	D.MALHOTRA



SECTION A–A (FOR GROUND FLOOR)

(REFER SHEET 2 OF 2 FOR SECTION A–A APPLICABLE TO UPPER FLOORS WITH SUNK SLAB)

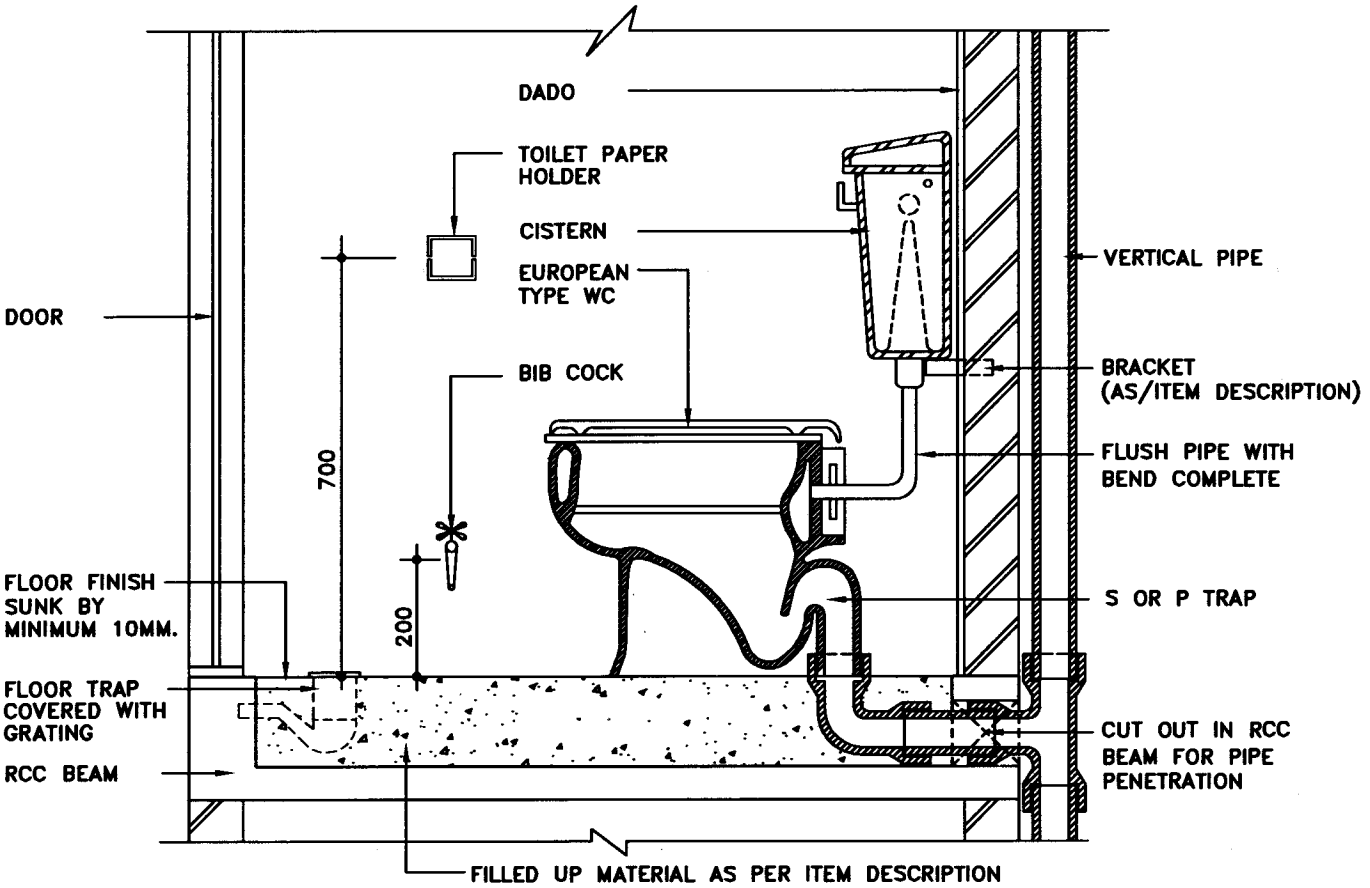


PLAN

NOTE: REFER SHEET 2 OF 2.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	02.02.22	REAFFIRMED & REISSUED AS STANDARD	NAVEEN	AKHILESH	SAMIR DAS	SANJAY MAZUMDAR
5	07.11.16	REVISED & REISSUED AS STANDARD	DK	JS/JKB	RAJANJI SRIVASTAVA	R. NANDA
4	09.11.11	REVISED & REISSUED	DK	SD	JKB	D.MALHOTRA

Approved by



SECTION A–A
(FOR UPPER FLOOR WITH SUNK SLAB)

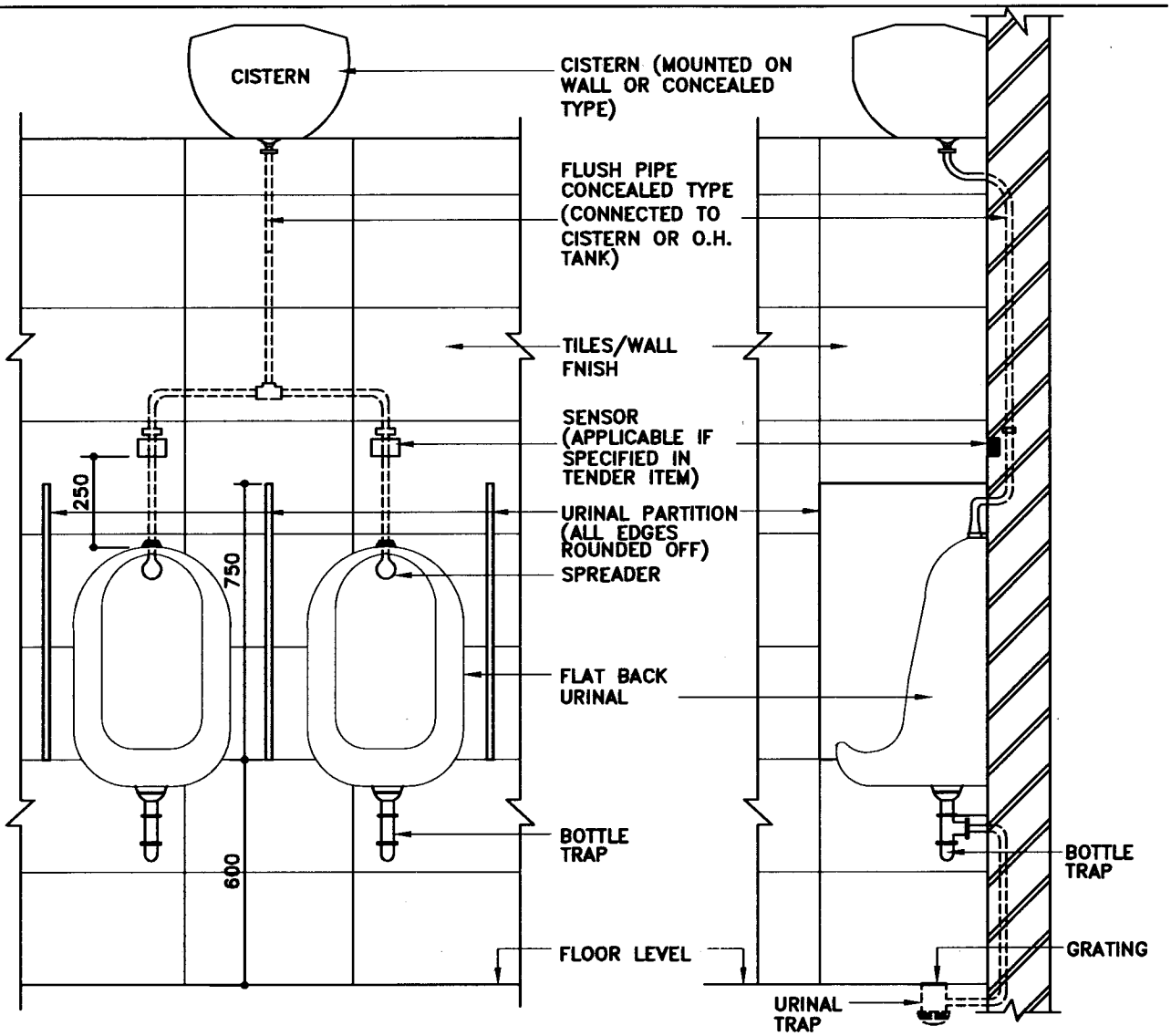
(REFER SHEET 1 OF 2 FOR SECTION A–A APPLICABLE TO GROUND FLOOR)

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. ALL FLOOR FINISH LEVEL INSIDE THE W.C. CUBICLE SHALL BE 10 TO 15MM LOWER THAN OUTSIDE.
3. PROVISION FOR NECCESSARY CUT–OUT IN THE R.C.C. STRUCTURAL BEAM SHALL BE KEPT (FOR DISPOSAL PIPE PENETRATION). THE LOCATION ANGLE, GRADIENT ETC. OF THE CUT–OUT SHALL BE AS PER SITE REQUIREMENTS.
4. REFER RELEVANT ARCHITECTURAL DRAWINGS FOR ACTUAL SIZE OF THE CUBICLE.

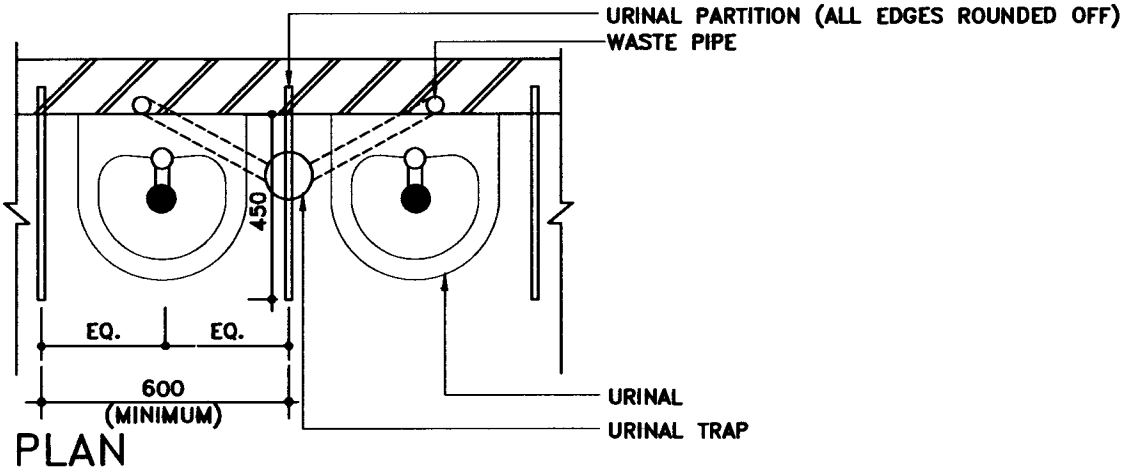
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
6	18.01.22	REAFFIRMED & REISSUED AS STANDARD	NAVEEN	AKHILESH	SAMIR DAS	SANJAY MAZUMDAR
5	07.11.16	REVISED & REISSUED AS STANDARD	DK	JS/JKB	RAJANJI SRIVASTAVA	R. NANDA
4	09.11.11	REVISED & REISSUED	DK	SD	JKB	D.MALHOTRA

URINALS FIXING DETAIL



ELEVATION

SIDE ELEVATION



PLAN

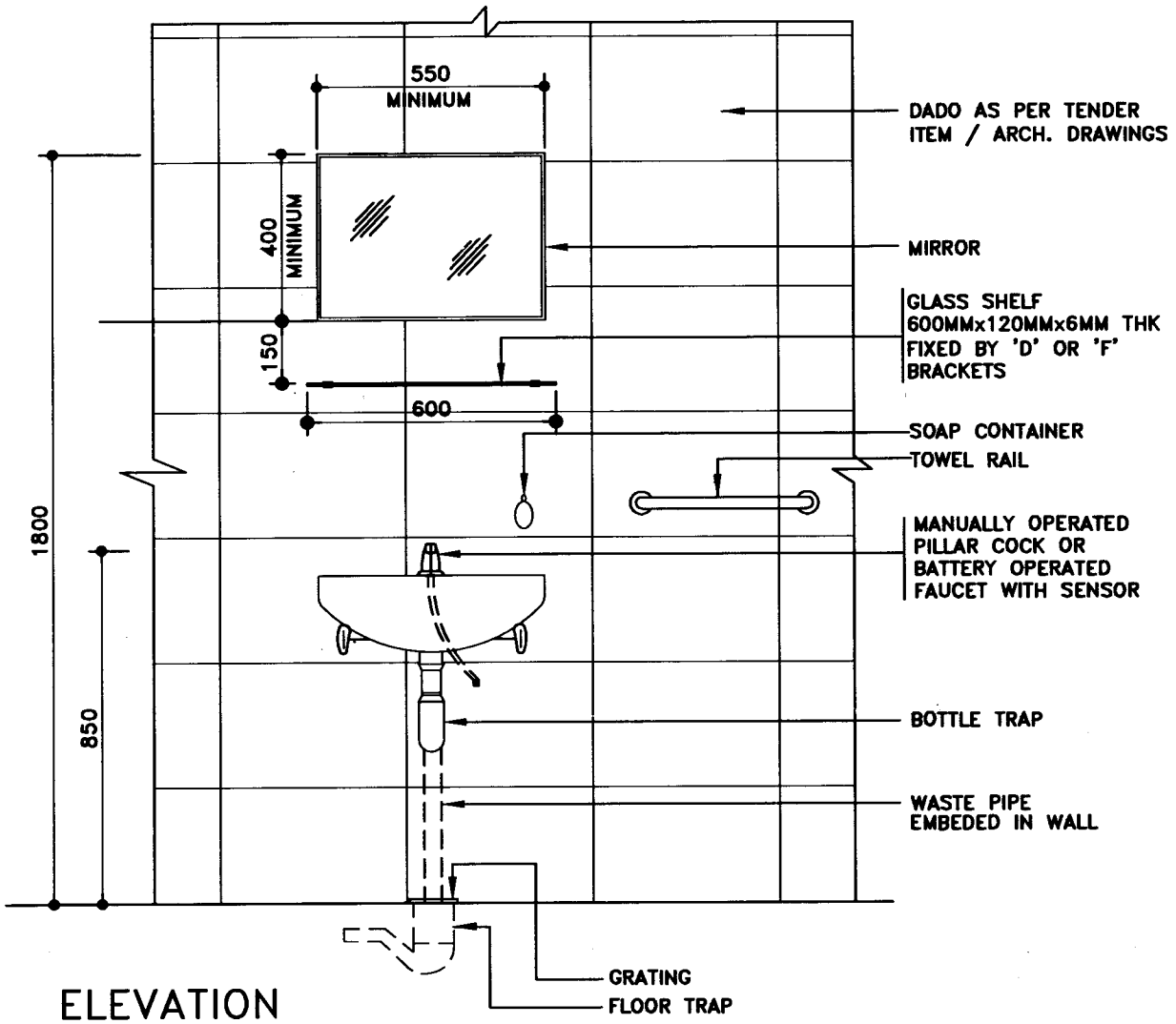
NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. THIS STANDARD IS INDICATIVE. TYPE AND NO. OF URINAL FIXTURES, FLUSHING ARRANGENT ETC. SHALL BE AS PER ARCHITECTURAL DRAWINGS & TENDER ITEM.
3. SENSORS SHOWN SHALL BE PROVIDED ONLY IN CASE THE SAME ARE SPECIFIED IN TENDER ITEM.

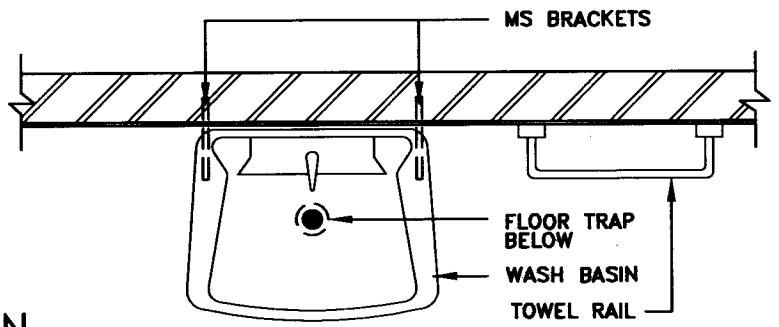
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	02.02.22	REVISED & REISSUED AS STANDARD	NAVEEN	AKHILESH	SAMIR DAS	SANJAY MAZUMDAR
5	01.12.16	REVISED & REISSUED AS STANDARD	DK	JS/JKB	RAJANJI SRIVASTAVA	R. NANDA
4	09.11.11	REVISED & REISSUED	DK	SD	JKB	D.MALHOTRA

Approved by

WASH BASIN FIXING DETAIL



ELEVATION



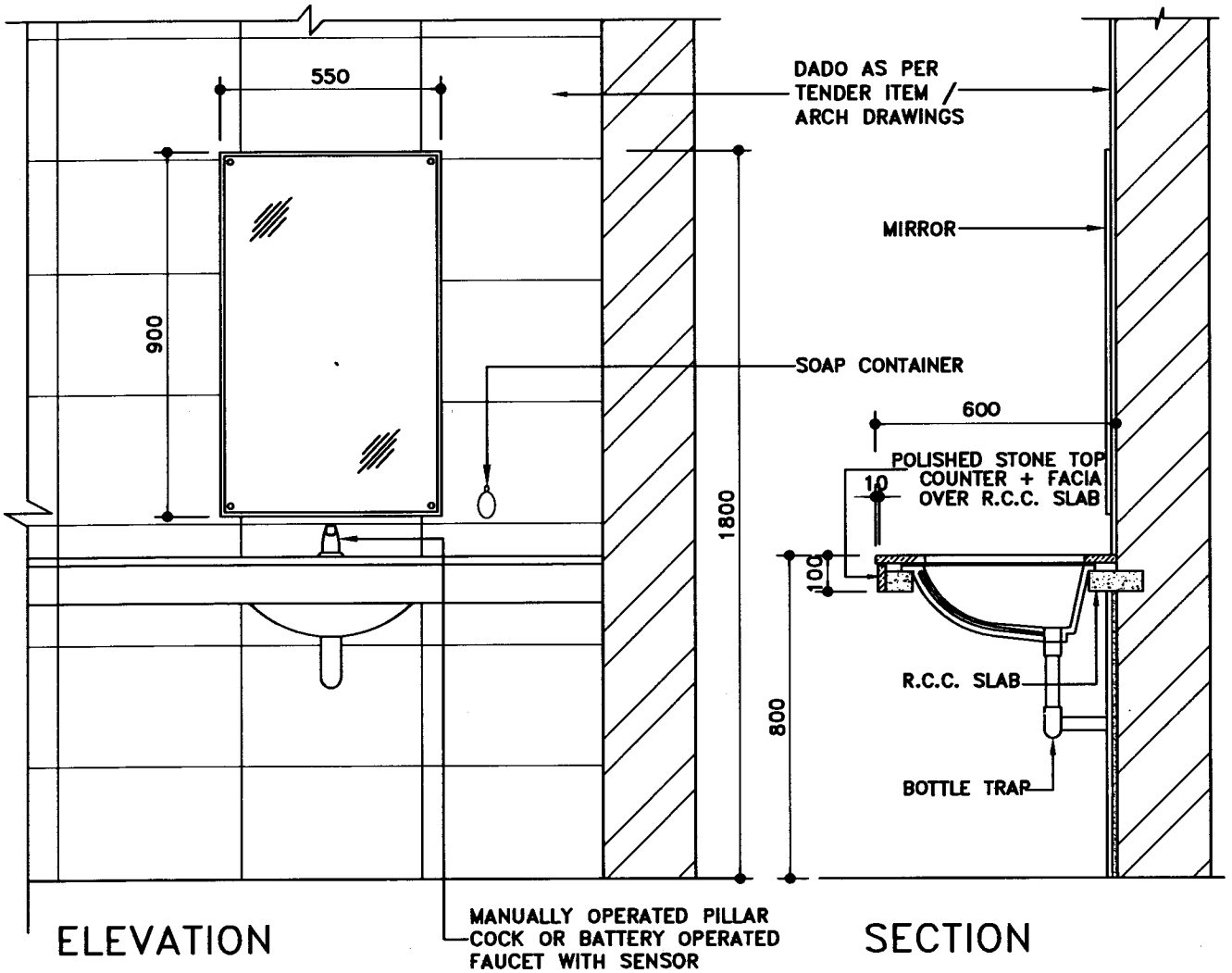
PLAN
(FOR WALL HUNG TYPE WASH BASIN)

NOTES:–

1. ALL DIMENSIONS IN MILLIMETRES.
2. THE SIZE OF MIRROR SHOWN IS INDICATIVE. ACTUAL SIZE SHALL BE AS PER ARCHITECTURAL DRAWINGS/ ITEMS DESCRIPTION.
3. THE ARRANGEMENT AND DETAIL OF WASH BASIN SHOWN (HERE AND IN SHEET–2) IS TYPICAL. FOR 2 OR MORE WASH BASIN, REFER RELEVANT ARCHITECTURAL DRAWING (FOR LOCATION & CONFIGURATION) WHICH SHALL BE READ IN CONJUNCTION WITH THIS STANDARD.
4. LOCATION & TOWEL RAIL IS INDICATIVE. REFER RELEVANT ARCHITECTURAL DRAWING FOR EXACT LOCATION.

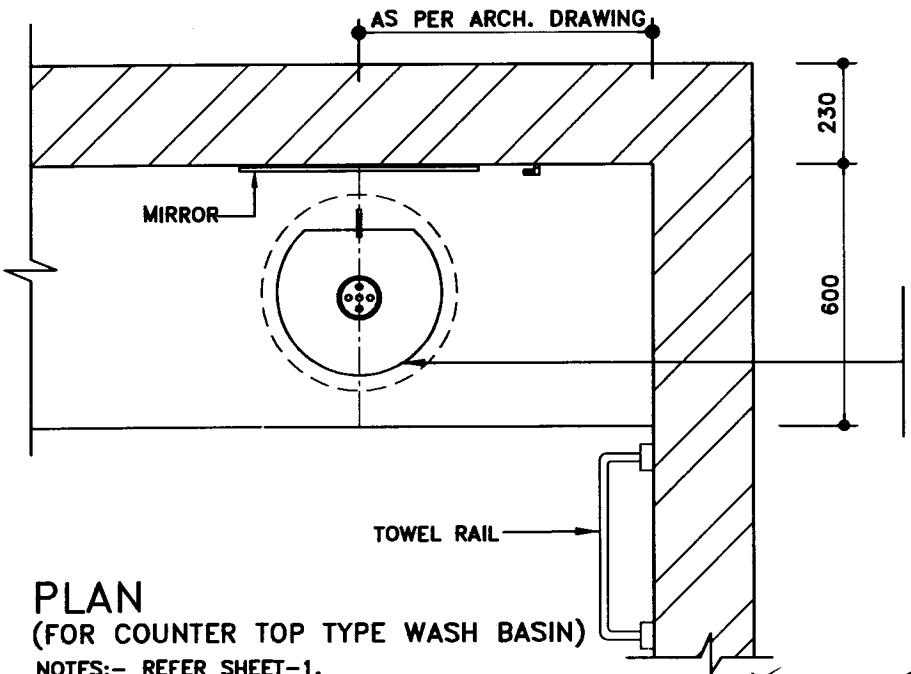
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	02.02.22	REAFFIRMED & REISSUED AS STANDARD	NAVEEN	AKHILESH	SAMIR DAS	SANJAY MAZUMDAR
5	21.11.16	REVISED & REISSUED AS STANDARD	MLT	JS/JKB	RAJANJI SRIVASTAVA	R. NANDA
4	09.11.11	REVISED & REISSUED	DK	SD	JKB	D.MALHOTRA

Approved by



ELEVATION

SECTION



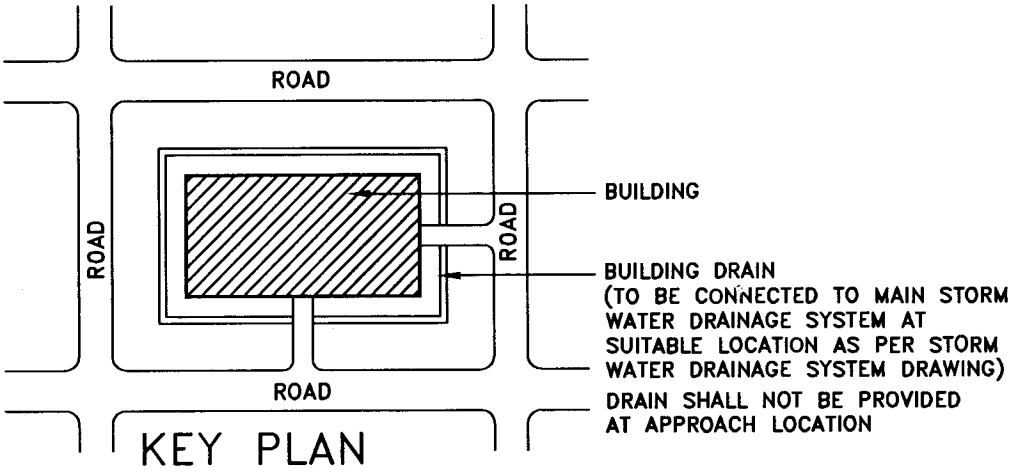
PLAN
(FOR COUNTER TOP TYPE WASH BASIN)

NOTES:- REFER SHEET-1.

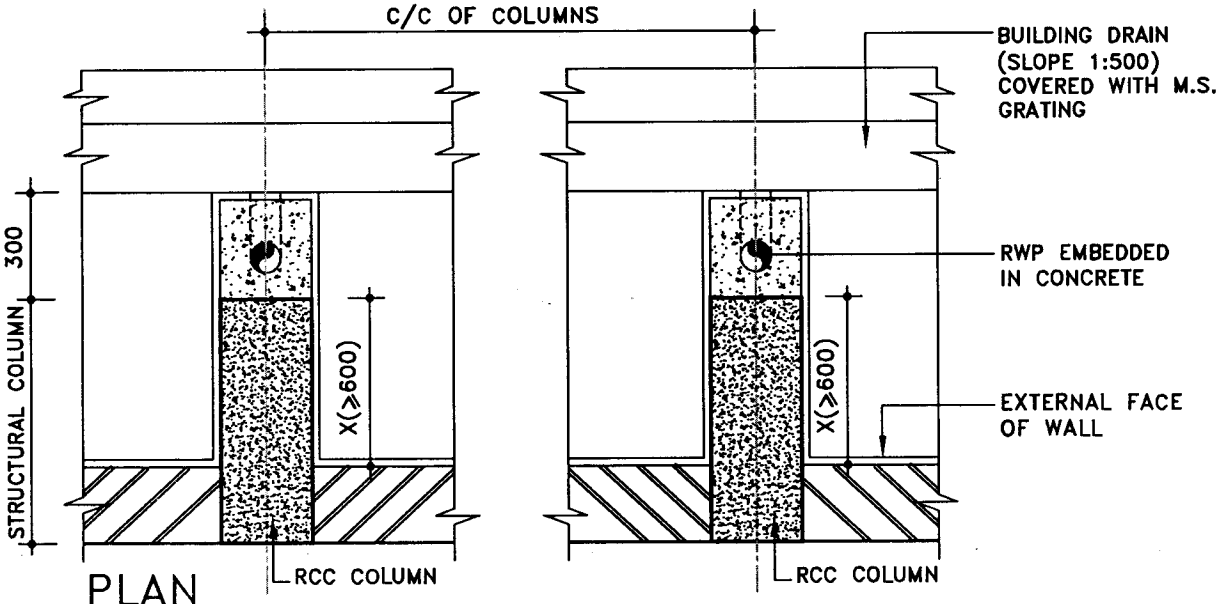
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	02.02.22	REAFFIRMED & REISSUED AS STANDARD	NAVEEN	AKHILESH	SAMIR DAS	SANJAY MAZUMDAR
5	21.11.16	REVISED & REISSUED AS STANDARD	MLT	JS/JKB	RAJANJI SRIVASTAVA	R. NANDA
4	09.11.11	REVISED & REISSUED	DK	SD	JKB	D.MALHOTRA

Approved by

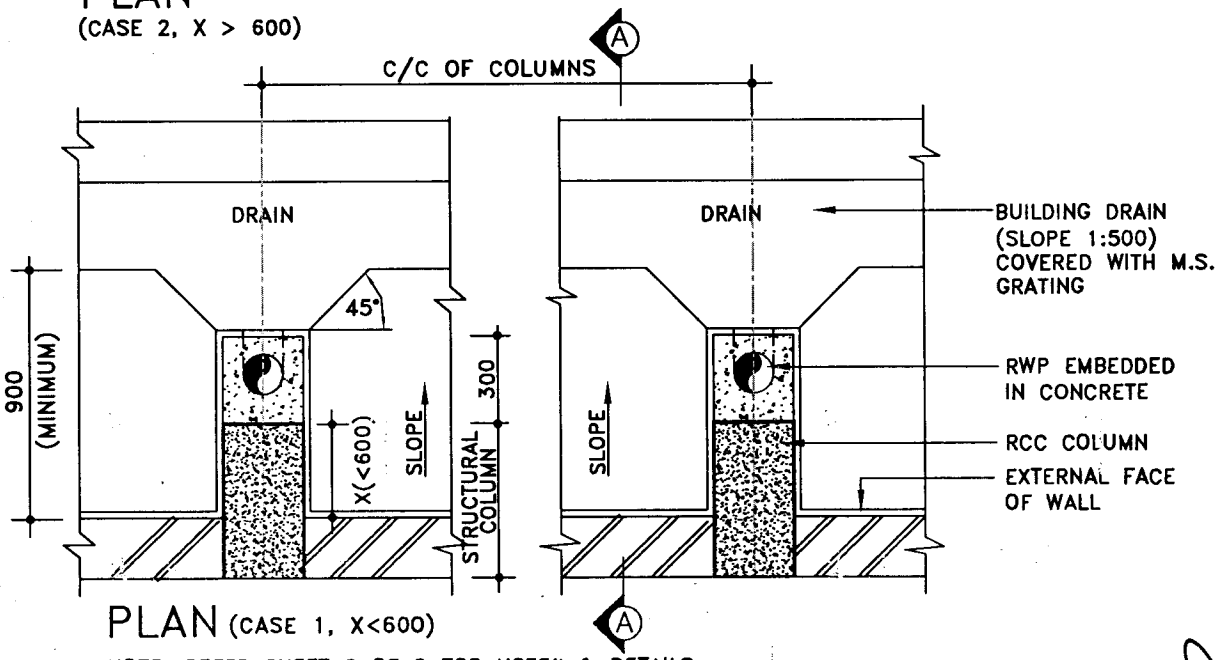
PLINTH PROTECTION
(WITH BUILDING DRAIN)



KEY PLAN



PLAN
(CASE 2, X > 600)

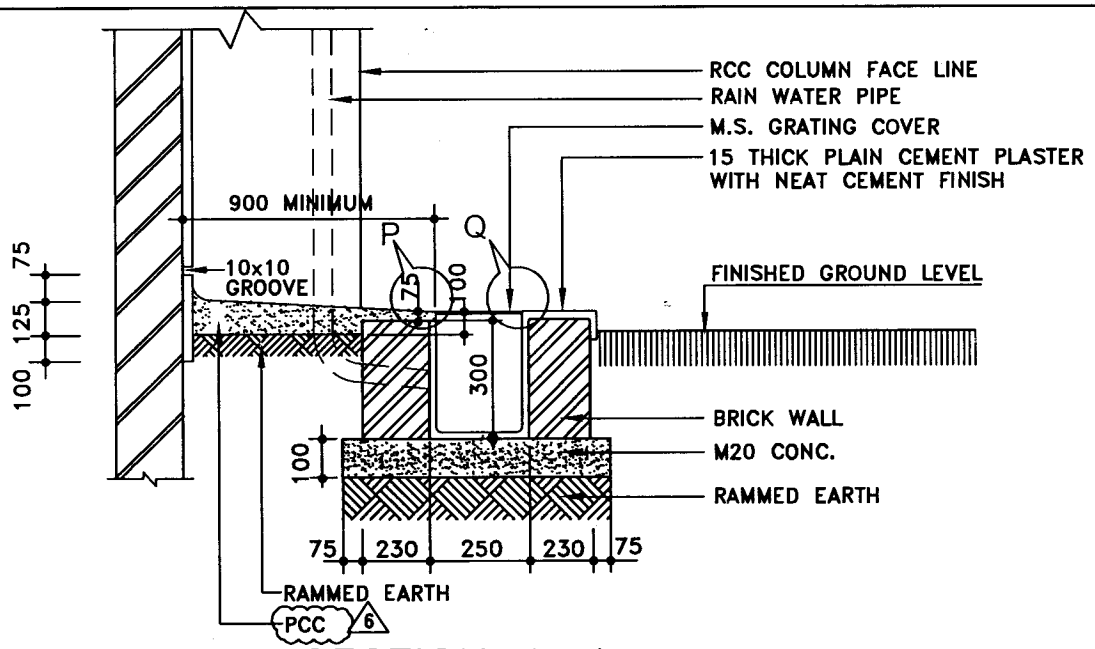


PLAN (CASE 1, X<600)

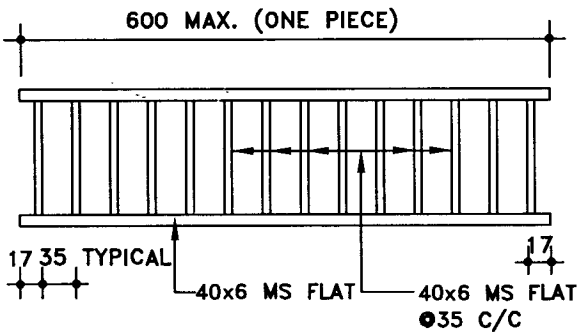
NOTE: REFER SHEET 2 OF 2 FOR NOTES & DETAILS

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
6	11.02.22	REVISED AND REISSUED AS STANDARD	NG	JS	SAMIR DAS	SANJAY MAZUMDAR
5	09.11.16	REVISED AND REISSUED AS STANDARD	BR	JS/JKB	RAJANJI SRIVASTAVA	R.NANDA
4	25.10.11	REVISED & REISSUED	DK	SD	JKB	D.MALHOTRA

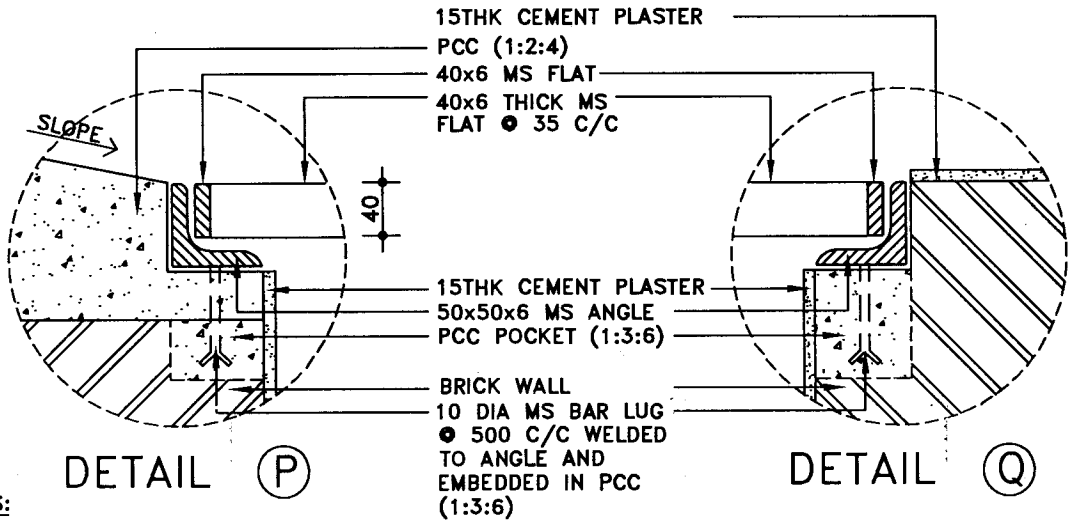
PLINTH PROTECTION
(WITH BUILDING DRAIN)



SECTION A–A



M.S. GRATING DETAIL



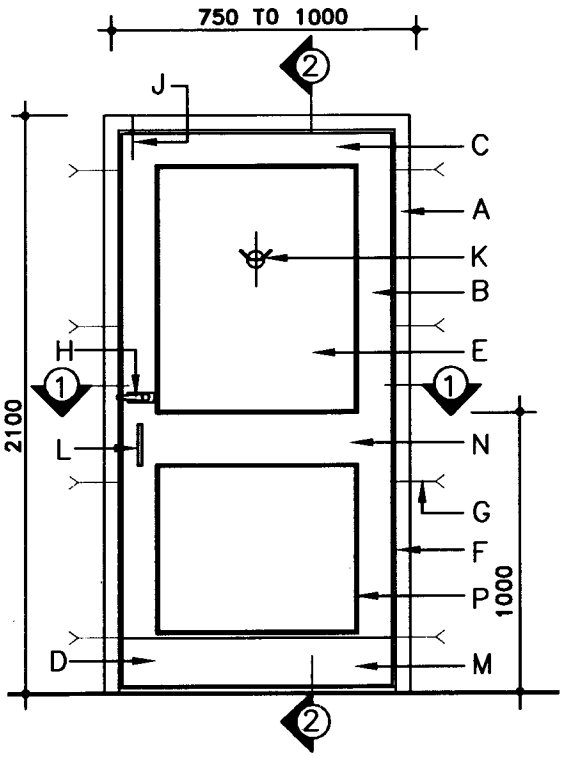
NOTES:

1. ALL DIMENSIONS ARE IN MM.
2. WIDTH OF THE PLINTH PROTECTION SHALL BE MINIMUM 900mm AND X+300 MAXIMUM UNLESS OTHERWISE MENTIONED IN BUILDING DRAWING.
3. PLINTH PROTECTION ALONG ANY PARTICULAR SIDE OF THE BUILDING SHALL BE OF CONSTANT WIDTH FOLLOWING THE EXTERNAL WALL ALIGNEMENT IF NOT SPECIFICALLY MENTIONED/INDICATED IN BUILDING DRAWING.
4. M.S. DRAIN COVER GRATING SHALL BE PROVIDED OVER BUILDING DRAIN UNLESS OTHERWISE MENTIONED/ INDICATED IN BUILDING DRAWING.

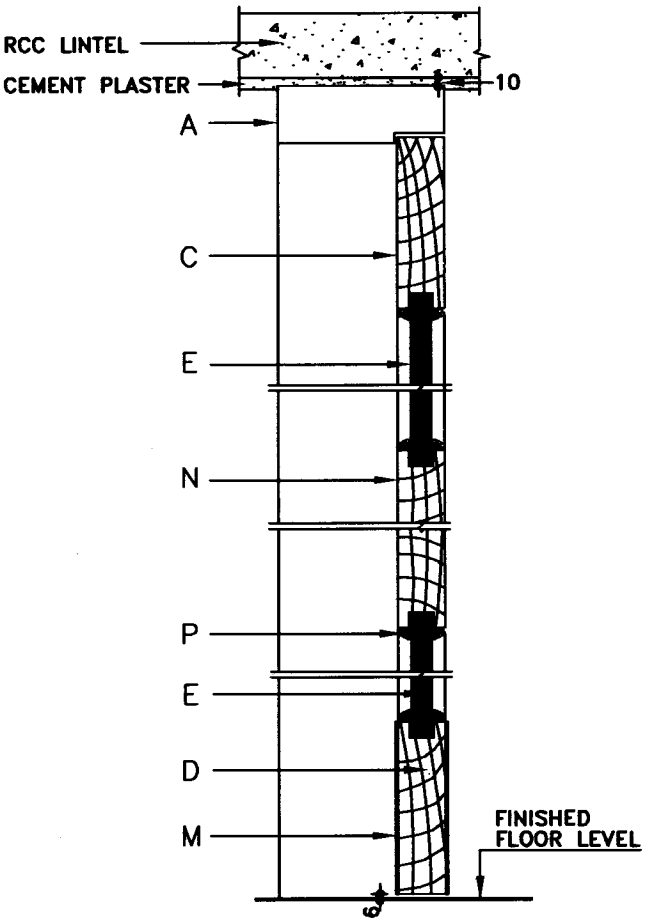
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	11.02.22	REVISED AND REISSUED AS STANDARD	NG	JS	SAMIR DAS	SANJAY MAZUMDAR
5	09.11.16	REVISED AND REISSUED AS STANDARD	BR	JS/JKB	RAJANJI SRIVASTAVA	R.NANDA
4	25.10.11	REVISED & REISSUED	DK	SD	JKB	D.MALHOTRA

Approved by

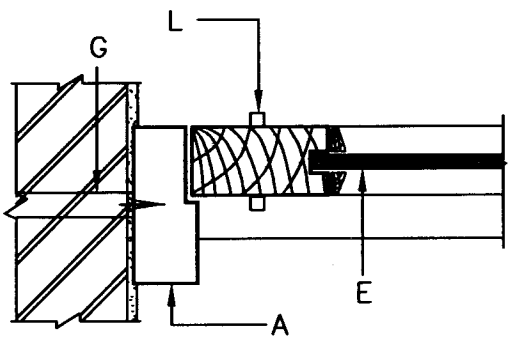
WOODEN PANEL DOOR (TOILET DOOR)



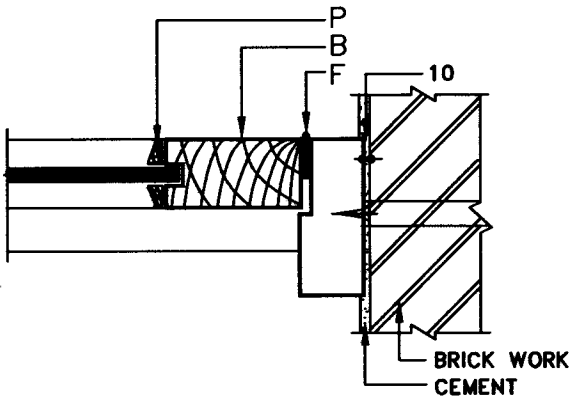
ELEVATION



SECTION 2–2



SECTIONAL PLAN 1–1



LEGEND:

- A: DOOR FRAME AS SPECIFIED
- B: TEAK WOOD STYLE 100x35
- C: TEAK WOOD TOP RAIL 100x35
- D: TEAK WOOD BOTTOM RAIL 200x35
- E: 12 THK. PARTICLE BOARD/MARINE PLY INFILL PANEL WITH SPECIFIED FACING.
- F: 150 LONG BUTT HINGES @ MAX. 600 C/C.
- G: MS HOLD FAST EMBEDDED IN CONCRETE/FASTENER
- H: TOILET DOOR LATCH
- J: TOWER BOLT
- K: COAT AND HAT HOOK

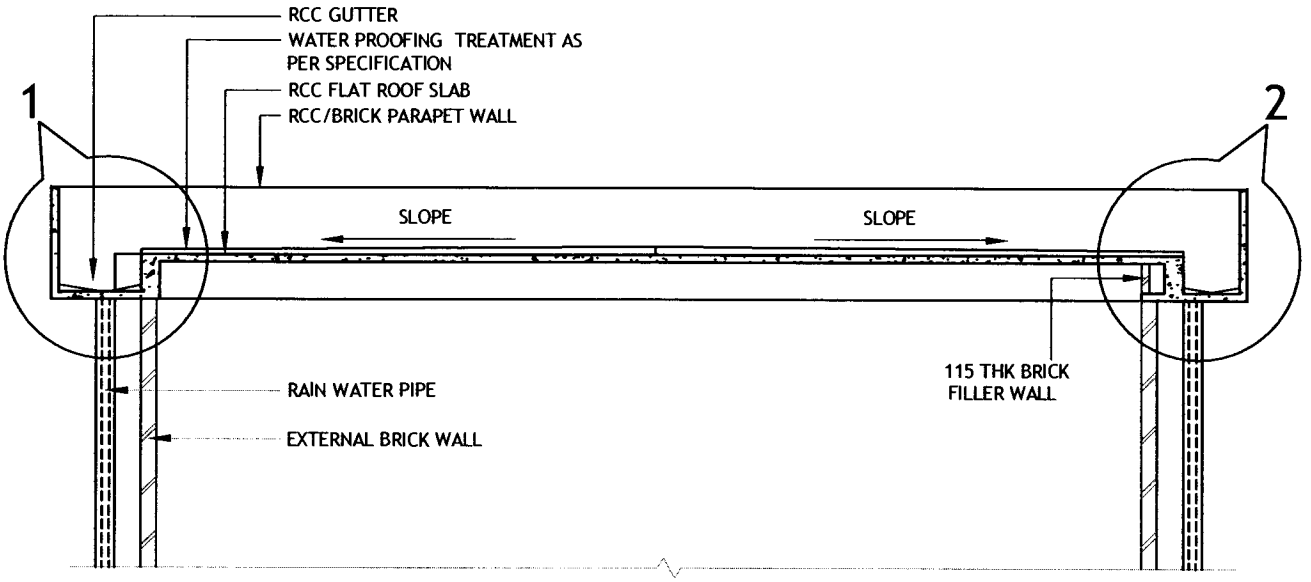
(INTERNAL SIDE OF THE DOOR)

- L: DOOR HANDLE (BOTH SIDE OF THE DOOR)
- M: ACRYLIC KICK PLATE 200X3 THICK.
- N: TEAK WOOD LOCK RAIL 150x35
- P: TEAK WOOD BEADING

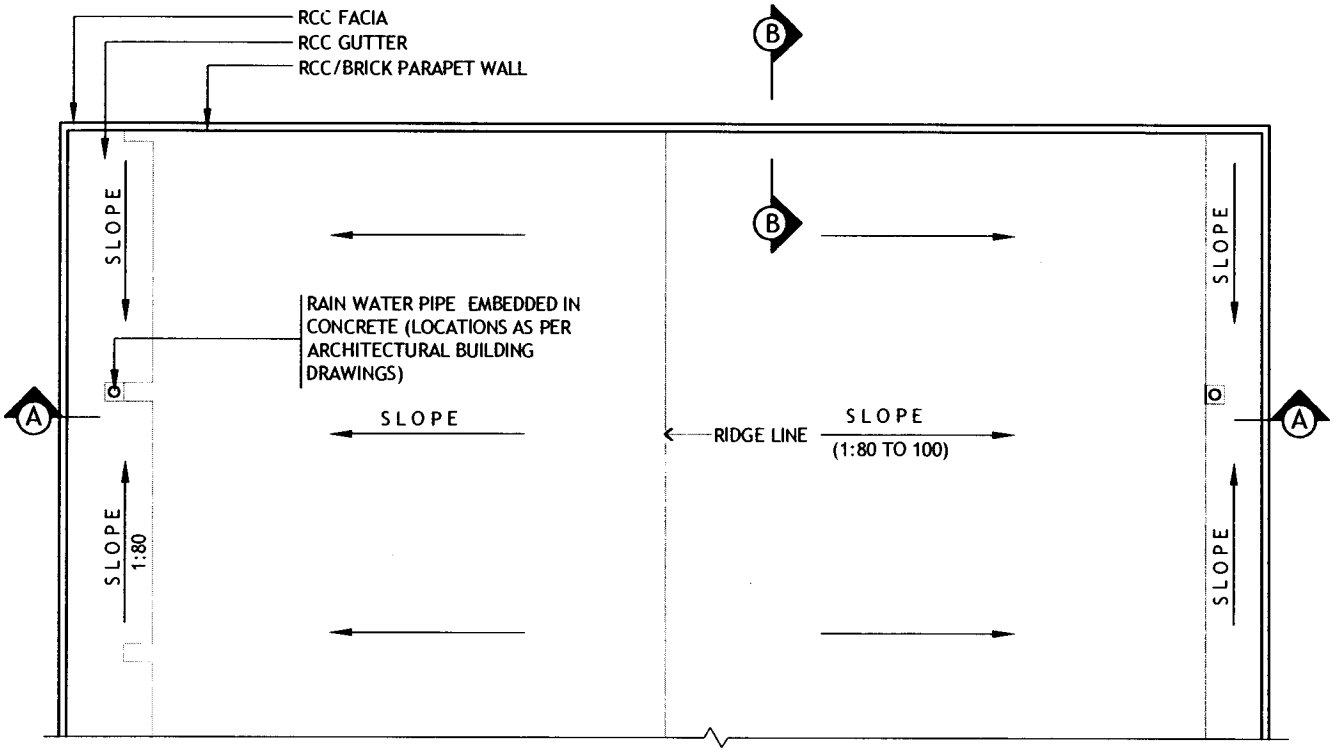
NOTE: ALL DIMENSIONS ARE IN MM

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	02.02.22	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	ANISH MAHALA	SAMIR DAS	SANJAY MAZUMDAR
5	21.11.16	REAFFIRMED & ISSUED AS STANDARD	DK	JS/JKB	RAJANJI SRIVASTAVA	R. NANDA

Approved by



SECTION A-A

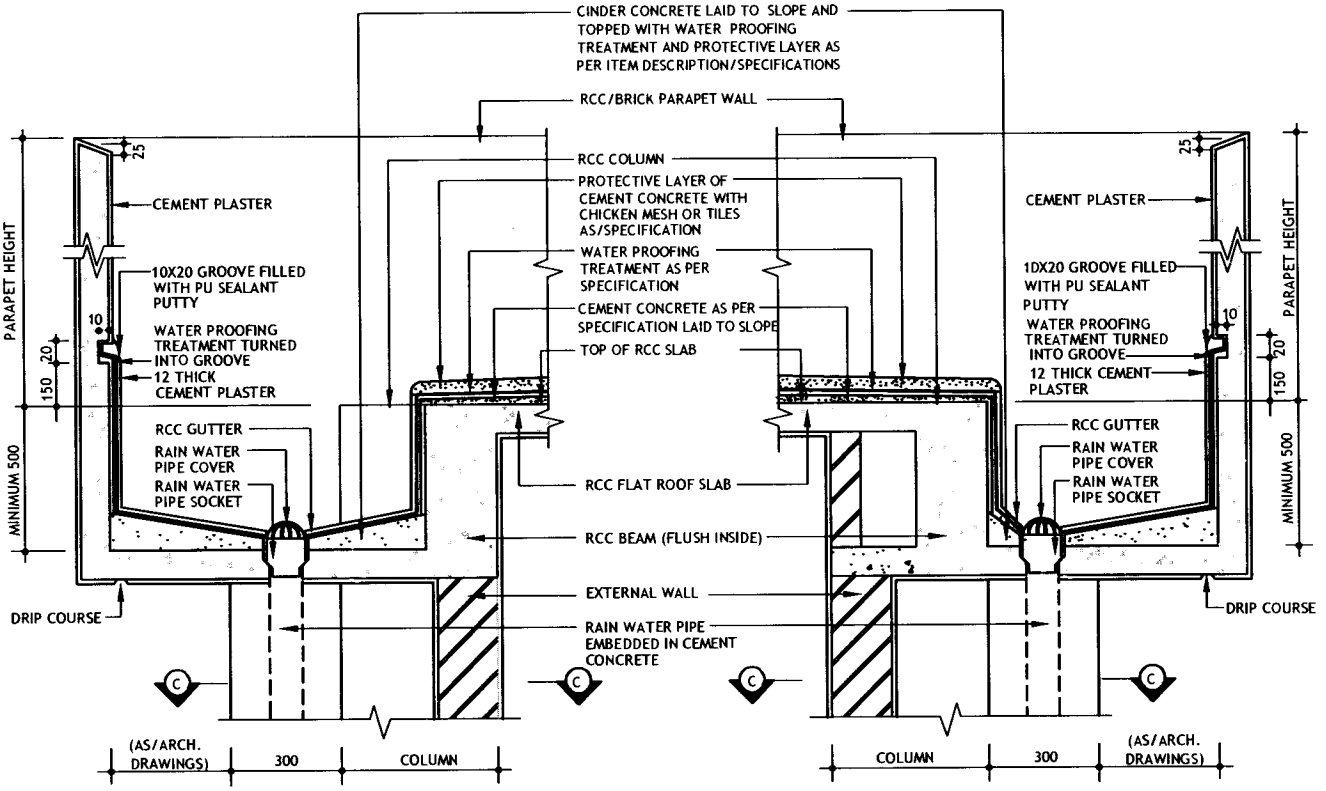


PART TERRACE PLAN

NOTES:

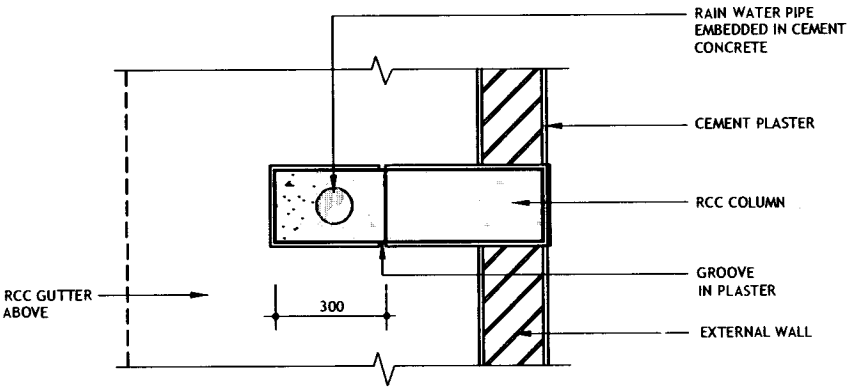
1. ALL DIMENSIONS ARE IN MM
2. SECTION A-A INDICATES RCC BEAM INSIDE ON ONE SIDE AND FLUSH OUTSIDE ON OTHER SIDE. THE LOCATION OF BEAM SHALL BE AS PER ARCHITECTURAL AND STRUCTURAL DRAWINGS.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
6	07.03.22	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	PIYALEE DAS	SAMIR DAS	SANJAY MAZUMDAR
5	07.03.17	REAFFIRMED & ISSUED AS STANDARD	VK/DK	JKB	RAJANJI SRIVASTAVA	R. NANDA



DETAIL - 1

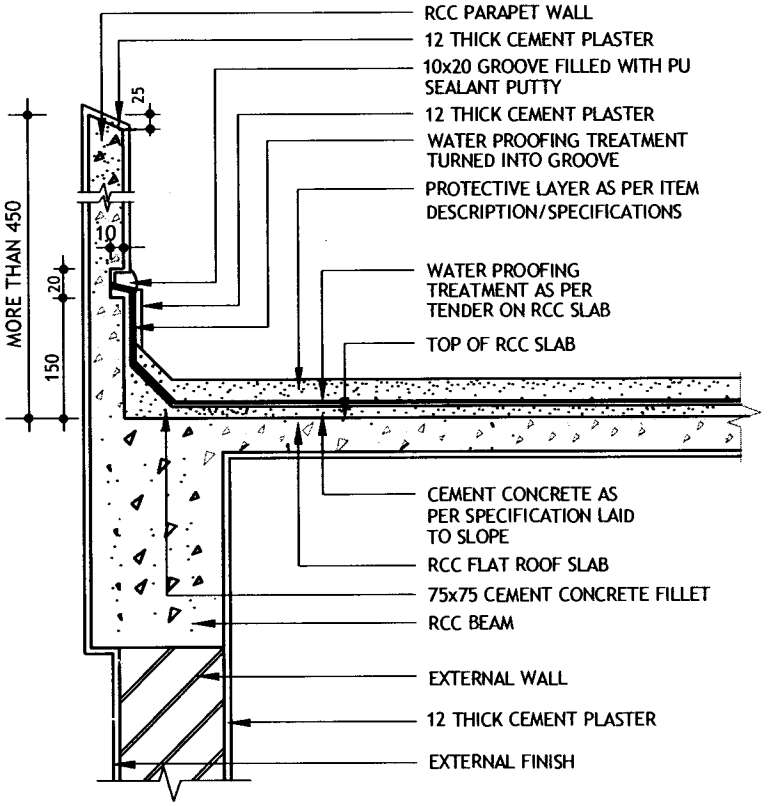
DETAIL - 2



SECTIONAL PLAN C-C

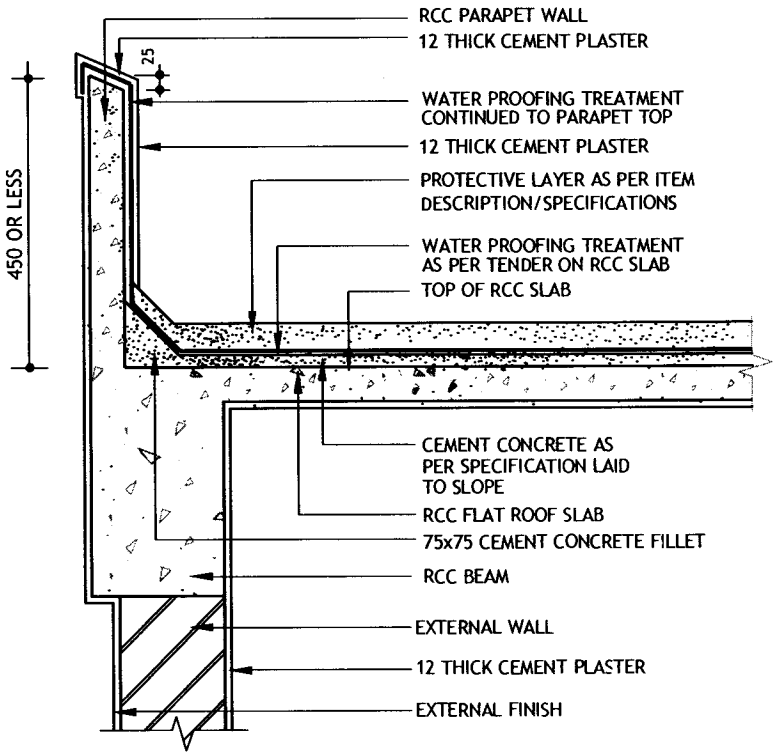
NOTE: REFER SHEET 1 OF 3

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
6	07.03.22	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	PIYALEE DAS	SAMIR DAS	SANJAY MAZUMDAR
5	07.03.17	REAFFIRMED & ISSUED AS STANDARD	VK/DK	JKB	RAJANJI SRIVASTAVA	R. NANDA



SECTION B-B

(PARAPET HEIGHT MORE THAN 450)



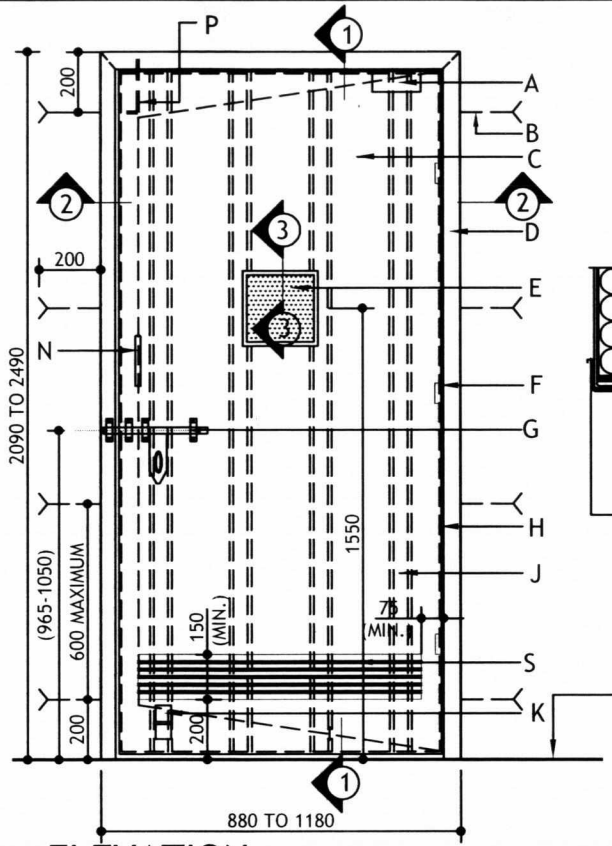
SECTION B-B

(PARAPET HEIGHT UP TO 450)

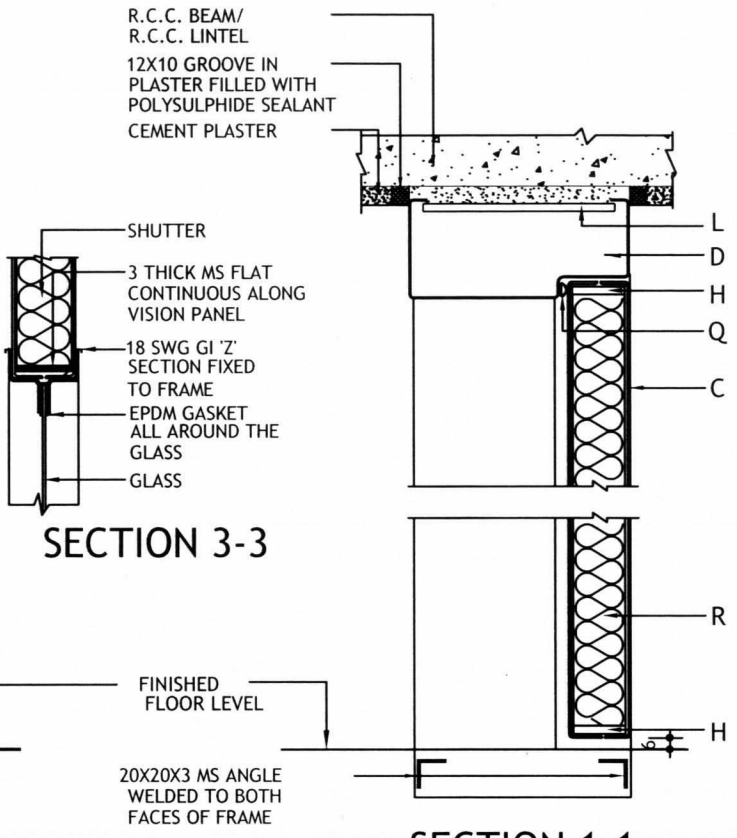
NOTE : ALL DIMENSIONS ARE IN MM

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
6	07.03.22	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	PIYALEE DAS	SAMIR DAS	SANJAY MAZUMDAR
5	07.03.17	REAFFIRMED & ISSUED AS STANDARD	VK/DK	JKB	RAJANJI SRIVASTAVA	R. NANDA

STEEL DOOR (PRESSED STEEL) SINGLE SHUTTER



ELEVATION

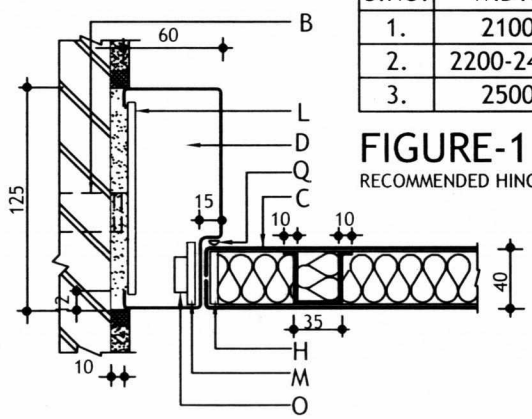


SECTION 1-1

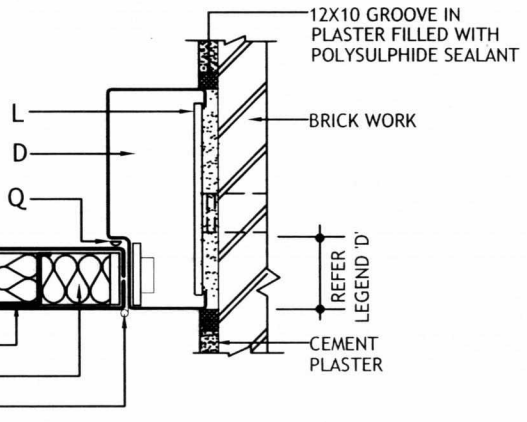
SECTION 3-3

S.NO.	WIDTH	HINGE
1.	2100	3
2.	2200-2400	4
3.	2500	5

FIGURE-1
RECOMMENDED HINGE LOCATION



SECTION 2-2



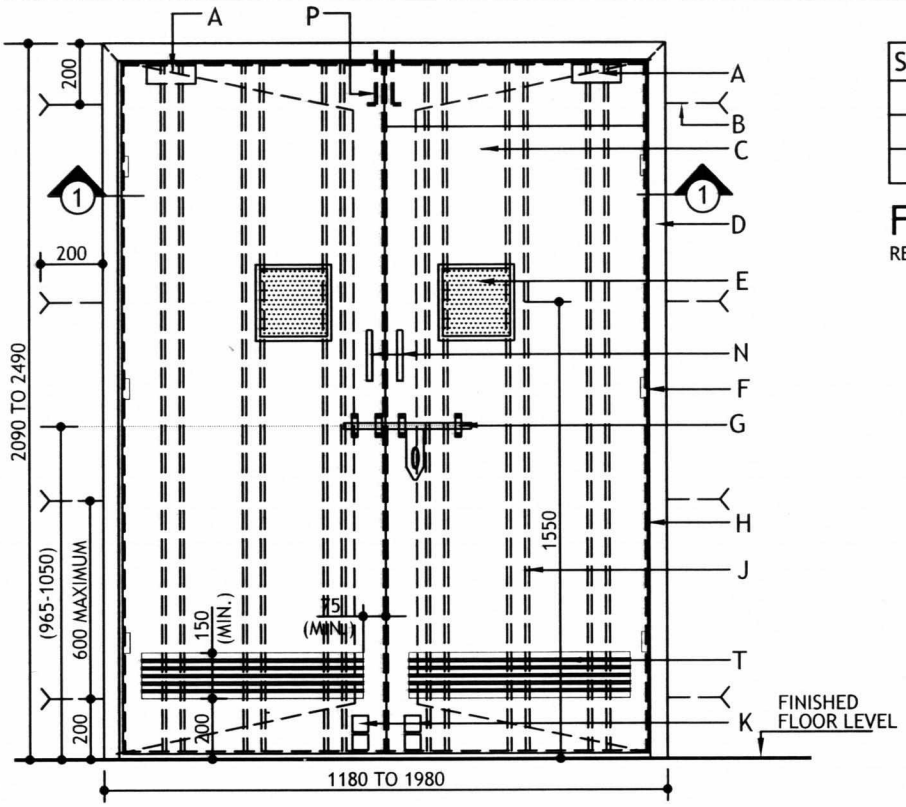
LEGEND :

A. OVER HEAD HYDRAULIC DOOR CLOSER (HEAVY DUTY).
B. MS HOLDFAST 200x25x6 THICK @ MAXIMUM 600 C/C WELDED TO FRAME SPACER (L).
C. 40 THICK (OVER ALL) 18 SWG GALVANIZED PRESSED STEEL SHUTTER FILLED WITH MINERAL WOOL (48Kg/cum).
D. 16 SWG GALVANIZED PRESSED STEEL FRAME OUT OF 125X60 PROFILE FILLED WITH CONCRETE (REBATE DIMENSION TO BE SUITABLY ADJUSTED FOR ACCOMMODATING GASKET FOR AIR TIGHT DOOR).
E. VISION PANEL (AS PER PROJECT DRAWING).
F. 100 LONG SS 304 GRADE HEAVY DUTY BALL BEARING HINGE AS PER FIGURE 1.
G. SS 304 GRADE 16 DIA 300 LONG ALDROP ON BOTH SIDES.
H. 3 THICK MS FLAT CONTINUOUS ALONG PERIMETER OF OF SHUTTER.
J. 18 SWG GI VERTICAL STIFFNER @ 200 C/C (SPACING TO BE ADJUSTED FOR VISION PANEL).
K. SPRING LOADED HEAVY DUTY DOOR STOPPER.
L. 3 THICK MS FLAT SPACER WELDED TO FRAME AT @ 500 C/C.
M. 40x150x3 THICK MS PAD WELDED TO FRAME AT ALL HINGE & LOCK LOCATIONS.
N. SS 304 GRADE 19 DIA, 200 LONG HANDLE ON BOTH SIDES.
O. 18 SWG GI MORTAR GUARD AT THE BACK OF HINGES & LOCK.
P. 10 DIA SS 304 TOWER BOLT (250 LONG FOR 2100 HT. & 600 LONG FOR 2500 HT.).
Q. 'D' PROFILE EPDM GASKET ALONG FRAME REBATE (FOR AIR TIGHT DOOR ONLY).
R. INSULATION AS PER ITEM DESCRIPTION.
S. LOUVER (SIZE AS PER PROJECT DRAWING) MADE 18 SWG GI (NOT REQUIRED FOR AC AND PRESSURISED AREA

NOTE: 1. ALL DIMENSIONS ARE IN MM

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	17.01.23	REVISED & ISSUED AS STANDARD	BABITA SHARMA	PIYALEE DAS	SAMIR DAS	SANJAY MAZUMDAR
5	24.04.17	REVISED & ISSUED AS STANDARD	DK	JS/JKB	RAJANJI SRIVASTAVA	R. NANDA

Approved by

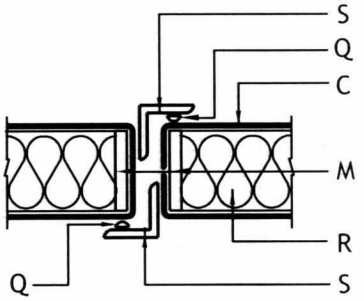


ELEVATION

S.NO.	WIDTH	HINGE
1.	2100	3
2.	2200-2400	4
3.	2500	5

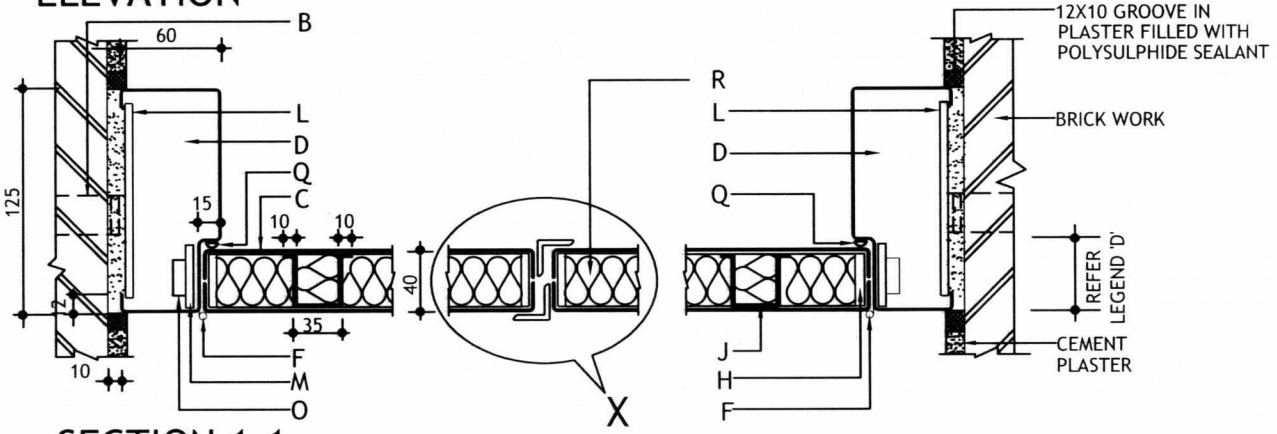
FIGURE-1

RECOMMENDED HINGE LOCATION



DETAIL X

NOTE: IN PLACE OF GI ANGLES (S) SUITABLE PROFILING/ DETAILING FOR CLOSURE OF SHUTTERS IS ALSO ACCEPTABLE.



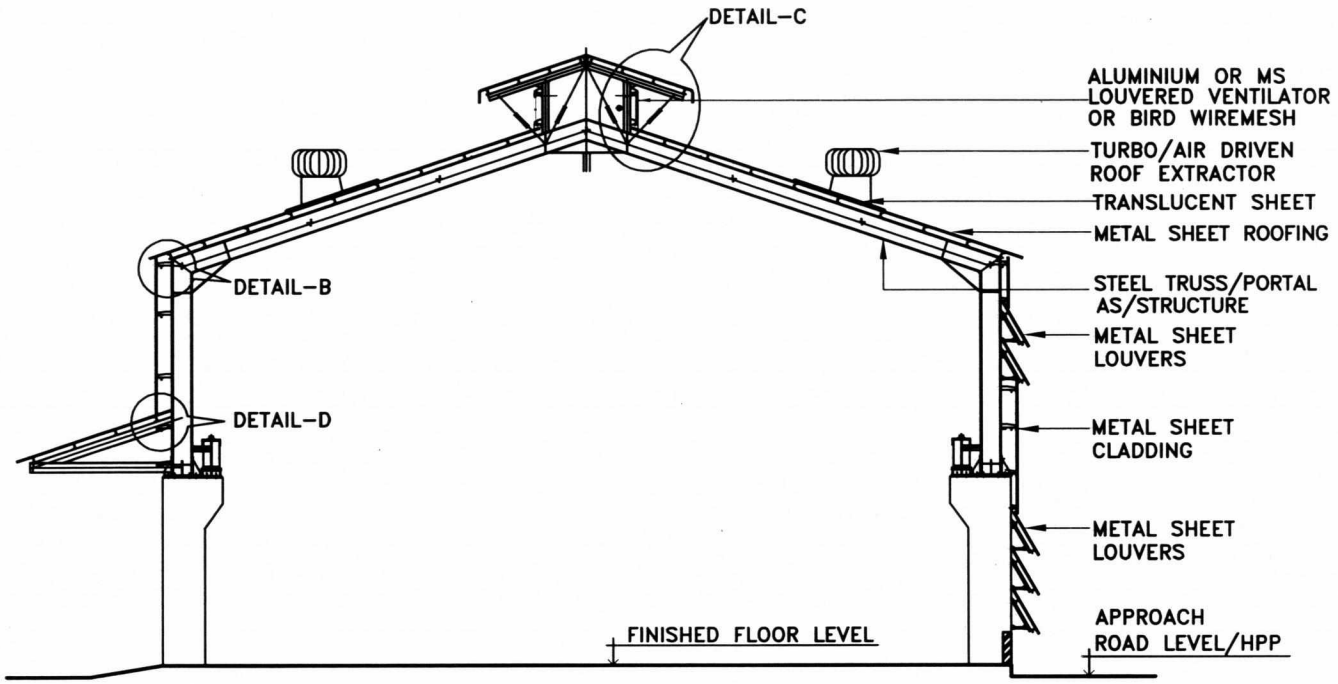
SECTION 1-1

LEGEND :

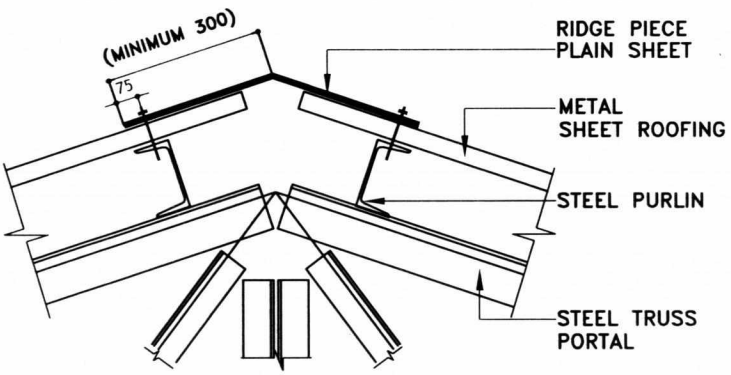
A. OVER HEAD HYDRAULIC DOOR CLOSER (HEAVY DUTY).
B. MS HOLDFAST 200x25x6 THICK @ MAXIMUM 600 C/C WELDED TO FRAME SPACER (L).
C. 40 THICK (OVER ALL) 18 SWG GALVANIZED PRESSED STEEL SHUTTER FILLED WITH MINERAL WOOL (48Kg/cum).
D. 16 SWG GALVANIZED PRESSED STEEL FRAME OUT OF 125X60 PROFILE FILLED WITH CONCRETE (REBATE DIMENSION TO BE SUITABLY ADJUSTED FOR ACCOMMODATING GASKET FOR AIR TIGHT DOOR).
E. VISION PANEL (AS PER PROJECT DRAWING).
F. 100 LONG SS 304 GRADE HEAVY DUTY BALL BEARING HINGE AS PER FIGURE 1.
G. SS 304 GRADE 16 DIA 300 LONG ALDROP ON BOTH SIDES.
H. 3 THICK MS FLAT CONTINUOUS ALONG PERIMETER OF OF SHUTTER.
J. 18 SWG GI VERTICAL STIFFNER @ 200 C/C (SPACING TO BE ADJUSTED FOR VISION PANEL).
K. SPRING LOADED HEAVY DUTY DOOR STOPPER.
L. 3 THICK MS FLAT SPACER WELDED TO FRAME AT @ 500 C/C.
M. 40x150x3 THICK MS PAD WELDED TO FRAME AT ALL HINGE & LOCK LOCATIONS.
N. SS 304 GRADE 19 DIA, 200 LONG HANDLE ON BOTH SIDES.
O. 18 SWG GI MORTAR GUARD AT THE BACK OF HINGES & LOCK.
P. 10 DIA SS 304 TOWER BOLT (250 LONG FOR 2100 HT. & 600 LONG FOR 2500 HT.).
Q. 'D' PROFILE EPDM GASKET ALONG FRAME REBATE (FOR AIR TIGHT DOOR ONLY).
R. INSULATION AS PER ITEM DESCRIPTION.
S. 2 THICK 25X25 GI ANGLE (VERTICAL) EACH WELDED TO ONE SHUTTER.
T. LOUVER (SIZE AS PER PROJECT DRAWING) MADE 18 SWG GI (NOT REQUIRED FOR AC AND PRESSURISED AREA

NOTE: 1. ALL DIMENSIONS ARE IN MM.
2. FOR OTHER DETAILS REFER STANDARD NO. 7-75-0070.

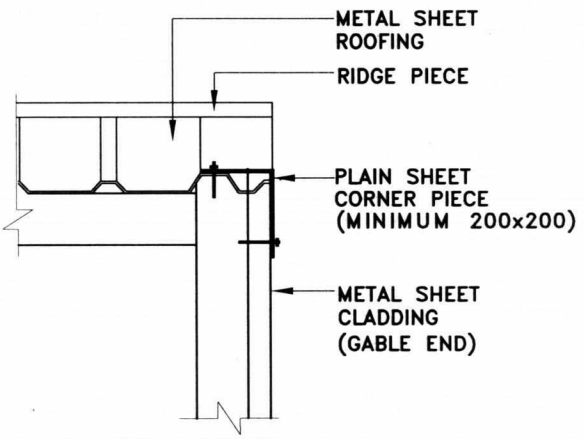
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
6	17.01.23	REVISED & ISSUED AS STANDARD	BABITA SHARMA	PIYALEE DAS	SAMIR DAS	SANJAY MAZUMDAR
5	24.04.17	REVISED & ISSUED AS STANDARD	DK	JS/JKB	RAJANJI SRIVASTAVA	R. NANDA



TYPICAL SECTION



DETAIL–A
(RIDGE FLASHING DETAIL)

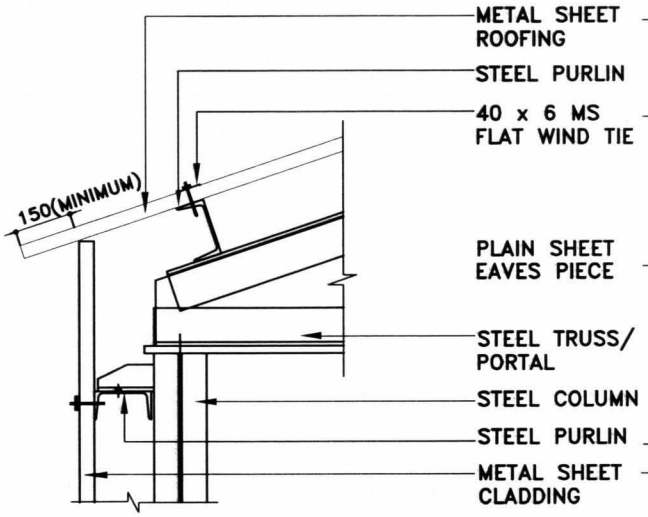


CORNER PIECE
FLASHING DETAIL
(ROOF AND GABLE END CLADDING)

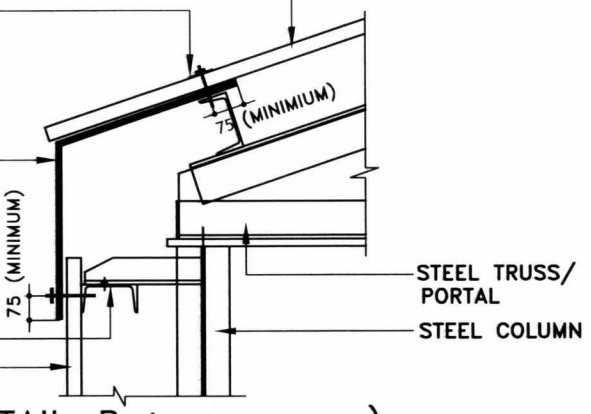
NOTES:

1. ALL DIMENSIONS ARE IN MM.
2. THIS STANDARD INDICATES VARIOUS ARCHITECTURAL FEATURES AND FLASHING DETAILS OF SHEDS. PROVISION OF FEATURES (ROOF MONITOR, ROOF EXTRACTOR, TRANSLUCENT SHEET, LOUVERS) AND THEIR SIZES, LOCATION ETC SHALL BE AS PER PROJECT DRAWINGS.
3. MATERIAL, THICKNESS AND OTHER DETAILS OF ROOFING, CLADDING, ACCESORIES (RIDGE FLASHING, CORNER PIECE, EAVES PIECE, APRON PIECE AND OTHER FLASHING) AND BIRD MESH SHALL BE AS PER PROJECT SPECIFICATION.

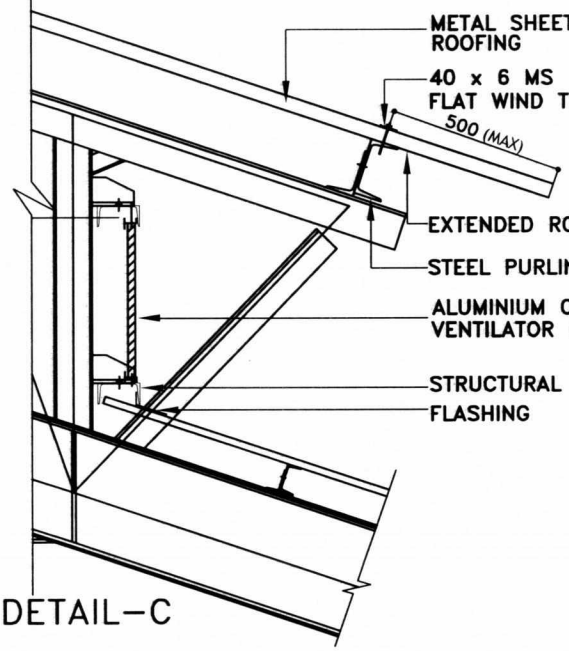
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
2	17.01.23	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	PIYALEE DAS	SAMIR DAS	SANJAY MAZUMDAR
1	16.01.18	REVISED & REISSUED AS STANDARD	RS	JS/SD	R. SRIVASTAVA	R. NANDA



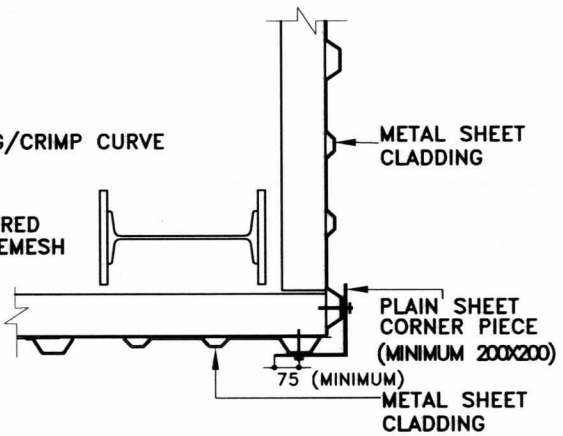
DETAIL–B (ALTERNATIVE–1)



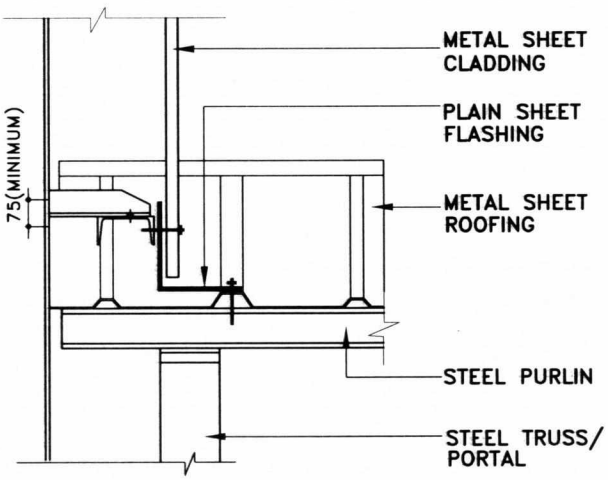
DETAIL–B (ALTERNATIVE–2)
EAVES FLASHING DETAIL



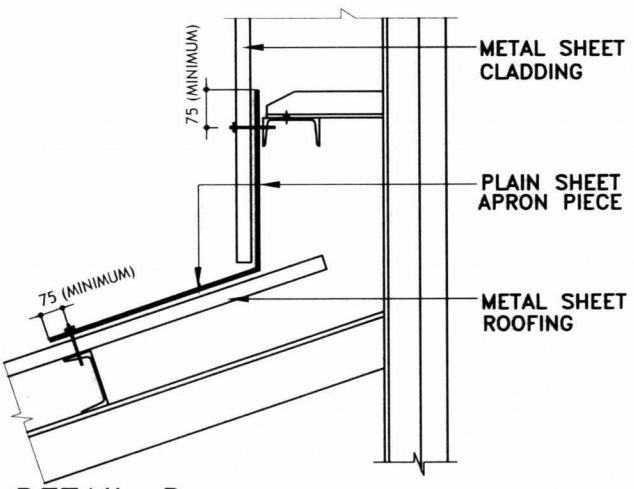
DETAIL–C



CORNER PIECE FLASHING DETAIL
(SIDE AND GABLE END CLADDING)



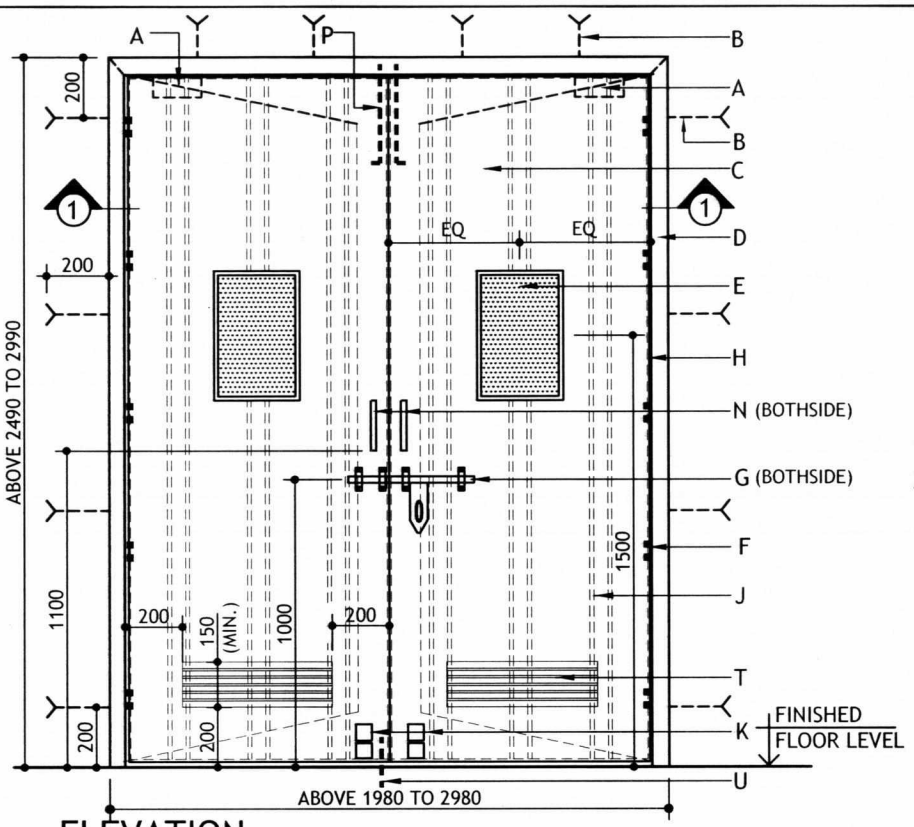
FLASHING DETAIL
(VERTICAL CLADDING AND ROOF)



DETAIL–D
(APRON FLASHING DETAIL)

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
2	17.01.23	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	PIYALEE DAS	SAMIR DAS	SANJAY MAZUMDAR
1	16.01.18	REVISED & REISSUED AS STANDARD	RS	JS/SD	R. SRIVASTAVA	R. NANDA

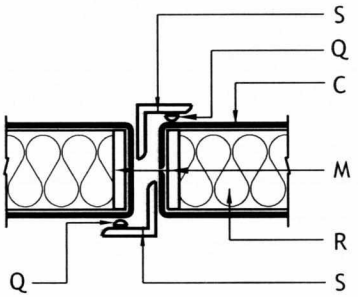
Approved by



ELEVATION

S.NO.	WIDTH	HINGES
1.	2500-2700	5
2.	2800-3000	6

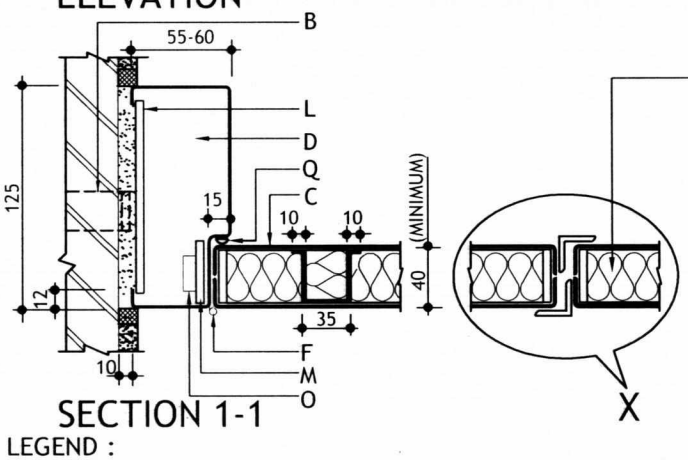
FIGURE-1
RECOMMENDED HINGE NUMBERS (MINIMUM)



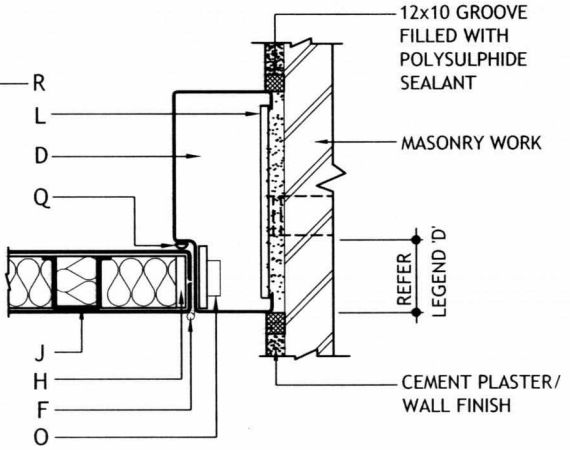
DETAIL X

NOTE :

IN PLACE OF GI ANGLES (S), SUITABLE PROFILING / DETAILING FOR CLOSURE OF SHUTTERS IS ALSO ACCEPTABLE.



SECTION 1-1

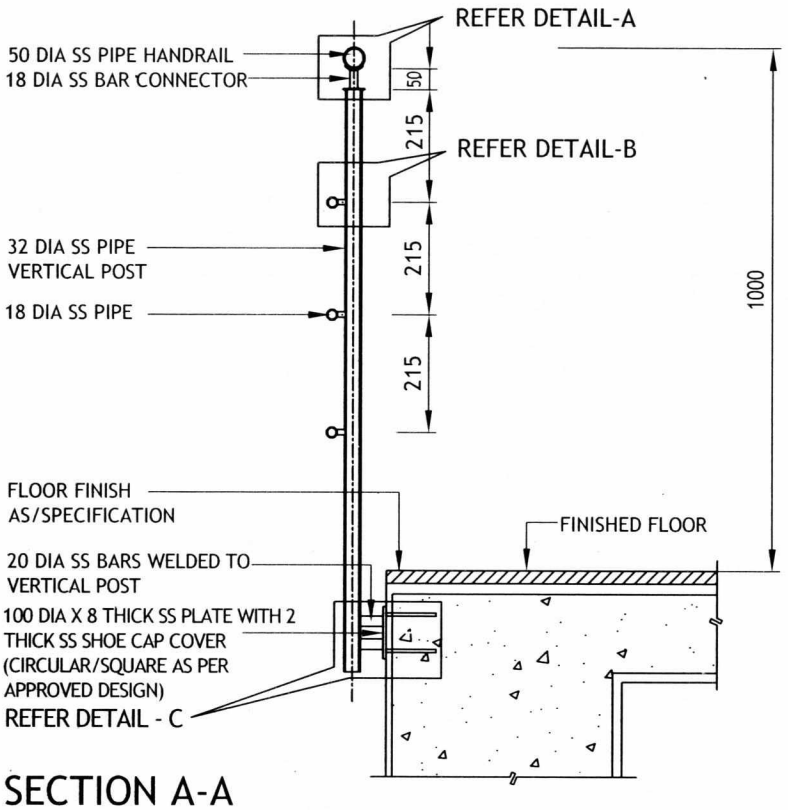


LEGEND :

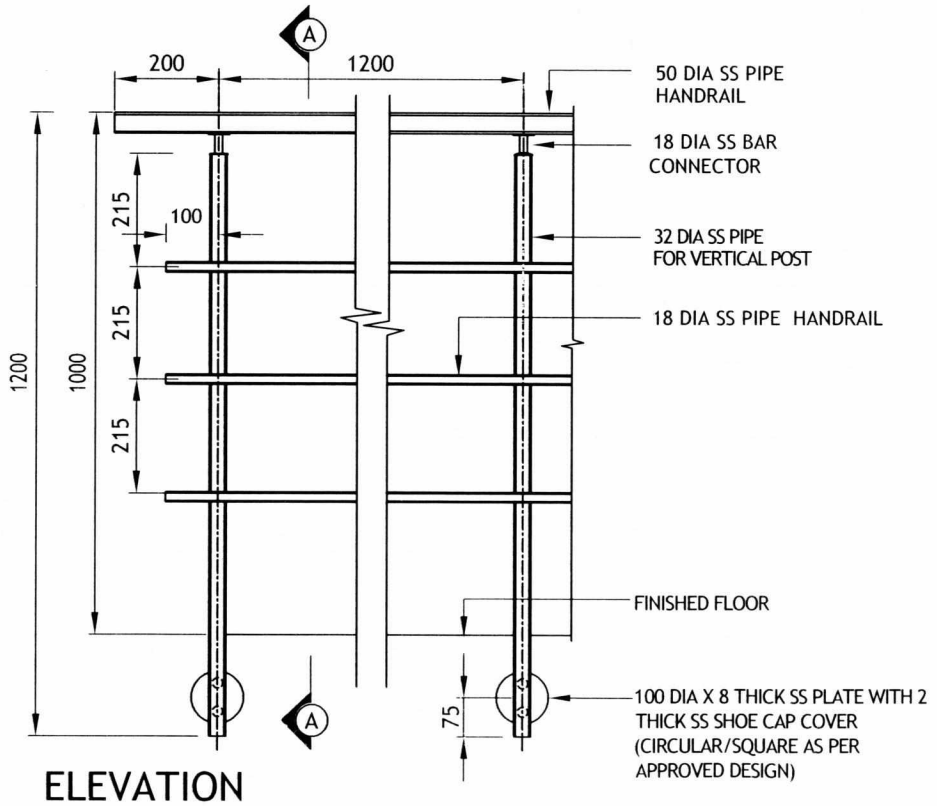
A. OVER HEAD HYDRAULIC DOOR CLOSER (HEAVY DUTY) ON BOTH SHUTTERS.
B. MS HOLDFAST 200X25X6 THICK OR 10X100 FRAME ANCHOR FASTENERS @ MAXIMUM 600 C/C WELDED TO FRAME SPACER (L).
C. 18 SWG GALVANIZED PRESSED STEEL SHUTTER FILLED WITH MINERAL WOOL (48KG/CUM) OR OTHER APPROVED MATERIAL SUCH AS HONEY COMB.
D. 16 SWG GALVANIZED PRESSED STEEL FRAME OUT OF (MIN) 125X55-60 PROFILE FILLED WITH CONCRETE (REBATE DIMENSION TO BE SUITABLY ADJUSTED FOR ACCOMODATING GASKET FOR AIR TIGHT DOOR).
E. VISION PANEL (300X450).
F. 100 LONG SS 304 GRADE HEAVY DUTY SS BALL BEARING HINGE AS PER FIGURE 1.
G. SS 304 GRADE 16 DIA 400 LONG SS ALDROP ON BOTH SIDES.
H. 3 THICK MS FLAT CONTINUOUS ALONG PERIMETER OF SHUTTER.
J. 18 SWG GI VERTICAL STIFFNER @ 200 C/C (SPACING TO BE ADJUSTED FOR VISION PANEL / LOUVERS).
K. SPRING LOADED HEAVY DUTY DOOR STOPPER.
L. 3 THICK MS FLAT SPACER WELDED TO FRAME AT @ 500 C/C.
M. 40x150x3 THICK MS PAD WELDED TO FRAME AT ALL HINGE & LOCK LOCATIONS.
N. SS 304 GRADE 19 DIA, 300 LONG SS HANDLE ON BOTH SIDES (THE HANDLES SHALL NOT BE INTERCONNECTED BY THROUGH BOLTING).
O. 18 SWG GI MORTAR GUARD AT THE BACK OF HINGES & LOCK.
P. SS-304 GRADE, SURFACE MOUNTED OR CONCEALED SS FLUSH BOLT, LENGTH UPTO 1400MM ON OUTER SIDE.
Q. 'D' PROFILE EPDM GASKET ALONG FRAME REBATE (FOR AIR TIGHT DOOR ONLY).
R. SHUTTER FILLER (REFER 'C').
S. 2 THICK 25X25 GI ANGLE (VERTICAL) WELDED TO EACH SHUTTER.
T. LOUVER MADE 18 SWG GI (NOT REQUIRED FOR AC AND PRESSURIZED AREA.
U. SS 304, 300 LONG SURFACE MOUNTED OR CONCEALED FLUSH BOLT ON INACTIVE LEAF.

NOTE: 1. ALL DIMENSIONS ARE IN MM.
2. FOR OTHER DETAILS REFER STANDARD NO. 7-75-0070, 7-75-0071

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
1	17.01.23	REVISED & ISSUED AS STANDARD	BABITA SHARMA	PIYALEE DAS	SAMIR DAS	SANJAY MAZUMDAR
0	01.06.20	ISSUED AS STANDARD	M L THAKUR	SAMIR DAS	RAJANJI SRIVASTAVA	S K SAXENA



SECTION A-A

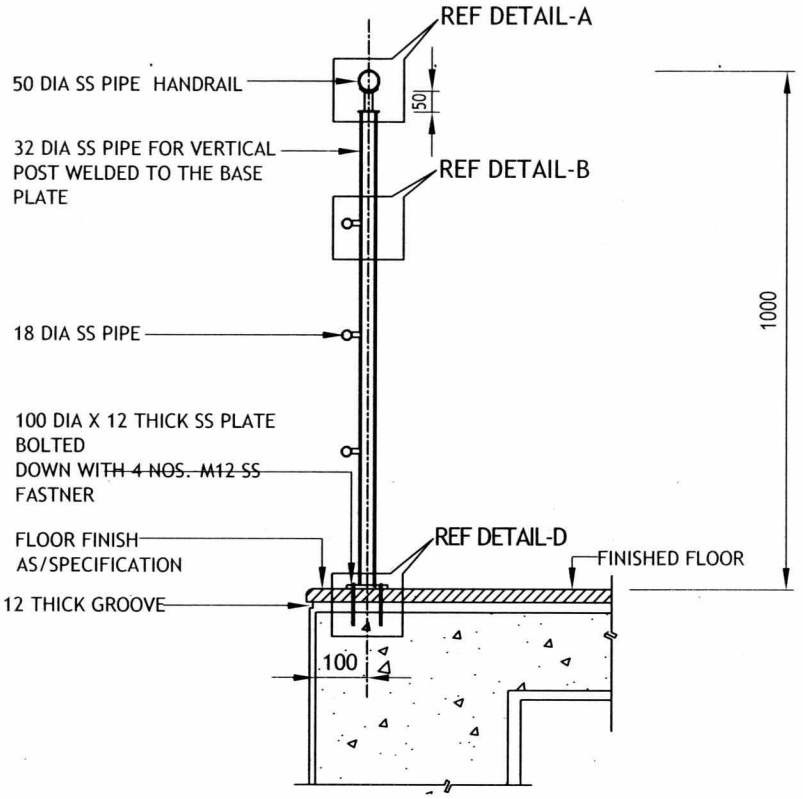


ELEVATION

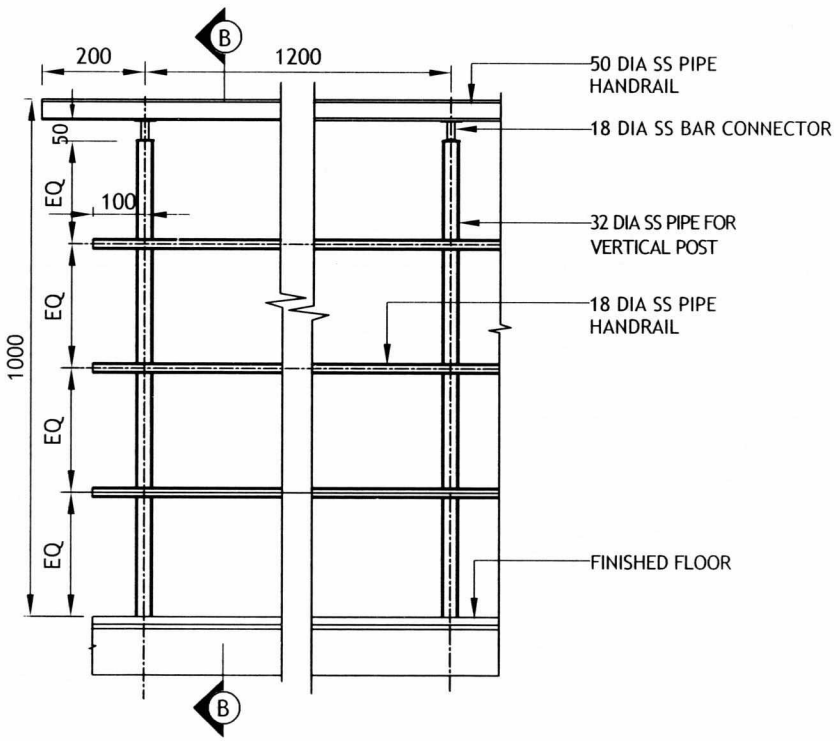
STAINLESS STEEL HANDRAIL FIXED ON SIDE OF SLAB & STAIRS (TYPE-A)

NOTE: 1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. 50 & 32 DIA (OUTER) PIPES SHALL BE OF 16 GAUGE. ALL OTHER MEMBERS SHALL BE OF 18 GUAGE/ APPLICABLE.
3. GRADE OF STEEL IS S/S 304 (SATIN FINISH).

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
2	16.10.23	REVISED & ISSUED AS STANDARD	M L THAKUR	SANDEEP	SAMIR DAS	SANJAY MAZUMDAR
1	30.03.21	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	SAMIR DAS	ANURAG SINHA	SANJAY MAZUMDAR



SECTION B-B

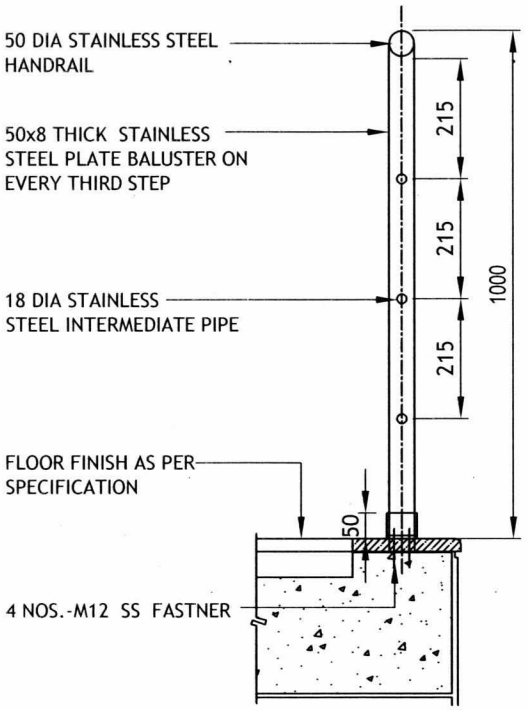


ELEVATION

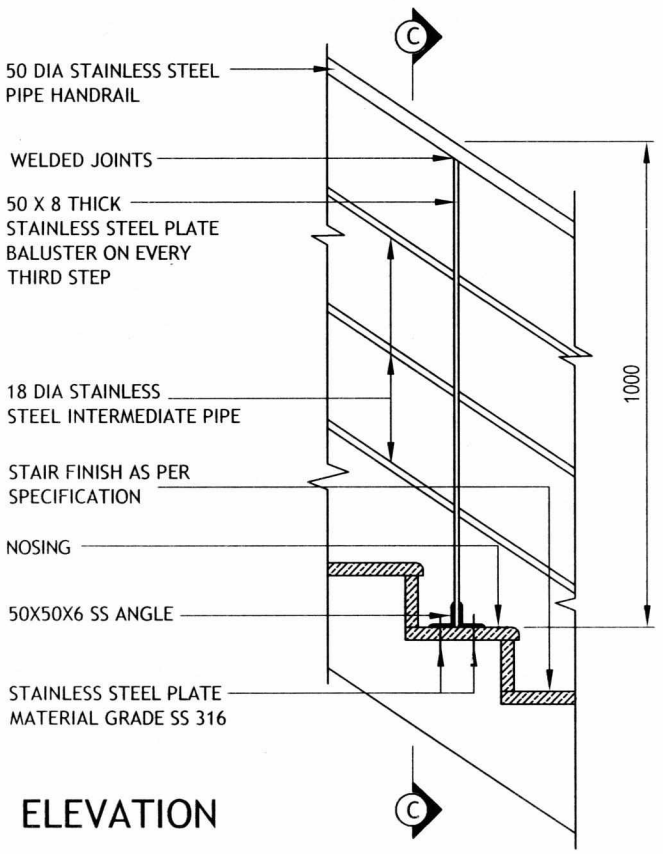
STAINLESS STEEL HANDRAIL FIXED OVER THE SLAB & STAIRS (TYPE-B)

NOTE: 1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. GRADE OF STEEL IS S/S 304 (SATIN FINISH).

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
2	16.10.23	REVISED & ISSUED AS STANDARD	M L THAKUR	SANDEEP	SAMIR DAS	SANJAY MAZUMDAR
1	30.03.21	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	SAMIR DAS	ANURAG SINHA	SANJAY MAZUMDAR



SECTION C-C

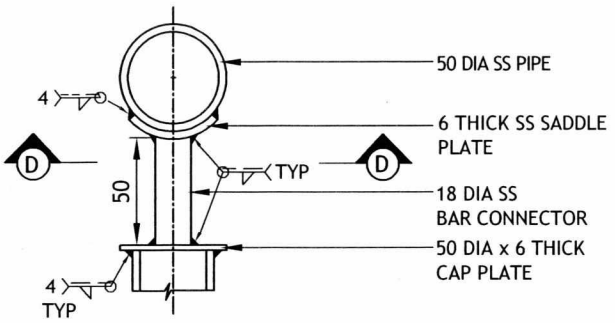


ELEVATION

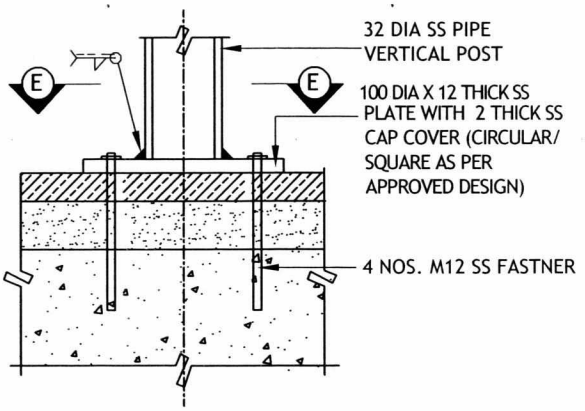
STAINLESS STEEL HANDRAIL FOR SLAB & STAIRS (TYPE-C)

NOTE: 1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. GRADE OF STEEL IS S/S 304 (SATIN FINISH).

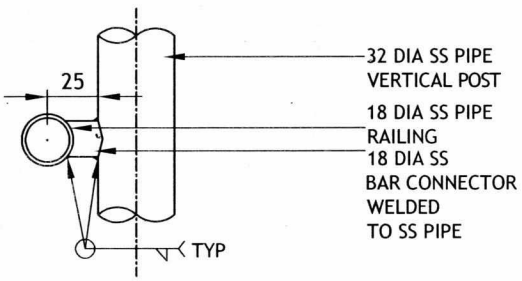
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
2	16.10.23	REVISED & ISSUED AS STANDARD	M L THAKUR	SANDEEP	SAMIR DAS	SANJAY MAZUMDAR
1	30.03.21	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	SAMIR DAS	ANURAG SINHA	SANJAY MAZUMDAR



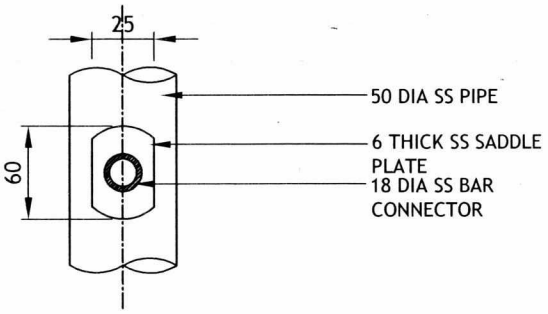
DETAIL A



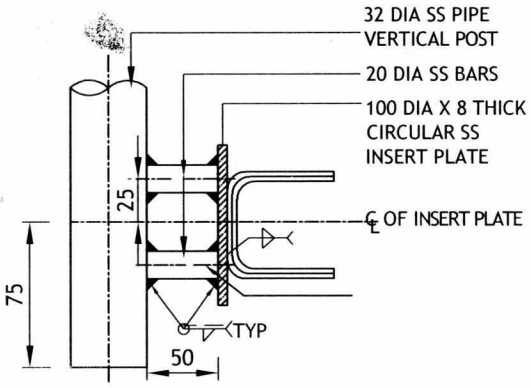
DETAIL D



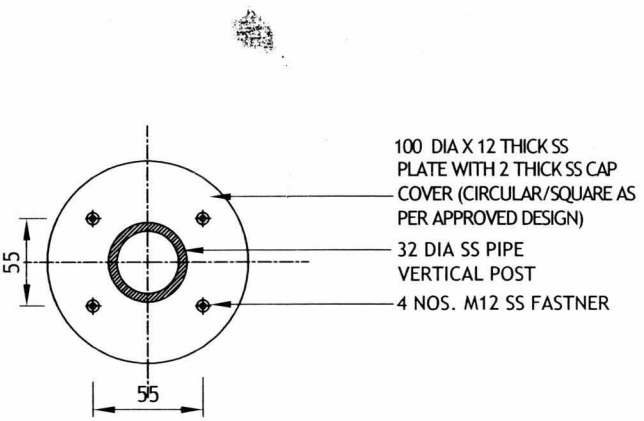
DETAIL B



SECTION D-D



DETAIL C
(TYPICAL DETAILS)

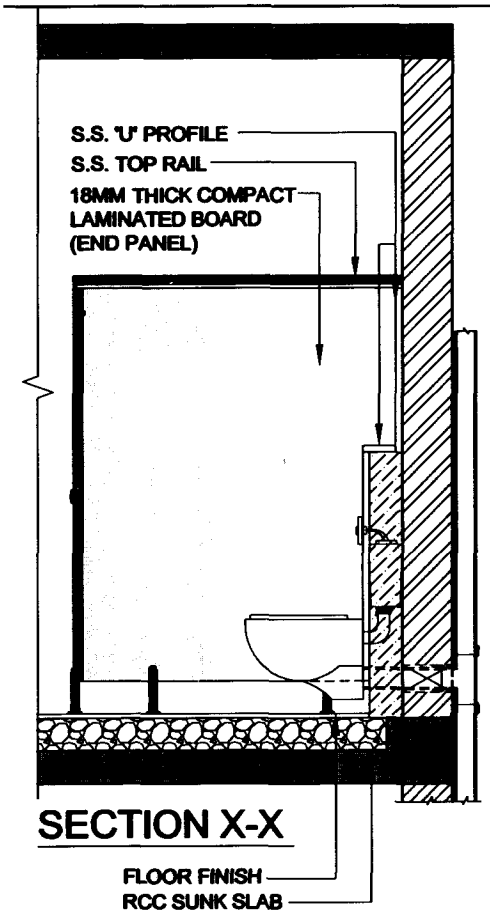


SECTION E-E

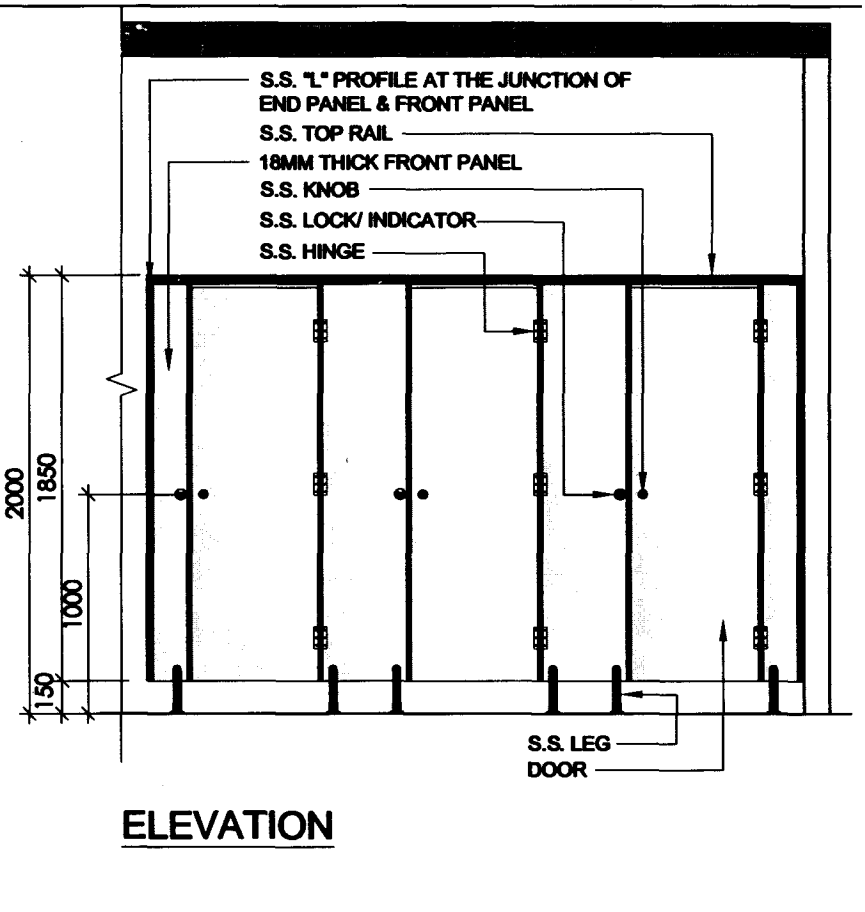
NOTE: 1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. GRADE OF STEEL IS S/S 304 (SATIN FINISH).

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
2	16.10.23	REVISED & ISSUED AS STANDARD	M L THAKUR	SANDEEP	SAMIR DAS	SANJAY MAZUMDAR
1	30.03.21	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	SAMIR DAS	ANURAG SINHA	SANJAY MAZUMDAR

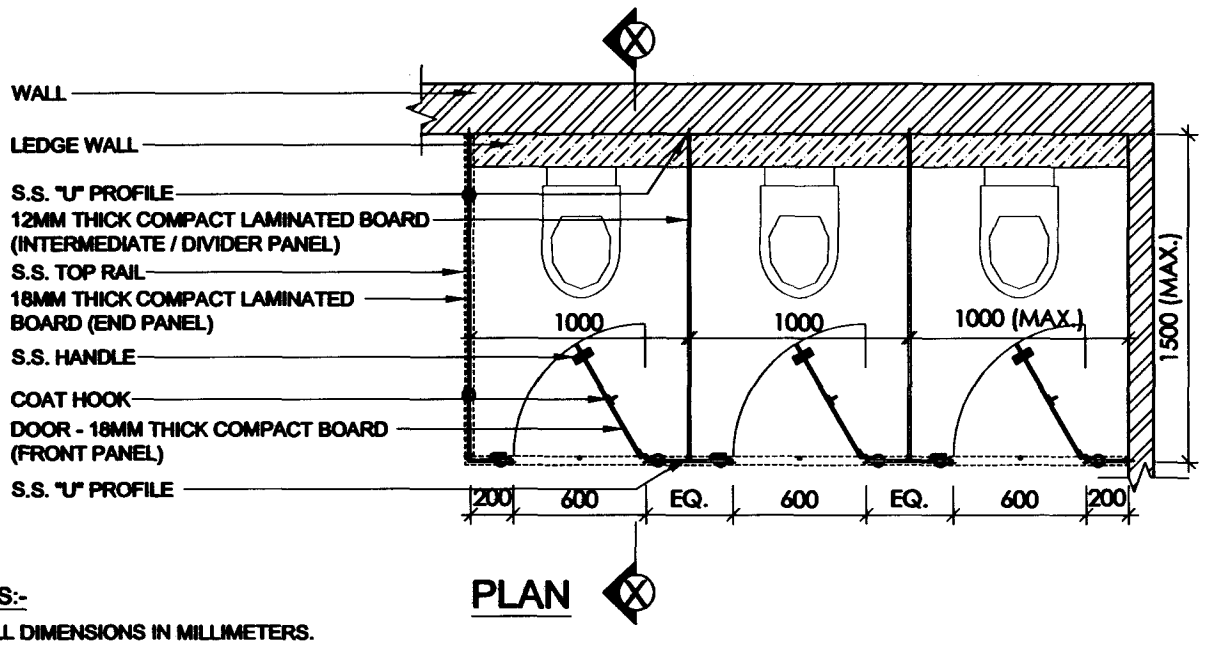
TOILET CUBICLES DETAILS



SECTION X-X



ELEVATION



PLAN

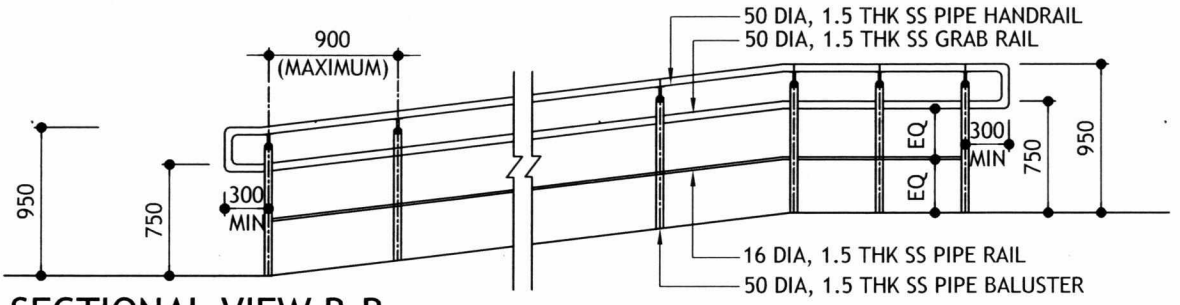
NOTES:-

1. ALL DIMENSIONS IN MILLIMETERS.
2. THIS STANDARD IS INDICATIVE AND TYPICAL CONSIDERING 3NO. OF W.C. CUBICLES. REFER RELEVANT ARCHITECTURAL DRAWING FOR EXACT NO. AND SIZES OF CUBICLES AND THEIR CONFIGURATION.
3. W.C. SEAT SHOWN IS INDICATIVE, EXACT TYPE OF SEAT (FLOOR MOUNTED OR WALL MOUNTED) SHALL BE AS PER TENDER ITEM.
4. ALL S.S. FITTINGS/ FIXTURES SHALL BE OF GRADE SS-316.
5. R.C.C. SUNK SLAB SHOWN IN SECTION X-X IS APPLICABLE FOR FIRST & HIGHER FLOORS ONLY (AND NOT FOR GROUND FLOOR).
6. FILLING MATERIAL FOR R.C.C. SUNK SLAB SHALL BE AS/ TENDER ITEM.

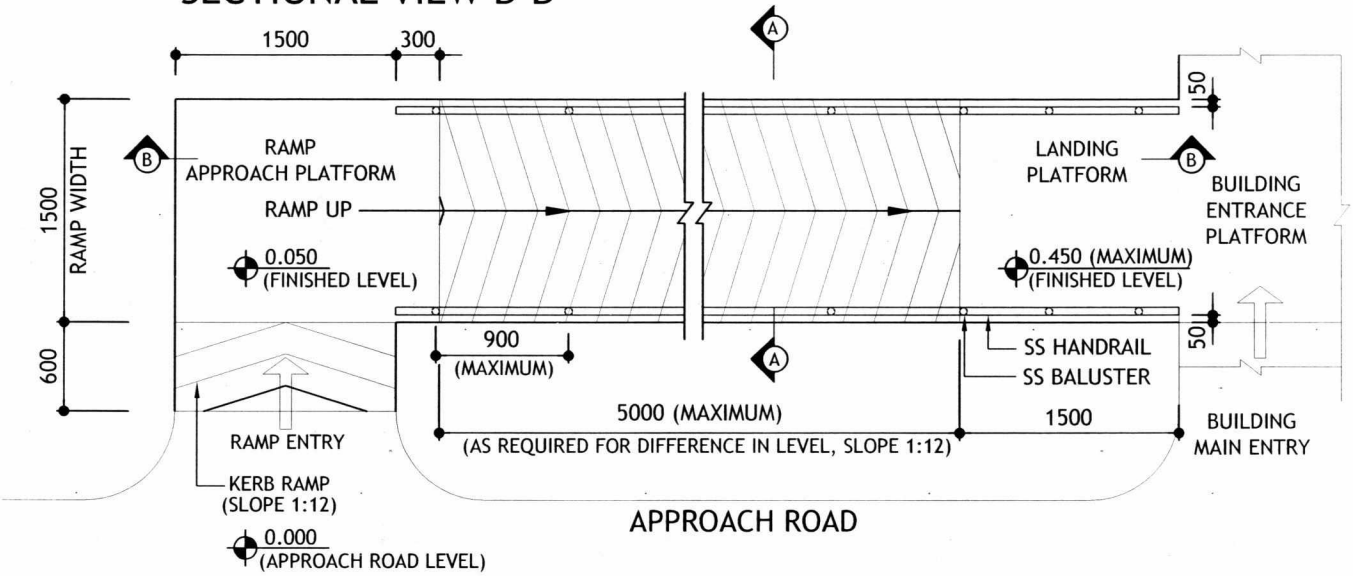
LEGEND:
S.S. = STAINLESS STEEL

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
1	02.02.22	REVISED & ISSUED AS STANDARD	BABITA SHARMA	PIYALEE DAS	SAMIR DAS	SANJAY MAZUMDAR
0	09.12.16	ISSUED AS STANDARD	DK	JS/JKB	RAJANJI SRIVASTAVA	R. NANDA

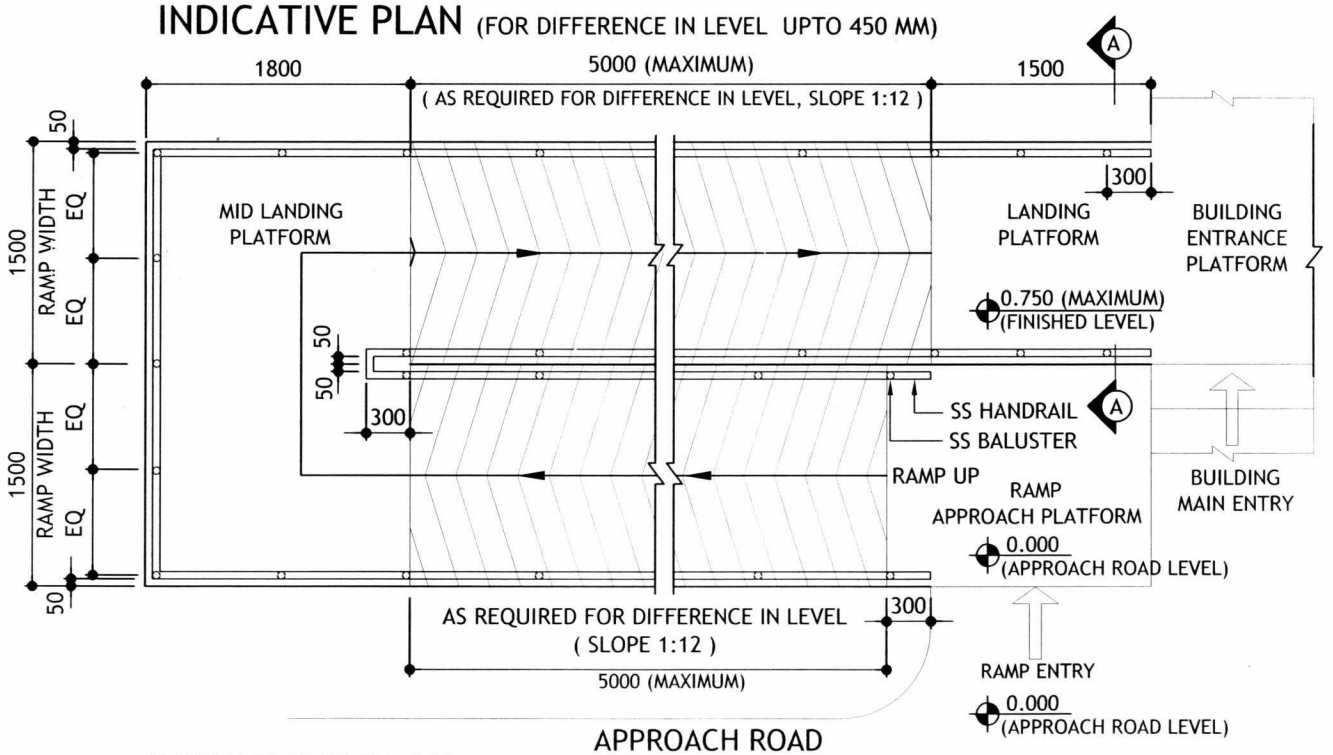
RAMP DETAIL
(FOR WHEEL CHAIR USERS)



SECTIONAL VIEW B-B



INDICATIVE PLAN (FOR DIFFERENCE IN LEVEL UPTO 450 MM)

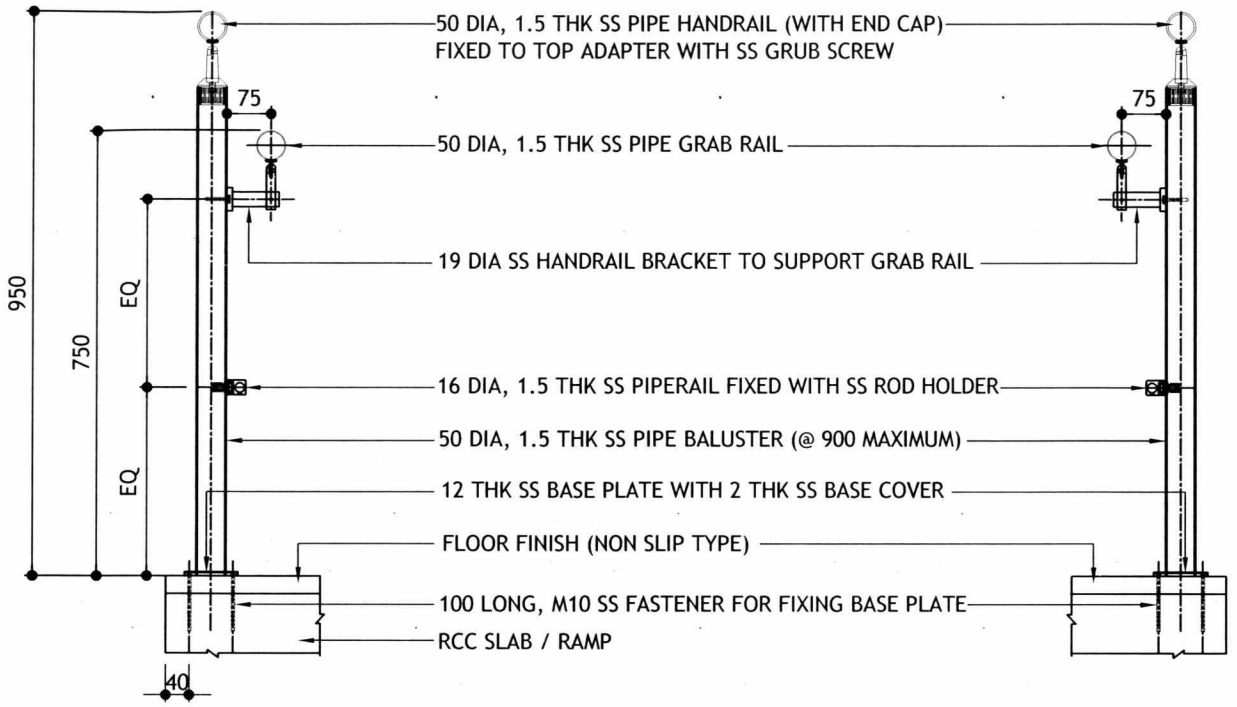


INDICATIVE PLAN (FOR DIFFERENCE IN LEVEL 451 TO 750 MM)

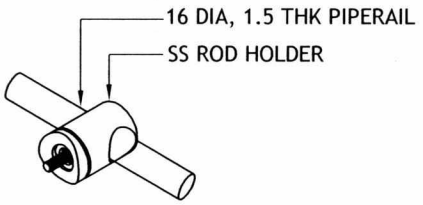
NOTE :

1. ALL DIMENSIONS ARE IN MM
2. SS - STAINLESS STEEL (GRADE-304)
3. ALL SS MEMBERS/FITTING SHALL BE OF SATIN FINISH.
4. THE RAMP ARRANGEMENT IS INDICATIVE. THE ARRANGEMENT SHALL BE AS PER ARCHITECTURAL DWG. BUT RAILING, LANDING DETAILS SHALL BE AS PER THIS STANDARD.

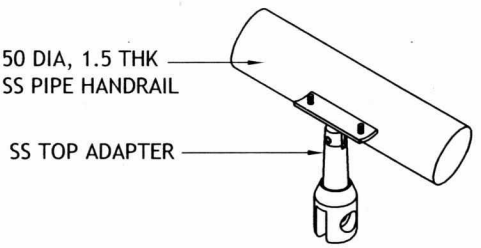
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
1	16.10.23	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	SANDEEP	SAMIR DAS	SANJAY MAZUMDAR
0	04.06.18	ISSUED AS STANDARD	MLT	SD	RS	R K TRIVEDI



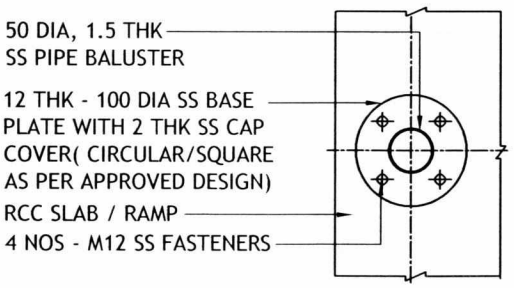
SECTION A-A



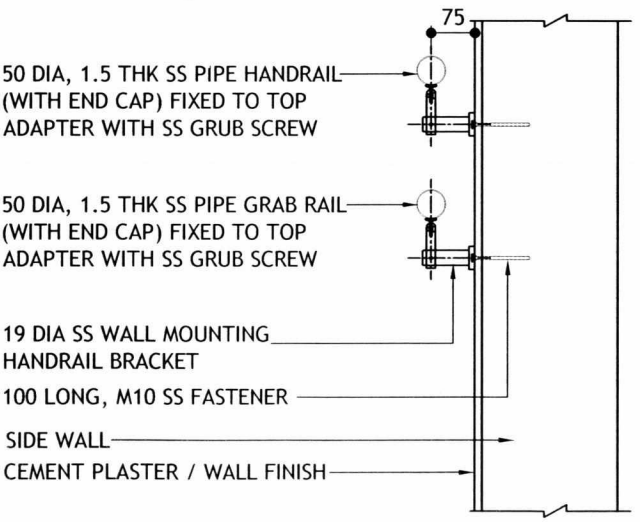
ROD HOLDER
(INDICATIVE VIEW)



TOP ADAPTER
(INDICATIVE VIEW)



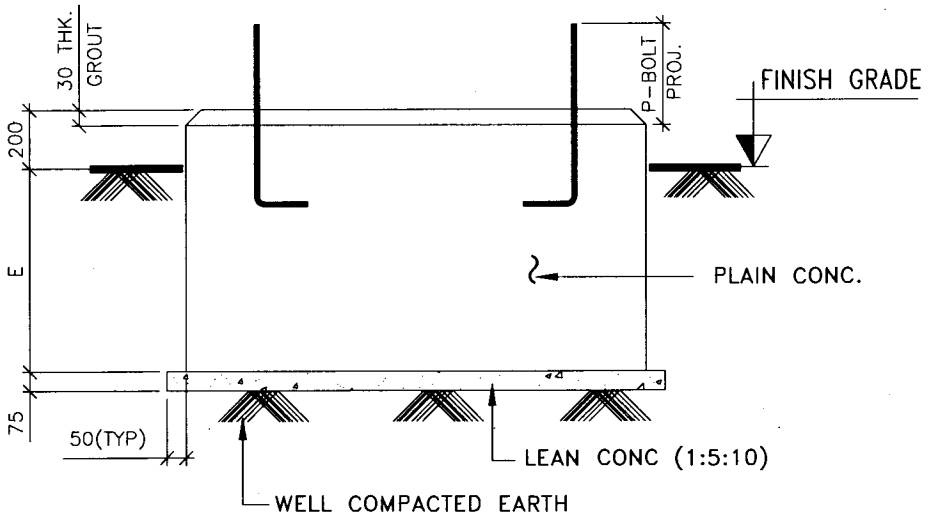
BASE PLATE DETAIL (PLAN)



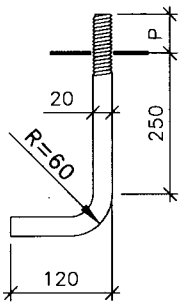
DETAIL OF GRAB RAIL
(ALONG WALL)

NOTE :
5. IN PLACE OF TOP ADAPTER & GRUB SCREW, WELDING USING SUITABLE SS MEMBER IS ACCEPTABLE IF SPECIFIED.

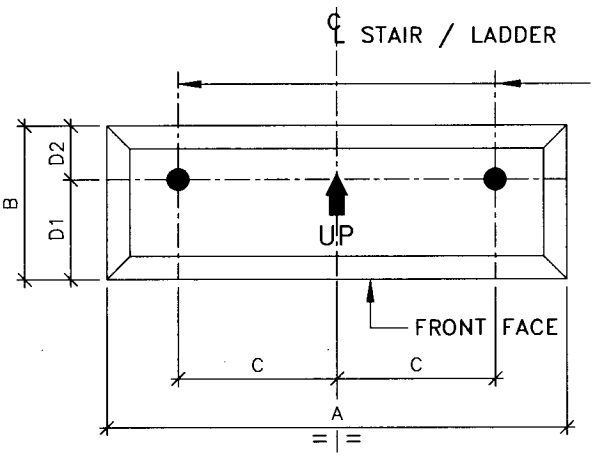
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
1	16.10.23	REAFFIRMED & ISSUED AS STANDARD	M L THAKUR	SANDEEP	SAMIR DAS	SANJAY MAZUMDAR
0	04.06.18	ISSUED AS STANDARD	MLT	SD	RS	R K TRIVEDI



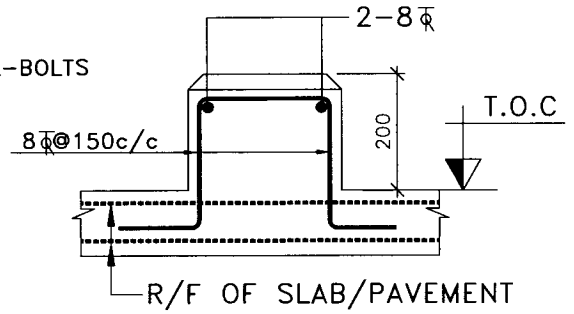
PEDESTAL FOR UNPAVED AREA



DET. OF L-BOLT



PLAN



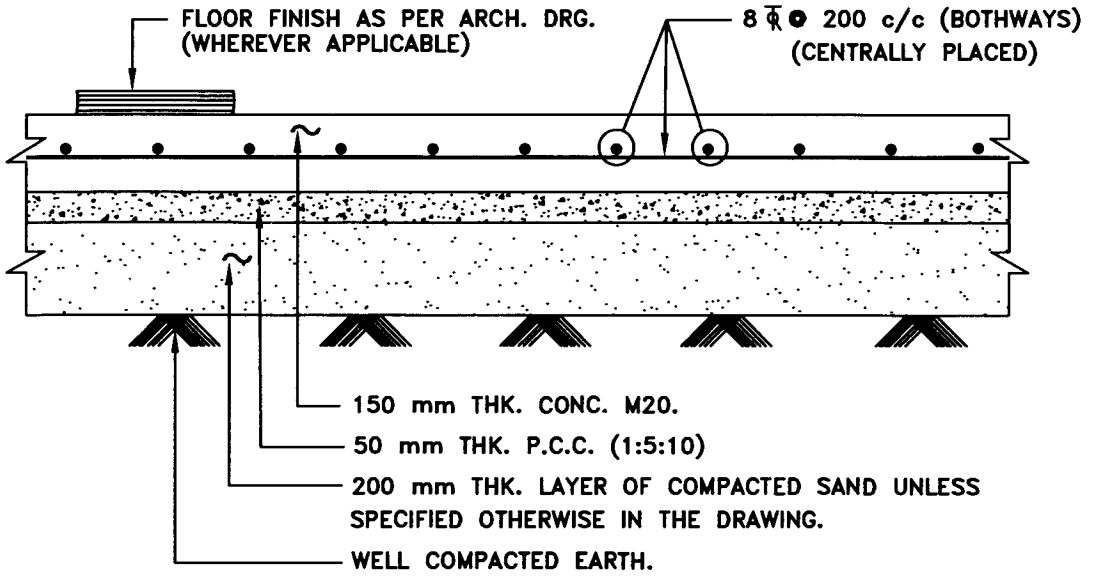
PEDESTAL ON CONC. PAVEMENT/R.C.C. SLAB

S.NO.	ITEM	WIDTH	A	B	C	D1	D2	P	E	NUT	REMARKS
1	LADDER	450	750	300	280	200	100	90	500	SINGLE	
2	STAIR	750	1100	310	421	160	150	90	600	SINGLE	FOR STRINGER BEAM MC150
3	STAIR	750	1100	355	421	255	100	90	600	SINGLE	FOR STRINGER BEAM MC200

NOTES:-

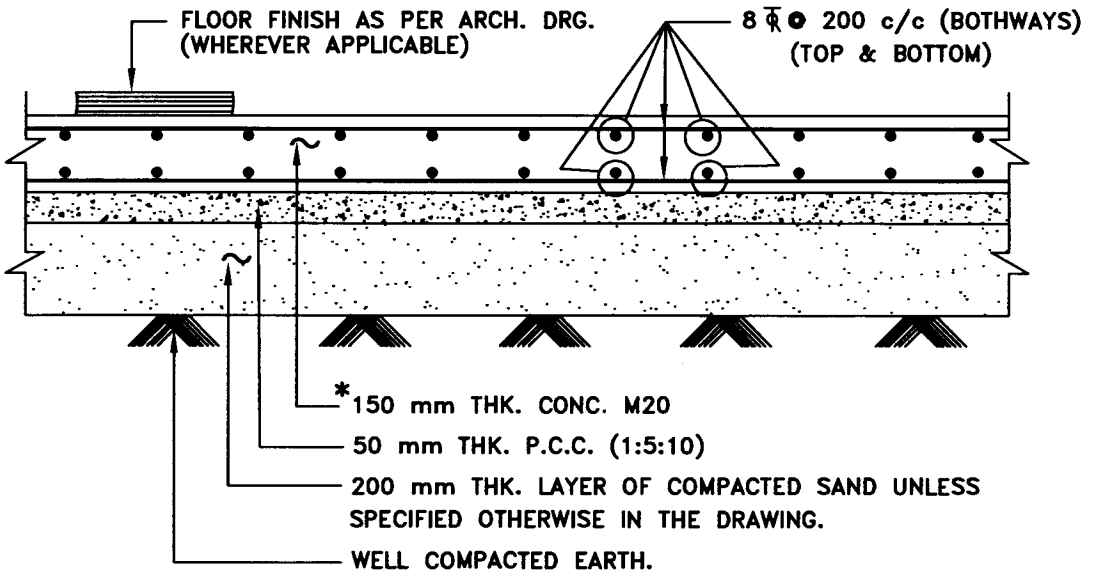
1. IN CASE OF PEDESTAL OVER PILE CAP/RCC FOUNDATION, DIMENSION 'E' TO SUIT ACCORDINGLY BUT NOT TO EXCEED VALUES GIVEN IN ABOVE TABLE.
2. CONCRETE GRADE SHALL BE AS PER GENERAL NOTES OF THE PROJECT BUT NOT LOWER THEN M20.
3. REBARS GRADE SHALL BE AS PER GENERAL NOTES OF THE PROJECT.
4. M20 L-BOLT AS PER DETAIL GIVEN ABOVE SHALL BE PROVIDED.
5. ANCHOR BOLT GRADE, NUTS, WASHERS & THREADING SHALL BE AS PER STANDARD NO. 7-68-0417.

Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by: Stds. Committee Convenor	Approved by: Stds. Bureau Chairman
8	08.07.21	REVISED AND ISSUED AS STANDARD	JITENDER GUPTA	ANKUR SHARMA	ANURAG SINHA	S. MAZUMDAR
7	16.09.16	REAFFIRMED AND ISSUED AS STANDARD	B.S SHARMA	R.B SHARMA	RAJAN JI SRIVASTAVA	R.NANDA



TYPE – I

(FOR PLANT BUILDINGS, SUB–STATION, CONTROL ROOM, PUMP HOUSE, UTILITY COMPRESSOR HOUSE, PARKING AREA, STORE & PORCH)



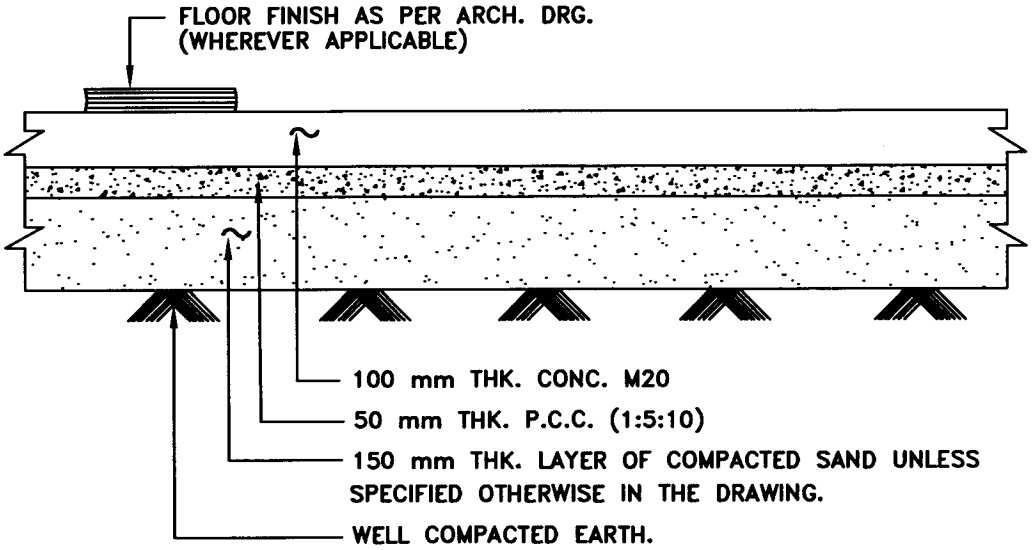
TYPE – II

(FOR WAREHOUSE, WORKSHOP, CEMENT GODOWN, FIRE STATION & PROCESS COMPRESSOR HOUSE)

*(FLOOR THICKNESS SHALL BE 150 mm FOR CLEAR COVER UPTO 40 mm AND FLOOR THICKNESS SHALL BE 200 mm FOR CLEAR COVER MORE THAN 40 mm)

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	12.04.22	REVISED AND RE–ISSUED AS STANDARD	OM PRAKASH	V. GOEL	ANURAG SINHA	SANJAY MAZUMDAR
5	20.10.16	REAFFIRMED AND ISSUED AS STANDARD	NARENDER KUMAR	V. GOEL	R. SRIVASTAVA	RAKESH NANDA
4	27.06.11	REAFFIRMED AND ISSUED AS STANDARD	SUSHMA	P.K.MITTAL	S.CHATURVEDI	D.MALHOTRA

Approved by



TYPE – III

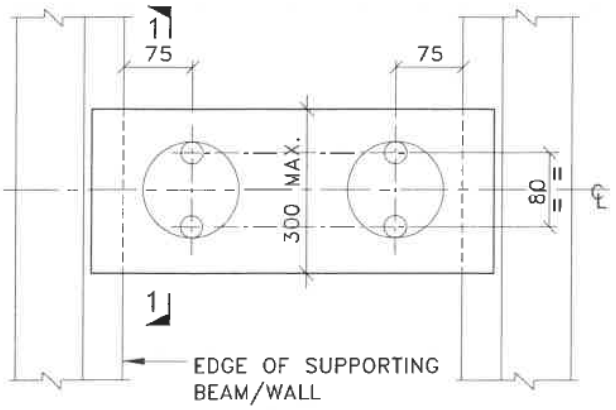
(FOR NON–PLANT BUILDINGS VIZ. ADMINISTRATION, LABORATORY, CANTEEN TIME OFFICE, GATE HOUSE, TRAINING CENTRE, GUEST HOUSE, SITE OFFICE, RESIDENTIAL BUILDINGS ETC.)

NOTES :–

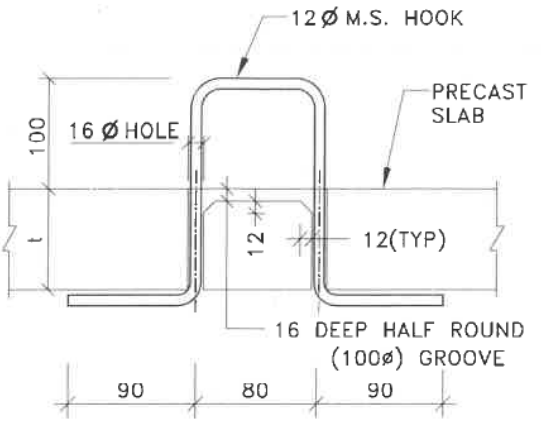
1. ALL DIMENSIONS ARE IN mm.
2. STRUCTURAL CONCRETE SLAB SHALL BE CAST IN ALTERNATE PANELS AND NO DIMENSION OF THE PANEL SHALL EXCEED 4.5 m.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman Approved by
6	12.04.22	REVISED AND RE–ISSUED AS STANDARD	OM PRAKASH	V. GOEL	ANURAG SINHA	SANJAY MAZUMDAR
5	20.10.16	REAFFIRMED AND ISSUED AS STANDARD	NARENDER KUMAR	V. GOEL	R. SRIVASTAVA	RAKESH NANDA
4	27.06.11	REAFFIRMED AND ISSUED AS STANDARD	SUSHMA	P.K.MITTAL	S.CHATURVEDI	D.MALHOTRA

STANDARD LIFTING HOOKS IN PRECAST SLABS AND CHEQ. PLATES

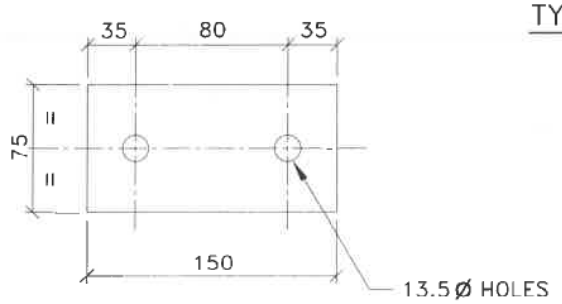


PLAN

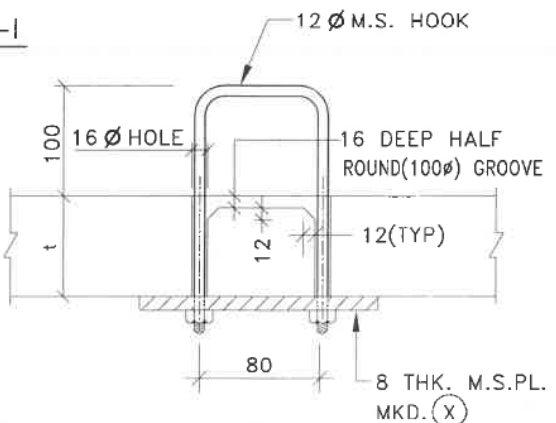


SECTION:1–1

TYPE–I

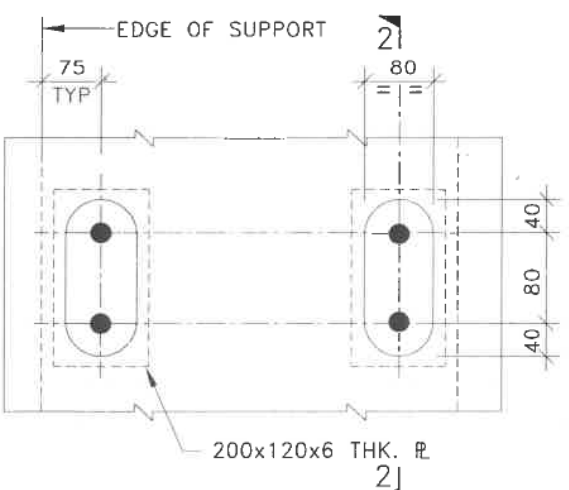


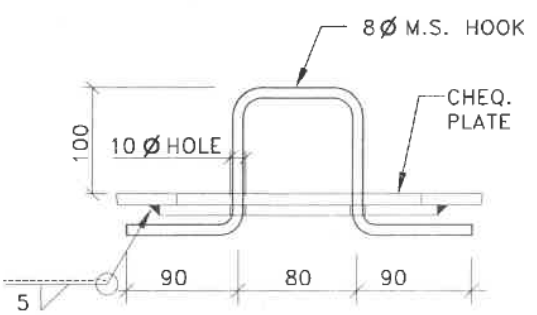
DETAIL OF M.S. PLATE MKD. (X)



SECTION:1–1

TYPE–II





SECTION:2–2

TYPE–III

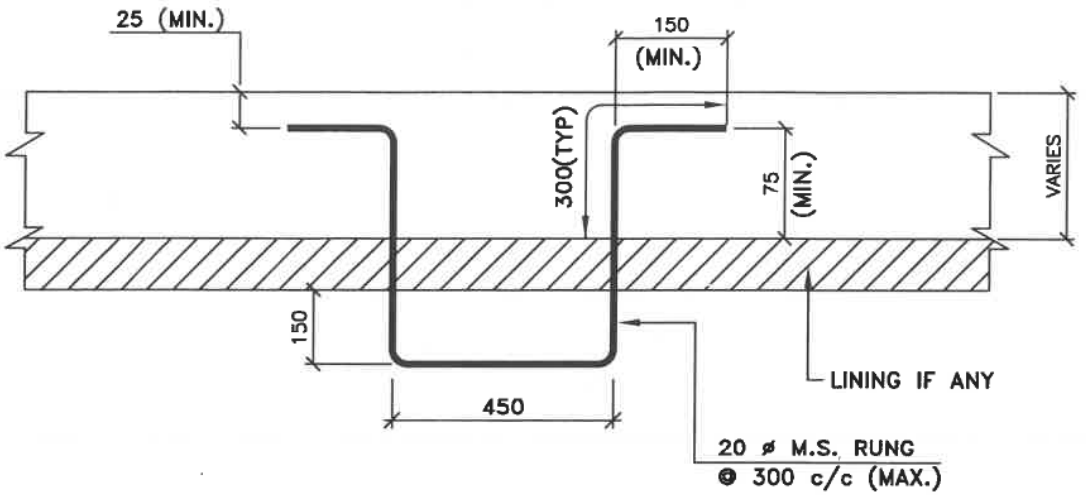
(FOR CHEQ. PLATE ONLY)

NOTES:

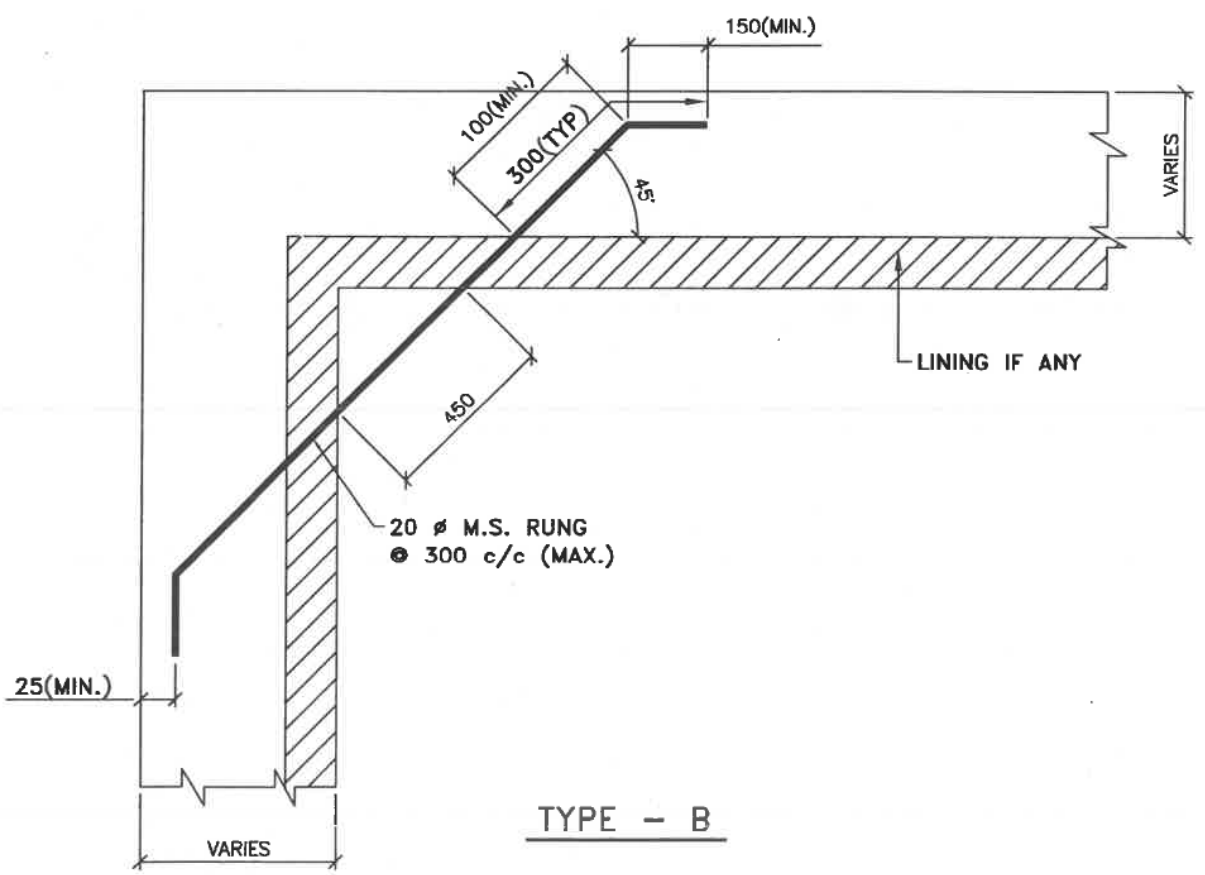
1. ALL DIMENSIONS ARE IN mm
2. FOR PRECAST SLABS GENERALLY LIFTING HOOK TYPE–I SHALL BE USED UNLESS TYPE–II IS SPECIFIED IN THE DRAWING.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
7	28.03.24	REVISED AND ISSUED AS STANDARD	SN	AD/MM	ANURAG SINHA	MAINAK NANDI
6	27.08.18	REAFFIRMED AND ISSUED AS STANDARD	KKS	A. SINHA	R. SRIVASTAVA	R. K. TRIVEDI

Approved by



TYPE – A



TYPE – B

NOTES :–

1. ALL DIMENSIONS ARE IN mm.
2. FIRST RUNG SHALL BE AT 300 mm FROM TOP.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
8	28.03.24	REAFFIRMED AND ISSUED AS STANDARD	SN	AD/MM	ANURAG SINHA	MAINAK NANDI
7	18.06.18	REAFFIRMED AND ISSUED AS STANDARD	ANNU	VIKRAM GUPTA	RAJANJI SRIVASTAVA	R K TRIVEDI

Approved by

GENERAL NOTES :-

1. ALL LUGS SHALL BE OF HIGH STRENGTH DEFORMED BARS OF GRADE Fe500/Fe500D CONFORMING TO IS 1786 (WITH GUARANTEED WELDABILITY) AND SHALL BE CONNECTED TO METAL INSERT PLATES BY 6 mm FILLET WELDS AS SHOWN IN SKETCHES.
2. METAL INSERT PLATES SHALL BE OF GRADE E250, CONFORMING TO IS 2062 (GR-A/BR/BO).
3. METAL INSERT PLATES MARKED ON DRAWING REFER AS UNDER

   IP-(A) @ (C)

   IP = INSERT PLATE

   A = TYPE OF INSERT PLATE

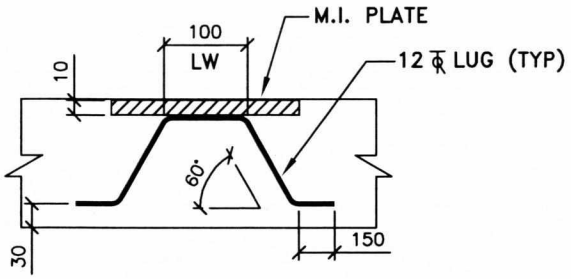
   C = ELEVATION OF INSERT PLATE (TOP EDGE)

   e.g IP-R9a @ EL.110.300 MEANS INSERT PLATE TYPE R9a AT EL.110.300.
4. METAL INSERT PLATES SHALL BE KEPT FLUSH WITH CONCRETE SURFACE.
5. THE LONGER SIDE OF METAL INSERT PLATE SHALL BE KEPT VERTICAL UNLESS SHOWN OTHERWISE.
6. METAL INSERT PLATE ON COLUMN OR BEAM SHALL BE KEPT SYMMETRICAL ABOUT ℄ OF COLUMN OR BEAM, UNLESS SHOWN OTHERWISE.

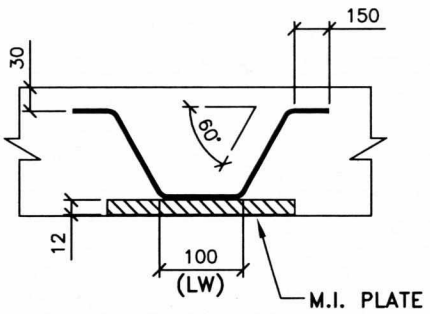
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
8	14.03.24	REVISED AND ISSUED AS STANDARD	EMMANUEL	SUDIP PAUL	ANURAG SINHA	MAINAK NANDI
7	06.06.18	REAFFIRMED AND ISSUED AS STANDARD	CS	AVM	R SRIVASTAVA	RK TRIVEDI

Approved by

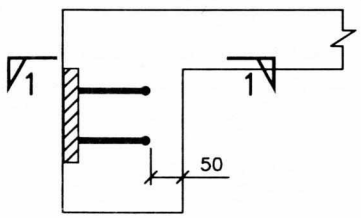
LUG BENDING DETAILS



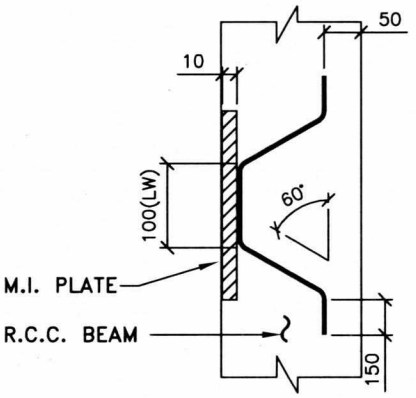
METAL INSERT DETAIL
ON TOP OF SLAB



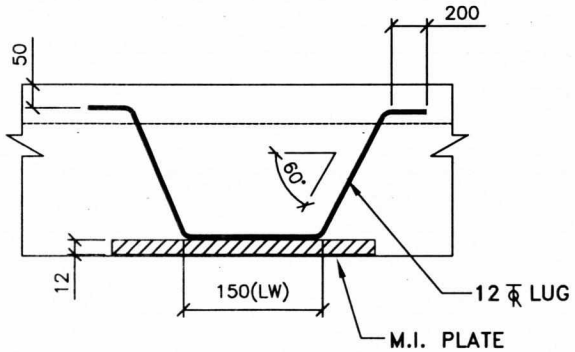
METAL INSERT DETAIL
ON BOTTOM OF SLAB



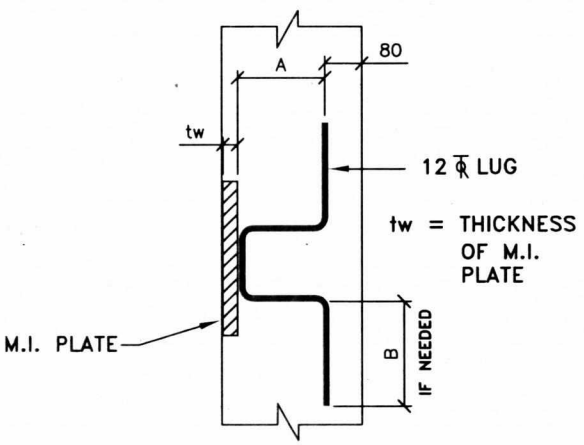
METAL INSERT DETAIL
ON SIDE OF BEAM



VIEW 1–1



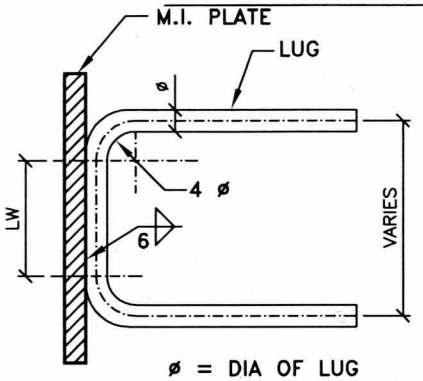
METAL INSERT DETAIL
ON BOTTOM OF BEAM
(FOR ALTERNATE DETAIL REF. SHT. 7 OF 7)



METAL INSERT DETAIL
ON COLUMNS

A+B = LUG EMBEDMENT REQUIRED AS PER SHT. 4,5,6 OF 7

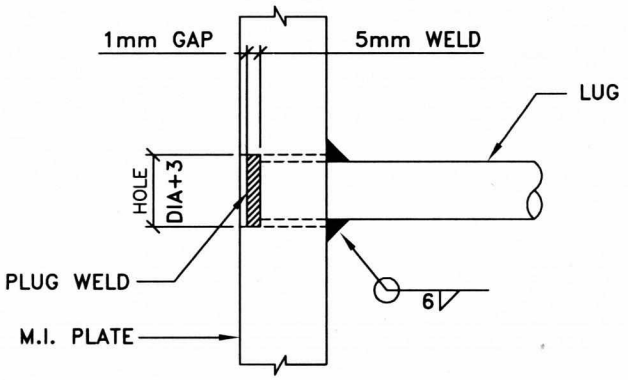
LUG BENDING DETAILS



ø = DIA OF LUG
LW = WELD LENGTH AVAILABLE

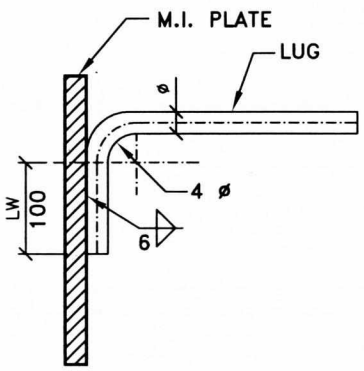
BENDING DIMENSIONS FOR 12ϕ & 16ϕ LUGS

(FOR SPACING OF LUGS ⩾ 190)
(NOT APPLICABLE FOR S1, S2, R1 & PS1)



WELD DETAIL OF 12ϕ & 16ϕ LUGS WITH M.I. PLATE

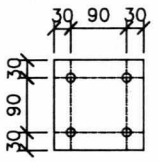
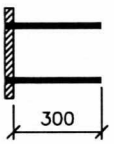
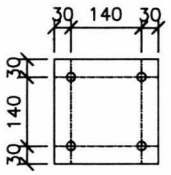
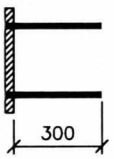
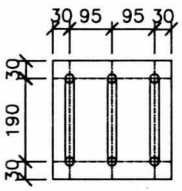
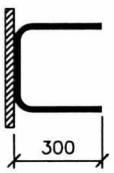
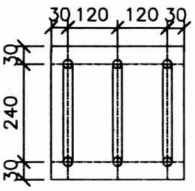
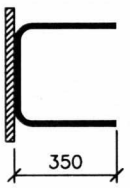
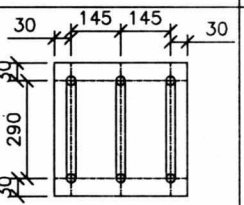
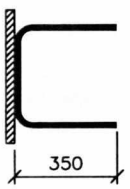
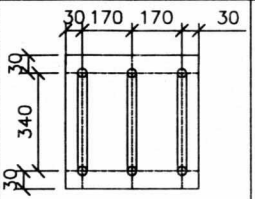
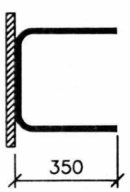
(FOR SPACING OF LUGS < 190)
(VALID FOR S1, S2 R1 & PS1)

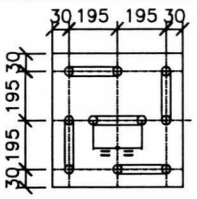
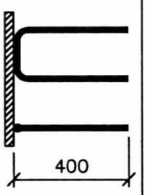
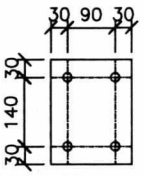
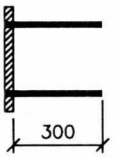
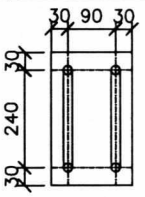
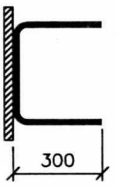
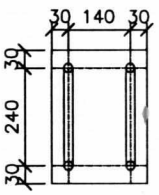
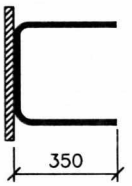
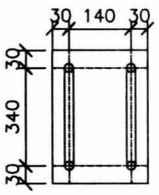
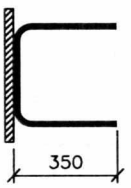
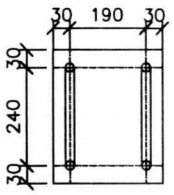
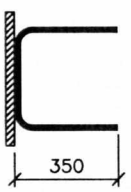


BENDING DIMENSIONS FOR 12ϕ & 16ϕ LUGS

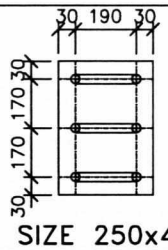
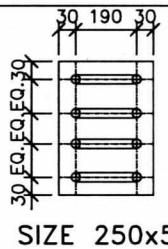
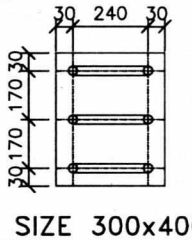
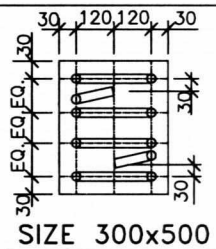
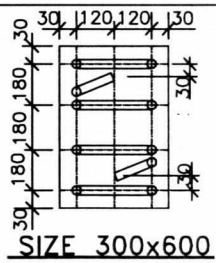
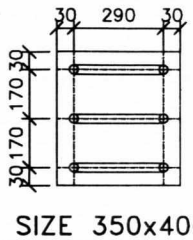
(VALID FOR R9, R10, R12, R13, R14, PS11, & PS12)

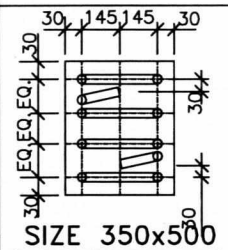
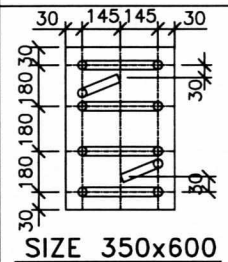
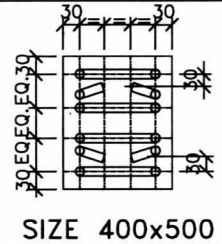
S/R DESIGNATES

S. NO.	TYPE OF INSERT	DIA OF LUGS	THK. OF INSERT	DETAILS OF INSERT PLATE	
				PLAN	CROSS SECTION
1.	S1a	12	12	 SIZE 150x150	
	S1b	16	16		
2.	S2a	12	12	 SIZE 200x200	
	S2b	16	16		
3.	S3a	12	12	 SIZE 250x250	
	S3b	16	16		
4.	S4a	12	12	 SIZE 300x300	
	S4b	16	16		
5.	S5a	12	12	 SIZE 350x350	
	S5b	16	16		
6.	S6a	12	12	 SIZE 400x400	
	S6b	16	16		

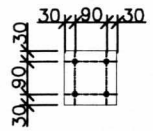
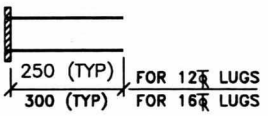
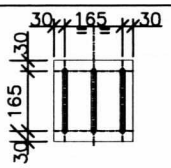
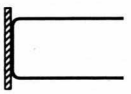
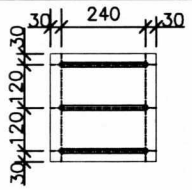
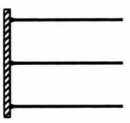
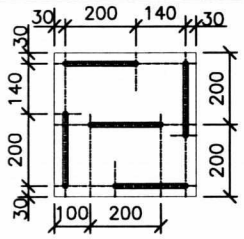
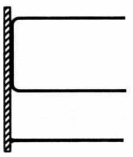
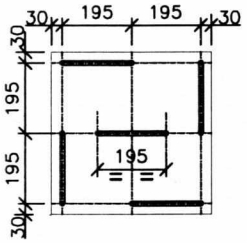
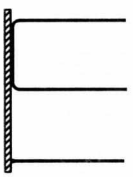
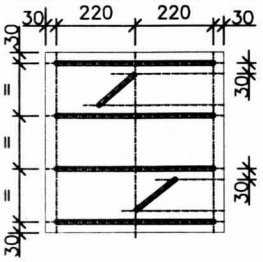
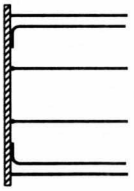
S. NO.	TYPE OF INSERT	DIA OF LUGS	THK. OF INSERT	DETAILS OF INSERT PLATE	
				PLAN	CROSS SECTION
7.	S7a	12	12	 SIZE 450x450	
	S7b	16	16		
8.	R1a	12	12	 SIZE 150x200	
	R1b	16	16		
9.	R2a	12	12	 SIZE 150x300	
	R2b	16	16		
10.	R3a	12	12	 SIZE 200x300	
	R3b	16	16		
11.	R4a	12	12	 SIZE 200x400	
	R4b	16	16		
12.	R5a	12	12	 SIZE 250x300	
	R5b	16	16		

R DESIGNATES

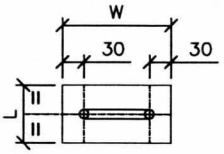
S. NO.	TYPE OF INSERT	DIA OF LUGS	THK. OF INSERT	DETAILS OF INSERT PLATE	
				PLAN	CROSS SECTION
13.	R6a	12	12	 SIZE 250x400	
	R6b	16	16		
14.	R7a	12	12	 SIZE 250x500	
	R7b	16	16		
15.	R8a	12	12	 SIZE 300x400	
	R8b	16	16		
16.	R9a	12	12	 SIZE 300x500	
	R9b	16	16		
17.	R10a	12	12	 SIZE 300x600	
	R10b	16	16		
18.	R11a	12	12	 SIZE 350x400	
	R11b	16	16		

S. NO.	TYPE OF INSERT	DIA OF LUGS	THK. OF INSERT	DETAILS OF INSERT PLATE	
				PLAN	CROSS SECTION
19.	R12a	12	12	 SIZE 350x500	
	R12b	16	16		
20.	R13a	12	12	 SIZE 350x600	
	R13b	16	16		
21.	R14a	12	12	 SIZE 400x500	
	R14b	16	16		

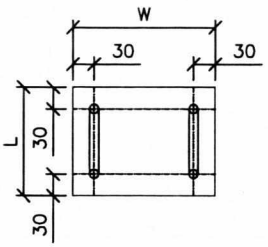
PS DESIGNATES

S.NO.	TYPE OF INSERT	DIA OF LUGS	THK. OF INSERT	DETAILS OF INSERT PLATE	
				PLAN	CROSS SECTION
1.	PS1	12	12	 SIZE 150x150	
	PS2	16	16		
2.	PS3	12	12	 SIZE 225x225	
	PS4	16	16		
3.	PS5	12	12	 SIZE 300x300	
	PS6	16	16		
4.	PS7	12	12	 SIZE 400x400	
	PS8	16	16		
5.	PS9	12	12	 SIZE 450x450	
	PS10	16	16		
6.	PS11	12	12	 SIZE 500x500	
	PS12	16	16		

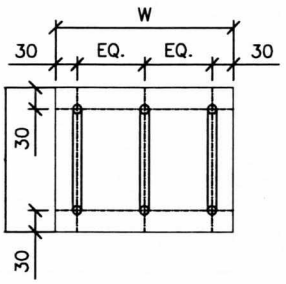
T DESIGNATES



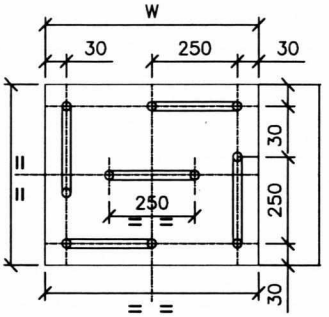
TYPE T1



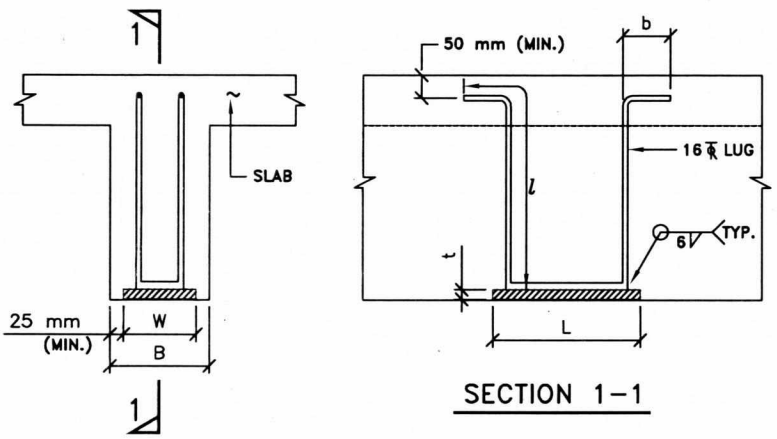
TYPE T2, T3 & T4



TYPE T5 & T6



TYPE T7



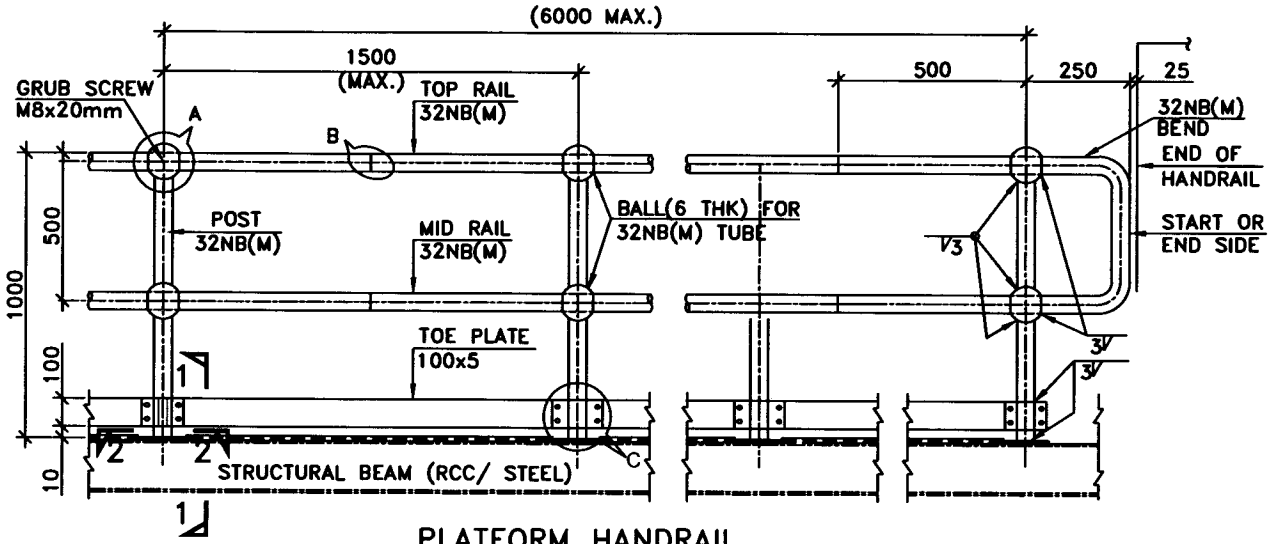
SECTION 1–1

TYPICAL FIXING DETAIL

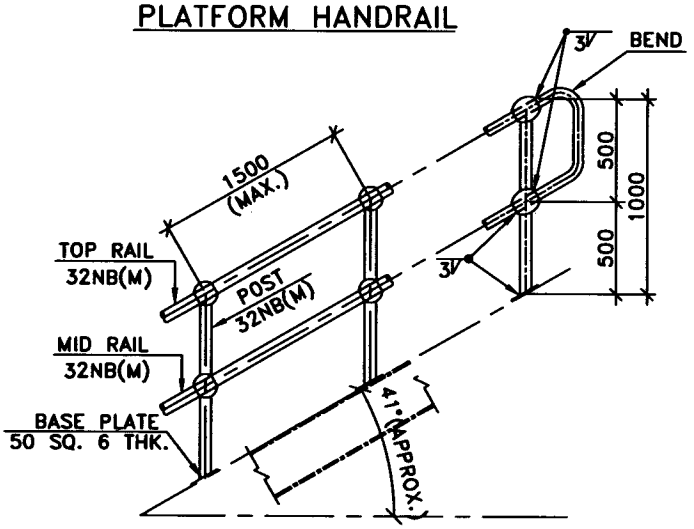
S.NO.	TYPE OF INSERT	WIDTH OF BEAM 'B' (mm)	MAXIMUM WIDTH OF PLATE 'W' (mm)	LENGTH OF PLATE 'L' (mm)	MAXIMUM 'b' (mm)	THICKNESS OF PLATE 't' (mm)	TOTAL ANCHORAGE LENGTH 'l' (mm)
1.	T1	230	180	180	110	16	350
2.	T2	300	220	250	110	20	350
3.	T3	350	270	250	110	20	350
4.	T4	400	320	250	110	20	350
5.	T5	450	370	300	110	32	350
6.	T6	500	420	300	110	32	350
7.	T7	500	420	400	110	32	350

NOTES :-

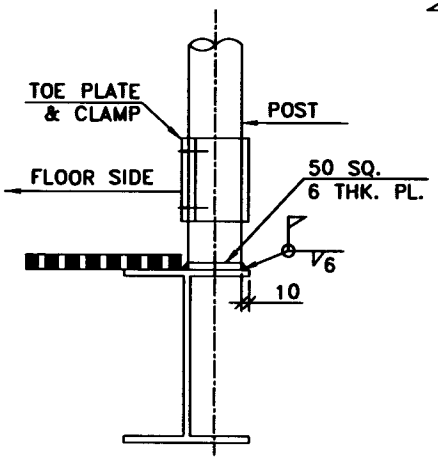
1. ALL DIMENSIONS ARE IN mm.
2. ALL M.S. TUBES SHALL CONFIRM TO IS : 1161/1239 & PLATE SHALL CONFIRM TO IS:2062.
3. PAINTING AND GALVANIZATION OF HANDRAIL SHALL BE AS PER JOB SPECIFICATION.



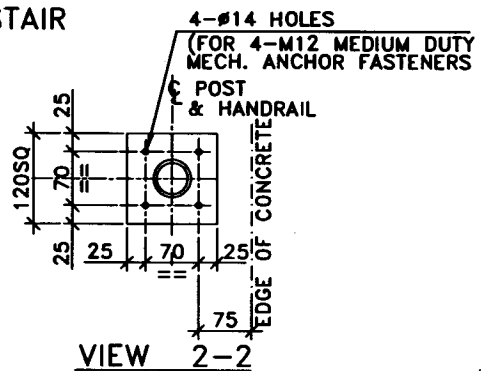
PLATFORM HANDRAIL



STAIR HANDRAIL
INCLINED RAILING
ON STEEL STAIR



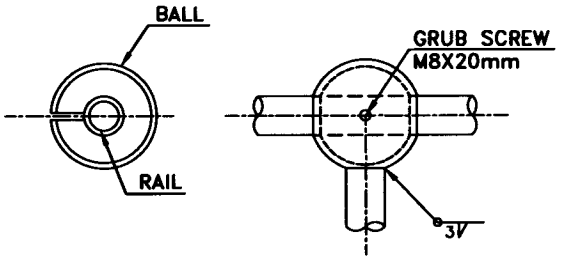
VIEW 1-1
HORIZONTAL RAILING
ON STEEL PLATFORM



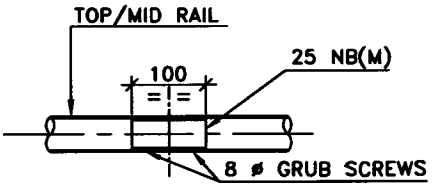
VIEW 2-2
BASE PLATE DETAIL
FOR VERTICAL POST
ON RCC BEAM/SLAB

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
1	23.02.2021	REAFFIRMED & REISSUED AS STANDARD	AK	SG/AS	RS	S.MAZUMDAR
0	15.10.2015	ISSUED AS STANDARD	KKS	SG/AS	RS	SC

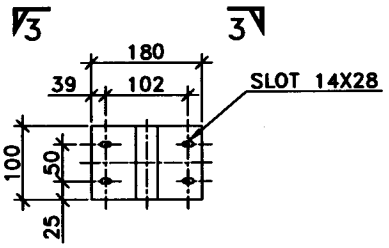
Approved by



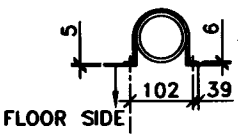
DETAIL– Ⓐ



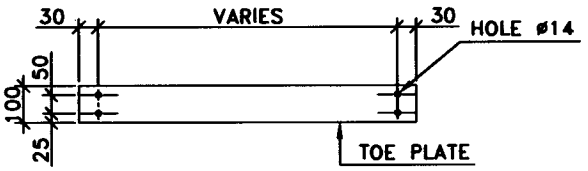
DETAIL – Ⓑ
DETAIL OF SPLICE



DETAIL – Ⓒ



VIEW 3–3
TOE PLATE CLAMP



TOE PLATE DETAIL

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
1	23.02.2021	REAFFIRMED & REISSUED AS STANDARD	AK	RBS	AS	S.MAZUMDAR
0	15.10.2015	ISSUED AS STANDARD	KKS	SG/AS	RS	SC

STANDARD LAP LENGTH FOR REBARS

TYPE OF REBARS	TYPE OF STRUCTURE	LAP LENGTH GRADE OF CONCRETE						TENSILE STRESS (σ_s) FOR Fe500 (N / mm^2)	DESIGN METHOD
		M20	M25	M30	M35	M40	M45		
HIGH STRENGTH DEFORMED BARS CONFORMING TO IS 1786 AS PER GENERAL NOTES OF THE PROJECT	GENERAL R.C.C STRUCTURES / LIQUID RETAINING STRUCTURES / CHIMNEY	57 D	49 D	46 D	40 D	36 D	36 D	435	LIMIT STATE
	STORAGE BINS	54 D	48 D	43 D	40 D	36 D	34 D	275	WORKING STRESS

REMARKS: 'D' DENOTES DIAMETER OF REBARS.

NOTES :-

1. LAP LENGTHS FOR REBARS, FULLY STRESSED TO TENSILE STESS AT DESIGN LOAD / WORKING LOAD, HAS BEEN DERIVED FROM THE BASIC FORMULA GIVEN BELOW (REFER CLAUSE 26.2.1, IS 456)

$$L_d = \frac{D\sigma_s}{4\tau_{bd}}$$

WHERE D = NOMINAL DIAMETER OF THE BARS ; L_d = LAP LENGTH

σ_s = TENSILE STRESS AT DESIGN LOAD / WORKING LOAD IN REBARS HAS BEEN ADOPTED AS 0.87fy FOR LIMIT STATE AND 0.55fy FOR WORKING STRESS

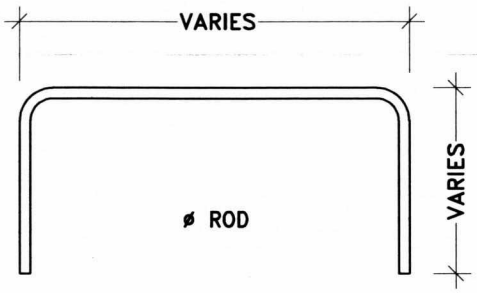
τ_{bd} = DESIGN BOND STRESS AS PER CLAUSE 26.2.1.1 OF IS 456 FOR LIMIT STATE AND TABLE 21 OF IS 456 FOR WORKING STRESS DESIGN.

2. IS CODE REFERENCES :

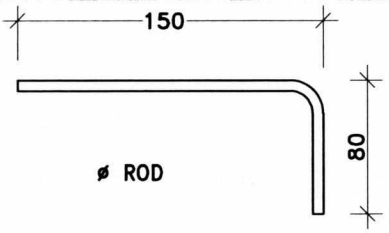
LIQUID RETAINING STRUCTURE	IS 3370
R.C.C CHIMNEYS	IS 4998
STORAGE BINS	IS 4995
GENERAL R.C.C STRUCTURES	IS 456

3. LAP LENGTH SHALL BE ROUNDED UP TO THE NEXT HIGHER WHOLE NUMBER.
4. THE LONGITUDINAL DISTANCE BETWEEN TWO ADJACENT LAPS SHOULD NOT BE LESS THAN 1.3 TIMES THE LAP LENGTH L_d.
5. LAP SPLICES SHALL NOT BE USED FOR BARS LARGER THAN 32mm.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Approved by Stds. Bureau Chairman
8	22.12.25	REVISED AND REISSUED AS STANDARD	AK	PM	AS	MN
7	28.09.20	REAFFIRMED AND ISSUED AS STANDARD	JG	AVM	AS	SM
6	21.07.14	REVISED AND ISSUED AS STANDARD	A.K. SHARMA	AMARJEET	P.K.MITTAL	S.CHANDA



TYPE–'A1'



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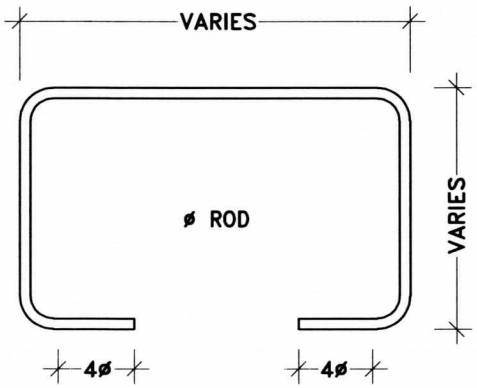

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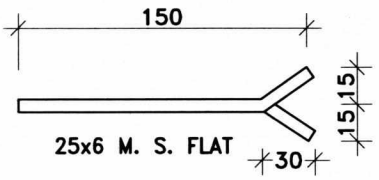

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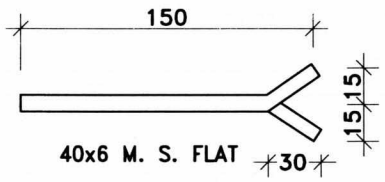

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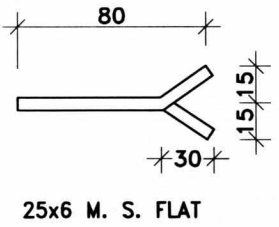

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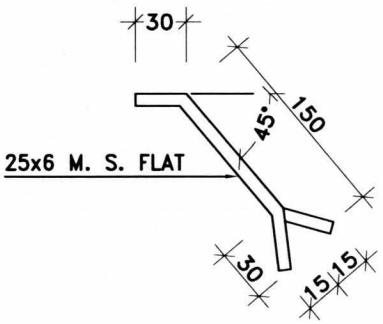
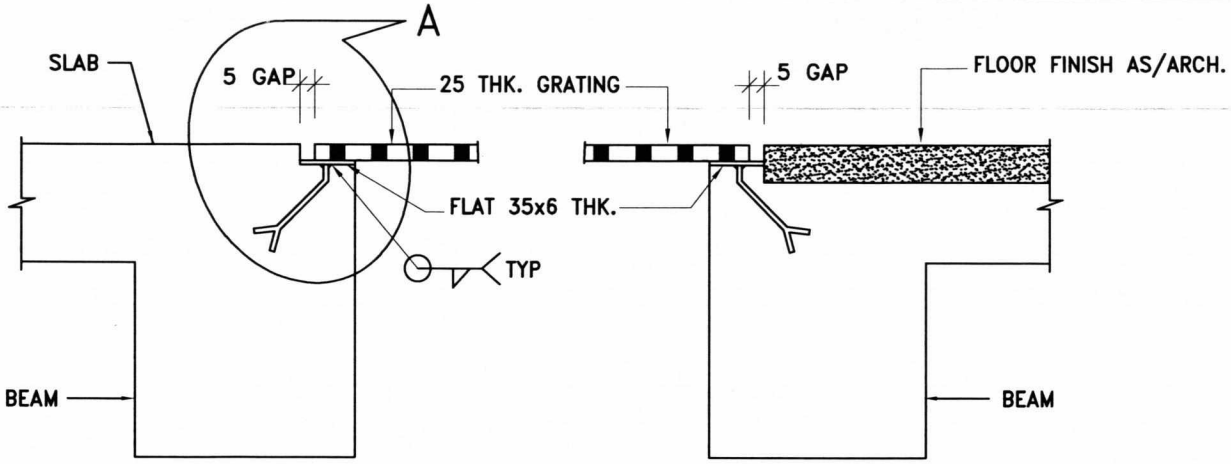


TYPE–'C4'

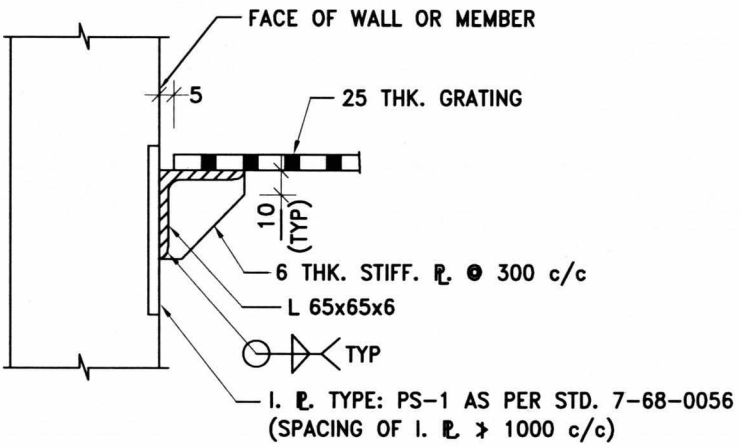
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
7	12.12.23	REAFFIRMED AND ISSUED AS STANDARD	SN	AD/MM	ANURAG SINHA	MAINAK NANDI
6	06.06.18	REAFFIRMED AND ISSUED AS STANDARD	CS	AVM	R.SRIVASTAVA	RK TRIVEDI

Approved by

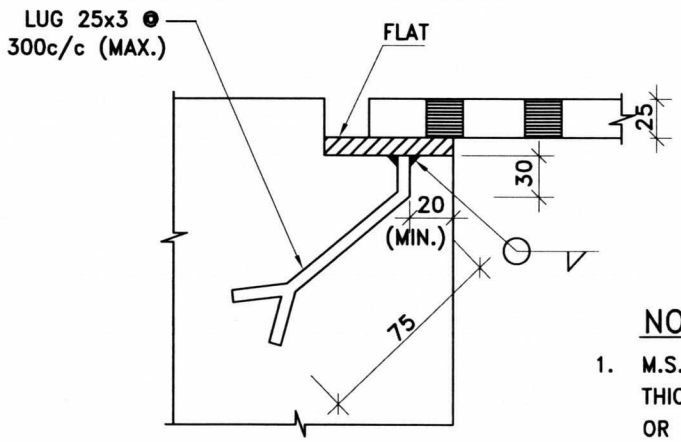


GRATING SUPPORT OVER BEAM WITHOUT FLOOR FINISH

GRATING SUPPORT OVER BEAM WITH FLOOR FINISH



GRATING SUPPORT ON WALL/COLUMN



DETAIL-'A'

NOTES:

1. M.S. LUGS SHALL BE SUITABLY BENT IF CONCRETE THICKNESS IS LESS THAN THE LENGTH OF LUGS OR LUGS INTERFERE WITH R/F BARS.
2. ALL DIMENSIONS ARE IN mm.

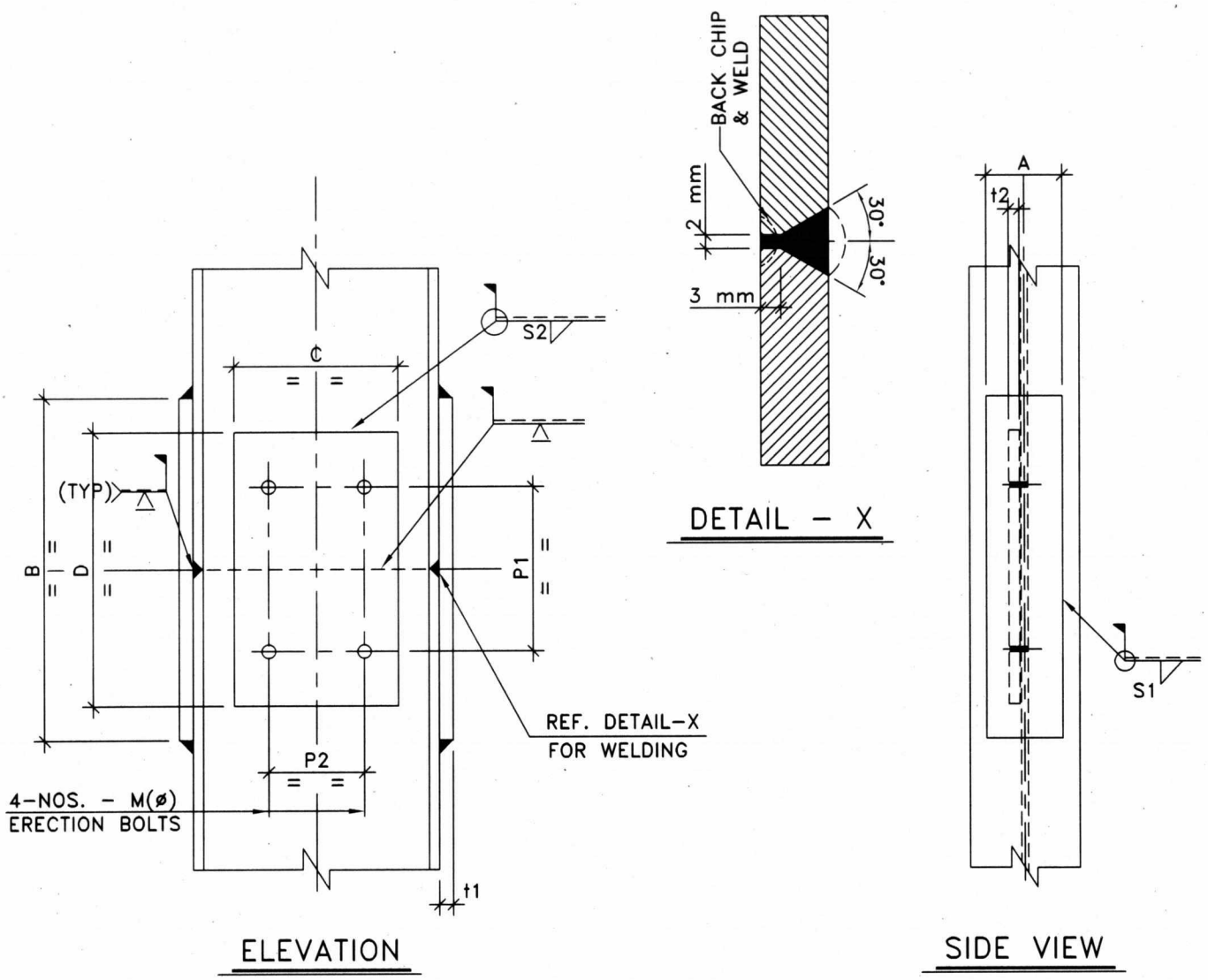
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
8	12.12.23	REVISED AND ISSUED AS STANDARD	SN	AD/MM	ANURAG SINHA	MAINAK NANDI
7	06.06.18	REAFFIRMED AND ISSUED AS STANDARD	CS	AVM	R.SRIVASTAVA	RK TRIVEDI

Approved by

NOTES :-

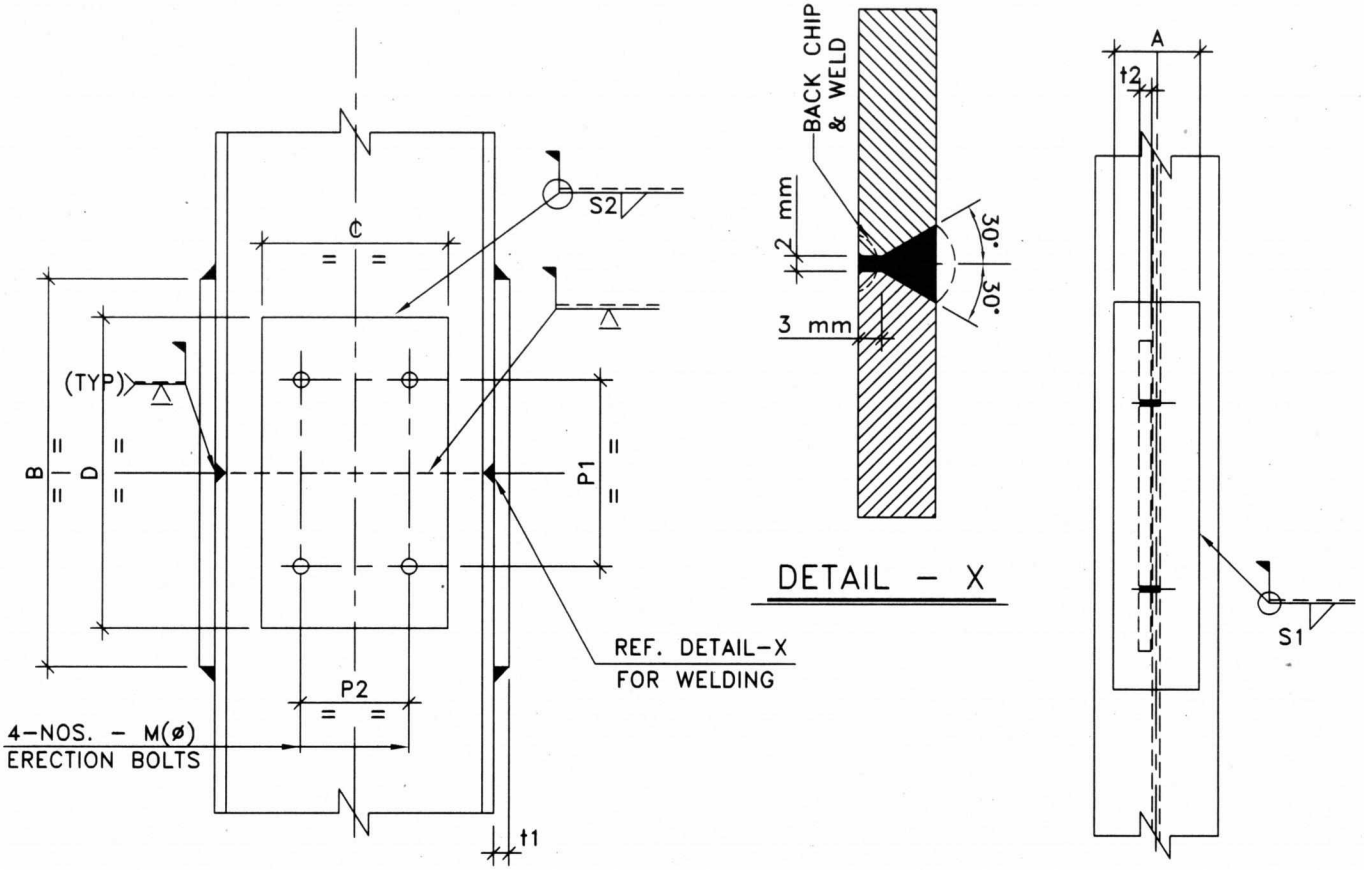
1. ALL DIMENSIONS ARE IN mm.
2. ALL BUTT WELD ARE FULL STRENGTH WELDS.
3. ALL EDGES SHALL BE PREPARED BEFORE BUTT WELDING.
4. SPLICE PLATES ARE DESIGNED FOR 40% OF FULL STRENGTH OF THE MEMBER.
5. SPLICE SHALL NOT BE LOCATED AT THE POINT OF MAXIMUM BENDING MOMENT AND/OR MAXIMUM SHEAR FORCE.
6. SPLICE PLATES MAY BE OMITTED FOR PURLINS & SIDE GIRTS FOR MEMBER SIZES UPTO 150MM DEPTH.
7. SPLICE DETAILS FOR APPROPRIATE GRADE OF STEEL LIKE E250, E350, Yst240, Yst310, Yst355, ETC. AS PER PROJECT GENERAL NOTES SHALL BE FOLLOWED.
8. NUMBER OF SPLICES PER MEMBER SHALL BE AS PER CLAUSE 5.2.8 OF SPECIFICATION NO. 6-68-0006.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
7	11-09-23	REVISED AND ISSUED AS STANDARD	JITENDER	AKSHAY/AMARJEET	ANURAG SINHA	SANJAY MAZUMDAR
6	27-03-19	REAFFIRMED AND ISSUED AS STANDARD	JG	AJS	RAJANJI SRIVASTAVA	R.K. TRIVEDI



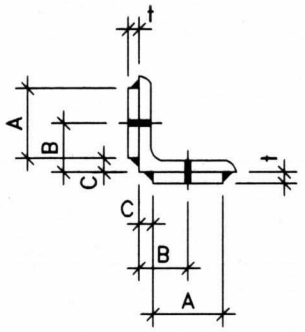
BEAMS

SIZE OF JOIST	FLANGE SPLICE PLATE					WEB SPLICE PLATE					ERECTION BOLTS		
	A	B (E250)	B (E350)	t1	WELD SIZE S1	C	D (E250)	D (E350)	t2	WELD SIZE S2	M(ø)	P1	P2
MB125	55	100	100	6	6	90	100	100	6	6	12	50	40
MB150	60	120	120	6	6	110	120	120	6	6	16	60	50
MB175	70	120	120	6	6	120	120	120	6	6	16	60	60
MB200	80	150	150	6	6	120	120	120	6	6	16	60	60
MB225	90	170	190	6	6	120	120	120	6	6	16	60	60
MB250	100	260	260	8	6	120	120	120	6	6	16	60	60
MB300	120	300	300	8	6	150	120	140	6	6	16	60	80
MB350	120	300	340	8	6	150	160	200	8	6	16	60	80
MB400	120	300	340	10	8	180	210	250	8	6	16	60	100
MB450	130	300	340	10	8	215	240	300	8	6	16	60	135
MB500	160	400	400	10	8	260	300	350	8	6	16	60	150
MB600	180	400	450	12	10	300	300	350	10	8	16	60	160

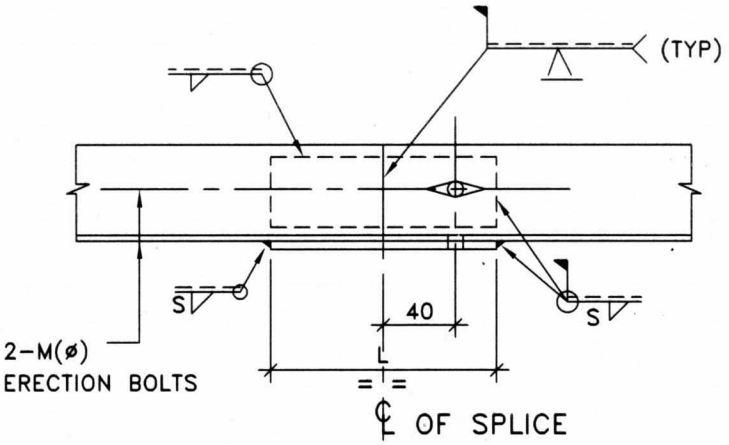


PARALLEL FLANGE BEAMS

MEMBER SIZE	FLANGE SPLICE PLATE					WEB SPLICE PLATE					ERECTION BOLTS		
	A	B (E250)	B (E350)	t1	WELD SIZE S1	C	D (E250)	D (E350)	t2	WELD SIZE S2	M(ø)	P1	P2
NPB 300x150x49.32	120	300	340	8	6	150	120	150	8	6	16	60	80
NPB 400x180x66.3	140	300	340	10	8	180	200	250	8	6	16	60	100
NPB 500x200x90.7	160	400	450	10	8	250	300	380	8	6	16	60	150
NPB 600x220x122.4	180	400	450	12	10	300	300	380	10	8	16	60	160
WPB 600x300x128.79	250	400	450	12	10	300	300	380	10	8	16	80	170
WPB 600x300x177.8	250	500	600	14	12	300	340	400	10	8	16	80	180
WPB 700x300x149.89	250	500	600	14	12	350	380	440	10	8	16	80	190
WPB 700x300x204.5	250	600	680	16	12	350	380	440	12	10	16	80	190
WPB 700x300x240.5	250	600	680	18	14	350	380	440	14	12	16	80	190
WPB 800x300x224.37	250	600	680	18	14	400	380	450	14	12	16	100	200
WPB 800x300x262.33	250	600	680	20	16	400	380	450	14	12	16	100	200
WPB 900x300x291.45	250	600	700	20	16	450	450	550	16	12	16	100	200



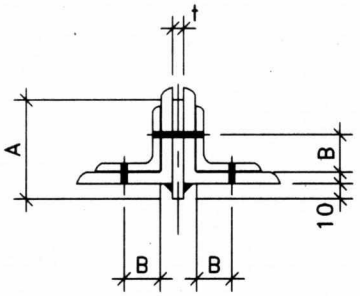
END VIEW



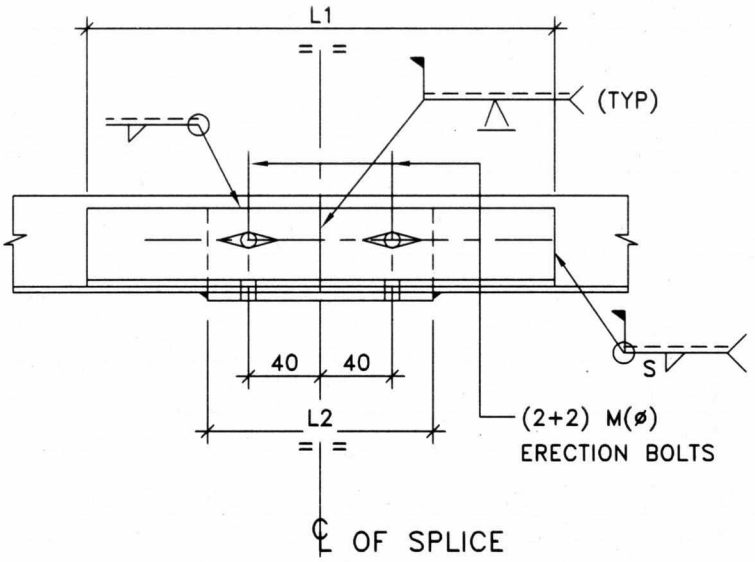
ELEVATION

EQUAL ANGLE (SINGLE)

SIZE OF ANGLE	SPLICE PLATE			B	C	BOLT DIA M(ø)	SIZE OF WELD (S)
	A	t	L				
L 50x50x6	30	6	130	28	10	12	5
L 65x65x6	45	6	130	35	10	12	5
L 65x65x8	45	6	130	35	10	12	6
L 75x75x6	55	6	130	40	10	16	6
L 75x75x8	55	6	130	40	10	16	6
L 90x90x6	60	6	130	50	15	16	6
L 90x90x8	60	8	130	50	15	16	8
L 100x100x8	60	8	150	60	20	16	8
L 130x130x10	70	8	200	80	30	16	8
L 150x150x10	80	8	200	90	35	16	8



END VIEW

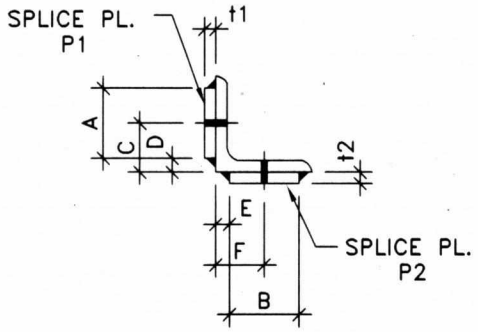


ELEVATION

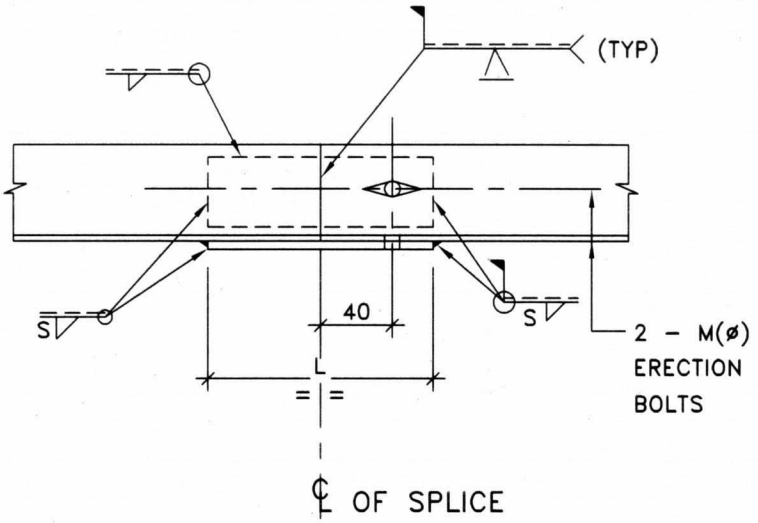
EQUAL ANGLES (DOUBLE)

SIZE OF ANGLE	SPLICE ANGLE	L1	SPLICE PLATE			B	ERECTION BOLT DIA M(ø)	SIZE OF WELD (S)
			A	t	L2			
JL 50x50x6	JL 35x35x6	150	50	t	130	19	12	5
JL 65x65x6	JL 35x35x6	150	65	t	130	19	12	5
JL 65x65x8	JL 50x50x6	200	65	t	130	28	12	6
JL 75x75x6	JL 50x50x6	200	75	t	130	28	12	6
JL 75x75x8	JL 50x50x6	230	75	t	130	28	12	6
JL 90x90x6	JL 50x50x6	240	90	t	130	28	12	6
JL 90x90x8	JL 65x65x6	270	90	t	130	35	12	6
JL 100x100x8	JL 65x65x6	300	100	t	130	35	12	6
JL 130x130x10	JL 75x75x8	400	130	t	130	40	16	6
JL 150x150x10	JL 90x90x8	480	150	t	130	50	16	6

t – THICKNESS OF PLATE AS PER DESIGN DRG./CONNECTION DESIGN.



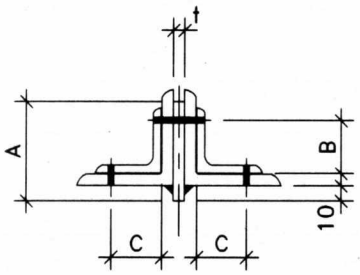
END VIEW



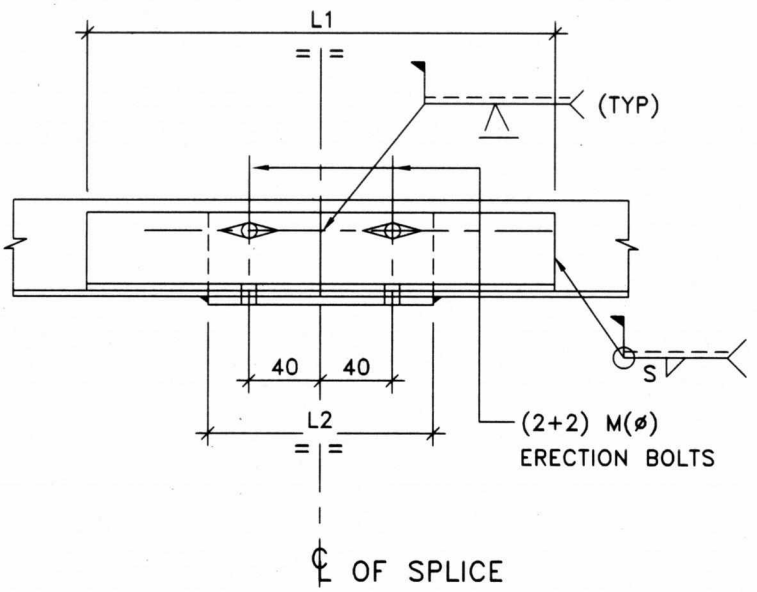
ELEVATION

UNEQUAL ANGLE (SINGLE)

SIZE OF ANGLE	SPLICE PLATE P1		SPLICE PLATE P2		L	C	D	E	F	EREC-TION BOLT DIA M(ø)	SIZE OF WELD (S)
	A	t1	B	t2							
L 75x50x6	35	6	30	6	130	40	20	10	28	12	6
L 100x75x6	40	6	45	6	130	60	40	15	40	12	6
L 100x75x8	60	6	50	6	130	60	30	15	40	12	6
L 125x75x8	75	6	50	6	150	75	40	15	40	12	6
L 125x75x10	75	6	50	6	200	75	40	15	40	12	6
L 150x75x10	100	6	50	6	250	90	40	15	40	12	6
L 150x115x10	100	6	75	6	250	90	40	30	70	16	6



END VIEW



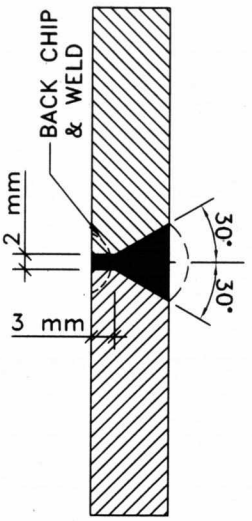
ELEVATION

UNEQUAL ANGLES (DOUBLE)

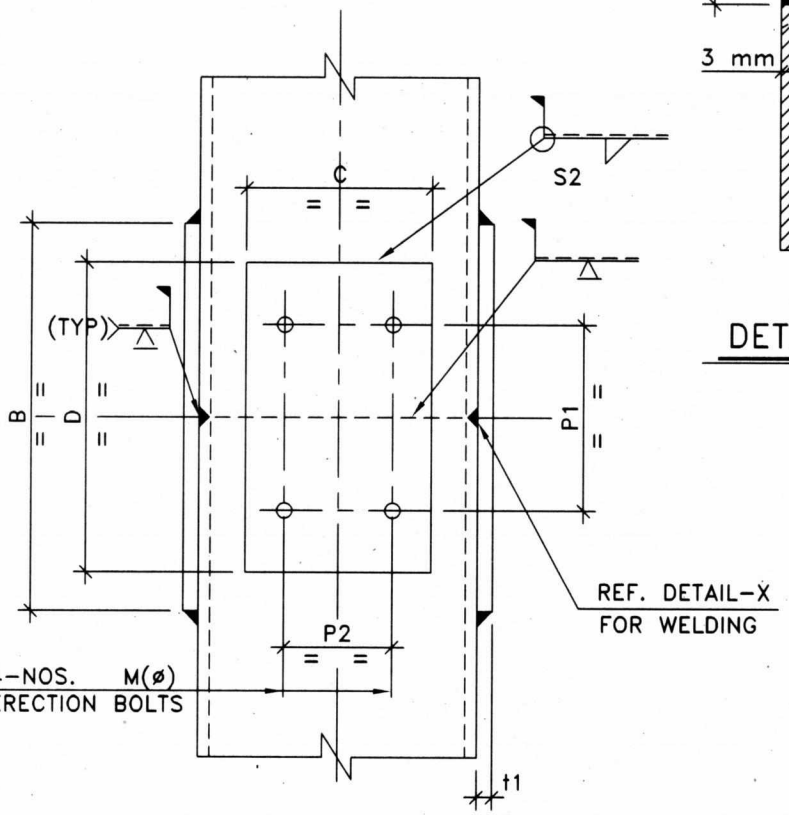
SIZE OF ANGLE	SPLICE ANGLE	L1	SPLICE PLATE			B	C	ERECTION BOLT DIA M(ø)	SIZE OF WELD (S)
			A	t	L2				
JL 75x50x6	JL 35x35x6	150	75	t	130	19	19	12	6
JL 100x75x6	JL 50x50x6	200	100	t	130	28	28	12	6
JL 100x75x8	JL 50x50x6	270	100	t	130	28	28	12	6
JL 125x75x8	JL 75x50x6	300	125	t	130	40	28	12	6
JL 125x75x10	JL 75x50x8	320	125	t	130	40	28	12	6
JL 150x75x10	JL 75x50x8	350	150	t	130	40	28	12	6
JL 150x115x10	JL 100x75x8	420	150	t	130	60	40	12	6

t – THICKNESS OF PLATE AS PER DESIGN DRG./CONNECTION DESIGN.

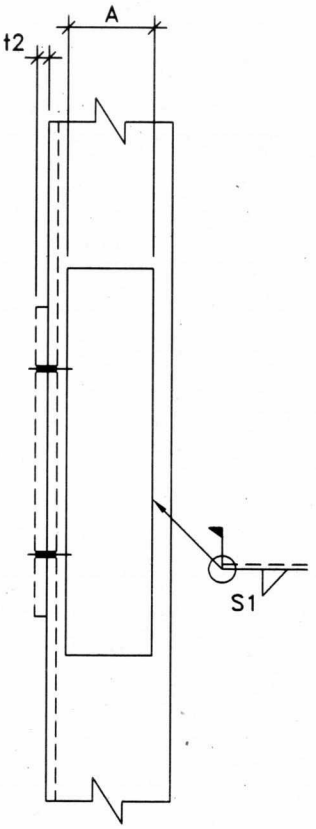
SECTION



DETAIL – X



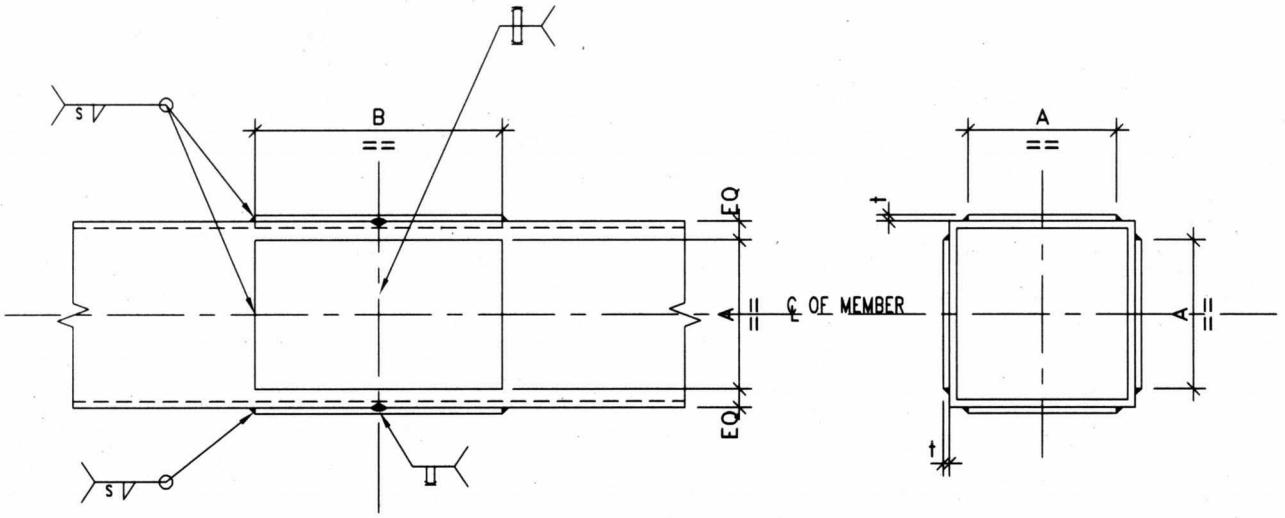
ELEVATION



END VIEW

CHANNELS

SIZE OF CHANNEL	FLANGE SPLICE PLATE					WEB SPLICE PLATE					ERECTION BOLTS			REMARKS
	A	B (E250)	B (E350)	t1	WELD SIZE S1	C	D (E250)	D (E350)	t2	WELD SIZE S2	M(ø)	P1	P2	
MC100	35	120	120	8	6	40	90	90	6	6	12	50	–	TWO BOLTS
MC125	45	120	120	8	6	50	90	90	6	6	12	50	–	TWO BOLTS
MC150	55	150	150	8	6	60	120	120	6	6	16	60	–	TWO BOLTS
MC175	55	150	150	10	8	120	120	120	6	6	16	60	60	
MC200	55	150	150	12	10	120	120	120	6	6	16	60	60	
MC225	60	160	160	12	10	120	120	120	6	6	16	60	60	
MC250	60	160	160	12	10	120	120	120	6	6	16	60	60	
MC300	70	160	160	12	10	150	120	140	6	6	16	60	60	
MC350	80	190	190	12	10	200	120	150	6	6	16	60	60	
MC400	80	190	190	12	10	240	140	180	6	6	16	60	60	

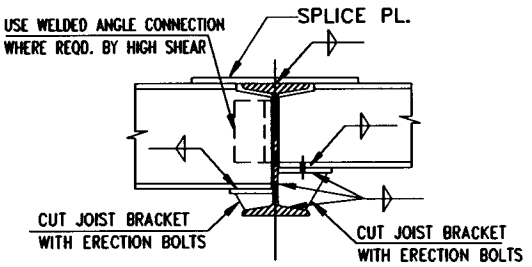


ELEVATION

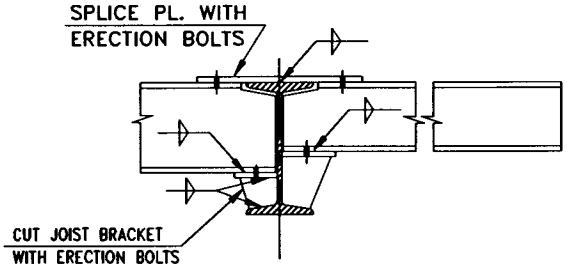
END VIEW

SQUARE HOLLOW SECTIONS

MEMBER SIZE	SPLICE PLATE					SIZE OF WELD (S)
	A	B (Yst240)	B (Yst310)	B (Yst355)	t	
SHS 75x4.9	40	100	100	100	6	6
SHS 100x6	60	100	100	100	6	6
SHS 132x5.4	90	120	120	120	6	6
SHS 150x6	110	120	120	120	6	6
SHS 180x8	130	180	200	220	6	6
SHS 200x10	150	250	310	320	8	6
SHS 220X10	170	300	350	350	8	6
SHS 250x10	200	300	350	350	10	8
SHS 300X10	240	300	350	350	10	8
SHS 300X12.5	240	350	420	440	10	8

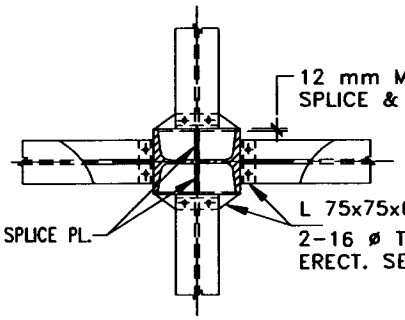


DETAIL–1

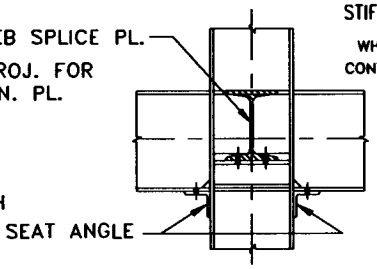


DETAIL–2

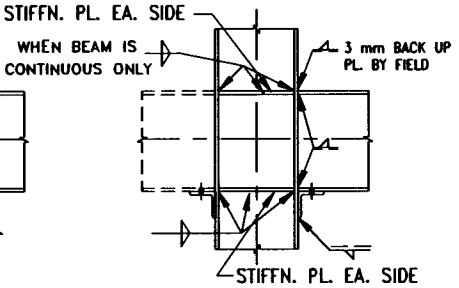
TYPICAL BEAM TO GIRDER CONNECTION



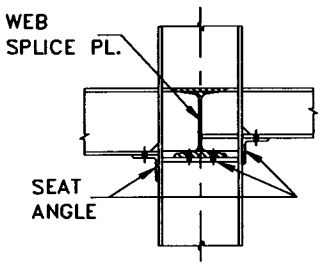
PLAN



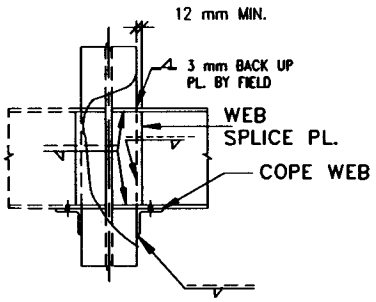
ELEVATION – A
(FOR DET. NOT SHOWN SEE ELEVATION B)



ELEVATION – B
(BEAM FRAMING AT 90° NOT SHOWN)



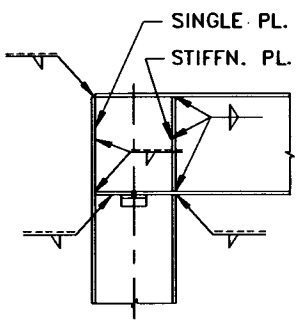
ELEVATION – C
(DET. NOT SHOWN SEE ELEVATION B)



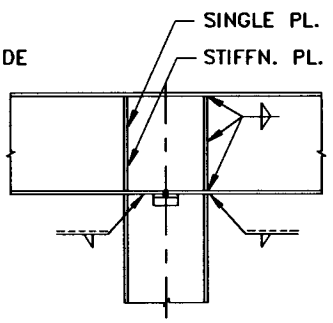
ELEVATION – D

NOTES :–
(ALSO APPLICABLE TO STD. NOS. 7–68–0209 & 7–68–0212)

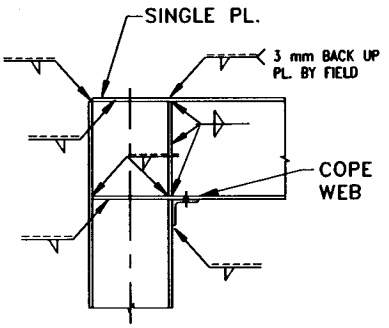
1. DETAILS SHOWN ARE TYPICAL ONLY AND SHALL BE USED WHEREVER DESIGN CONSIDERATIONS PERMIT IN WELDED CONTINUOUS FRAME STRUCTURE.
2. ALL MATERIAL & FABRICATION SHALL CONFORM TO IS CODE FOR FUSION WELDING IN BUILDING CONSTRUCTION.
3. OMIT ERECTION ANGLES & CLIPS WHEN WELDS ARE MADE IN SHOP.
4. ALL REINFORCING FILLET WELDS USED IN CONJUNCTION WITH V–WELDS SHALL BE 5 mm.
5. MILLED ENDS MAY BE ELIMINATED ON SMALL, LIGHTLY LOADED COLUMNS.
6. AT INTERSECTIONS, THICKNESS OF CONNECTION PLATES AND/ OR STIFFENER PLATES TO BE GOVERNED BY MAX. BEAM FLANGE THICKNESS.



DETAIL–4



DETAIL–5



DETAIL–6

TYPICAL BEAM TO COLUMN RIGID CONNECTION

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
6	28–09–20	REAFFIRMED AND ISSUED AS STANDARD	JG	AVM	AS	SM
5	07–08–14	REAFFIRMED AND ISSUED AS STANDARD	SUSHMA	V.GOEL	P.K.MITTAL	S.CHANDA

TABLE–1 (FOR CABLE DUCT)

W \ L	4500	5000	6000	7000	8000
1200	MC200	MC200	MC250	MC250*	MC300*
1000	MC150	MC200	MC200*	MC250*	MC250*
800	MC150	MC150	MC200	MC200*	MC250*
600	MC150	MC150	MC150	MC150*	MC250*
400	MC150	MC150	MC150	MC150*	MC250*

TABLE–2 (FOR CABLE/ LADDER TRAY)

W \ L	4500	5000	6000	7000	8000
1000	MC125	MC125	MC125*	MC150*	MC150*
600	MC125	MC125	MC125*	MC125*	MC150*
400	MC125	MC125	MC125*	MC125*	MC125*

* REFER NOTE–5

LEGEND:–

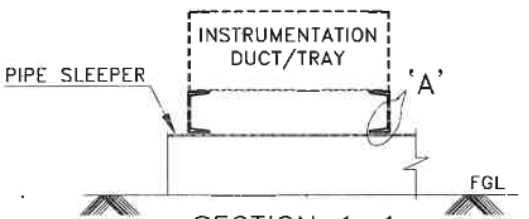
L : c/c SPACING OF PIPE RACK PORTALS/PIPE SLEEPERS.

W : WIDTH OF INSTRUMENTATION CABLE DUCT AS/RELEVANT PIPING/INSTRUMENTATION DRG.

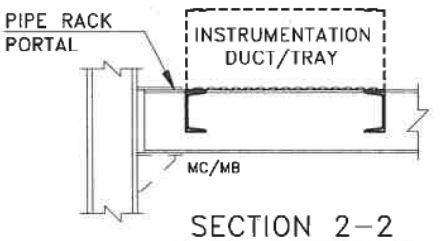
NOTES :–

1. ALL DIMENSIONS ARE IN mm.
2. THE MATERIAL OF CONSTRUCTION SHALL BE STRUCTURAL STEEL CONFORMING TO IS:2062 GRADE 350 BR/BO.
3. THE CONSTRUCTION SHALL CONFORM TO THE REQUIREMENTS AS PER SPECIFICATION NO. 6–68–0006.
4. A GAP OF MIN. 200MM SHALL BE MAINTAINED BETWEEN EDGE OF CABLE DUCT AND THAT OF WALKWAY.
5. COMPRESSION FLANGE OF CABLE/ DUCT TRAY SUPPORTING MEMBER SHALL BE RESTRAINED BY USING ANGLE 50X50X6 AT A SPACING OF 3M FOR DUCTS AND 1.5M FOR CABLE/ LADDER TRAY.
6. SPLICE PLATE SHALL BE PROVIDED ON BOTTOM FACE OF TOP FLANGE OF CHANNEL.

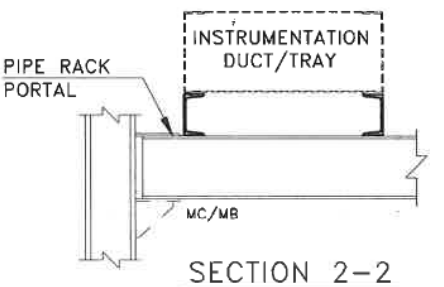
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
4	06.06.24	REVISED & REISSUED AS STANDARD	ANNU AHUJA	VIKRAM GUPTA	ANURAG SINHA	MAINAK NANDI
3	28.03.19	REVISED & REISSUED AS STANDARD	JC	AJS	RAJANJI SRIVASTAVA	R.K. TRIVEDI



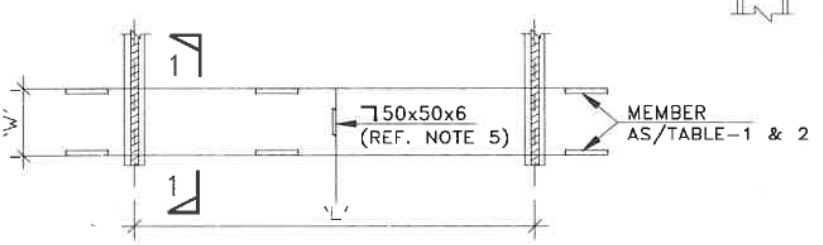
SECTION 1–1



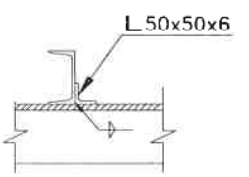
SECTION 2–2
(OPTION–1)



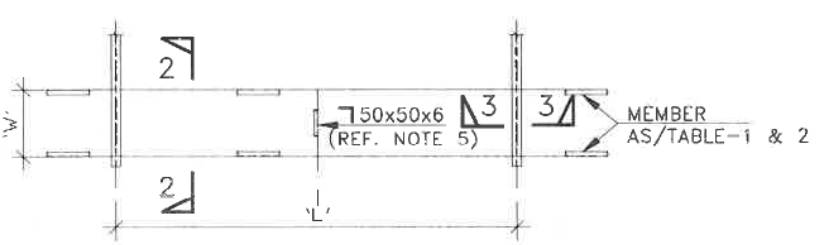
SECTION 2–2
(OPTION–2)



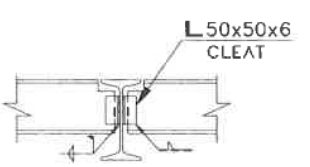
TYPICAL ARRANGEMENT SHOWING INSTRUMENTATION CABLE DUCT/TRAY SUPPORTS ON PIPE SLEEPERS



DETAIL 'A'



TYPICAL ARRANGEMENT SHOWING INSTRUMENTATION CABLE DUCT/TRAY SUPPORTS ON PIPE RACKS

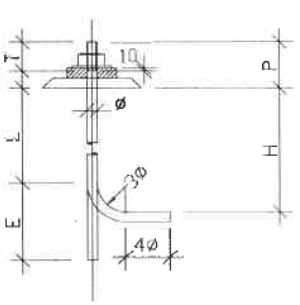


SECTION 3–3
(OPTION–1)

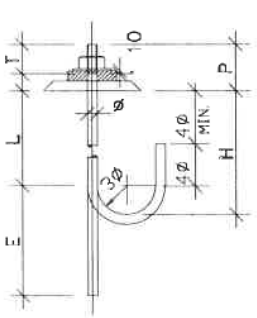
GRADE OF CONC.	BOLT TYPE	DIMENSIONS MM		BOLT DIA (ø) IN MM											
				10	12	16	18	20	22	24	27	30	33	36	39
M20	I & III	L		250	300	450	450	550	600	650	750	850	950	1000	1100
		E		95	115	155	170	190	210	230	255	285	315	345	370
		H	TYPE-I	280	336	498	504	610	666	722	831	940	1049	1108	1217
			TYPE-III	430	486	648	654	910	966	1022	1281	1390	1499	1558	1667
	II & IV	L		200	200	300	350	400	450	450	550	600	700	700	800
		E		150	180	240	270	300	330	380	405	450	495	540	585
		H	TYPE-II	230	236	348	404	460	516	522	631	690	799	808	917
			TYPE-IV	380	386	498	554	760	816	822	1081	1140	1249	1258	1367
M25	I & III	L		200	250	400	400	450	550	550	650	700	800	850	950
		E		95	115	155	170	190	210	230	255	285	315	345	370
		H	TYPE-I	230	286	448	454	510	616	622	731	790	899	958	1067
			TYPE-III	380	436	598	604	810	916	922	1181	1240	1349	1408	1517
	II & IV	L		150	150	250	250	300	350	350	450	500	550	600	650
		E		150	180	240	270	300	330	360	405	450	495	540	585
		H	TYPE II	180	186	298	304	360	416	422	531	590	649	708	767
			TYPE-IV	330	336	440	454	660	716	722	981	1040	1099	1158	1217
M30	I & III	L		180	220	315	335	390	445	470	550	600	680	735	815
		E		95	115	155	170	190	210	230	255	285	315	345	370
		H	TYPE-I	210	260	365	390	450	515	545	635	690	780	845	935
			TYPE-III	360	410	515	540	750	815	845	1085	1140	1230	1295	1385
	II & IV	L		150	150	200	200	250	275	300	350	375	425	450	500
		E		150	180	240	270	300	330	360	405	450	495	540	585
		H	TYPE-II	180	190	250	255	310	345	375	435	465	525	560	620
			TYPE-IV	330	340	400	405	610	645	675	885	915	975	1010	1070

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
9	06.06.24	REVISED AND ISSUED AS STANDARD	ANNU AHUJA	VIKRAM GUPTA	ANURAG SINHA	MAINAK NANDI
8	27.03.19	REVISED AND ISSUED AS STANDARD	JITENDER GUPTA	AMARJEET	RAJANJI SRIVASTAVA	R.K.TRIVEDI
7	26.11.13	REVISED AND ISSUED AS STANDARD	A.K. SHARMA	AMARJEET	P.K.MITTAL	S.CHANDA

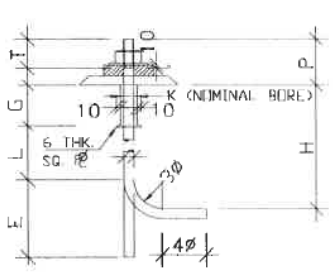
GRADE OF CONC.	BOLT TYPE	DIMENSIONS MM		BOLT DIA (ø) IN MM											
				10	12	16	18	20	22	24	27	30	33	36	39
M35	I & III	L		160	190	275	295	340	390	410	480	525	595	640	710
		E		95	115	155	170	190	210	230	255	285	315	345	370
		H	TYPE-I	190	230	325	350	400	460	485	565	615	695	750	830
			TYPE-III	340	380	475	500	700	760	785	1015	1065	1145	1200	1280
	II & IV	L		150	150	150	150	180	225	225	275	300	350	350	400
		E		150	180	240	270	300	330	360	405	450	495	540	585
		H	TYPE-II	180	190	200	205	240	290	300	360	390	450	460	520
			TYPE-IV	330	340	350	355	540	590	600	810	840	900	910	970
M40	I & III	L		150	170	240	255	300	340	360	425	460	525	565	625
		E		95	115	155	170	190	210	230	255	285	315	345	370
		H	TYPE-I	180	210	290	310	360	410	435	510	550	625	675	745
			TYPE-III	330	360	440	460	660	710	735	960	1000	1075	1125	1195
	II & IV	L		150	150	150	150	175	200	200	225	250	275	300	325
		E		150	180	240	270	300	330	360	405	450	495	540	585
		H	TYPE-II	180	190	200	205	235	270	275	310	340	375	410	445
			TYPE-IV	330	340	350	355	535	570	575	760	790	825	860	895



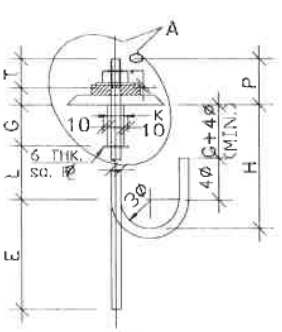
TYPE – I



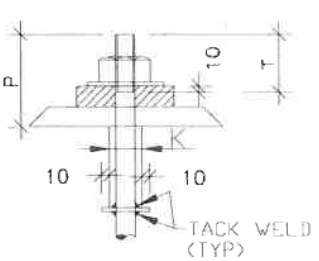
TYPE – II



TYPE – III



TYPE – IV



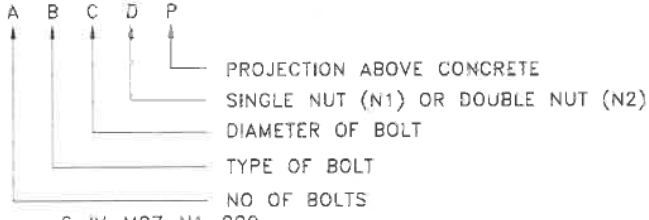
DETAIL–A (TYP)

GRADE OF CONC.	BOLT TYPE	DIMENSIONS MM			BOLT DIA (ø) IN MM																										
					10	12	16	18	20	22	24	27	30	33	36	39	42	45	48	52	56	60	64								
M20,M25, M30,M35 & M40	III & IV	SLEEVE	G		150	150	150	150	300	300	300	450	450	450	450	450															
			K		50	50	50	50	50	80	80	80	80	80	80	100															
	I TO IV IX & XII	THREADED (T) LENGTH	SINGLE NUT		40	45	55	60	60	65	70	75	80	90	95	100															
			DOUBLE NUT		50	60	70	75	80	90	95	105	110	120	130	140															
M20 & M25	V		G		150	150	150	200	300	300	300	450	450	450	450	550	600	650	700	750	800	900	900								
			H		210	222	234	291	398	410	417	580	585	598	608	722	786	841	905	975	1035	1150	1171								
	V & VI		W		80	80	90	100	100	130	130	140	150	170	180	200	210	220	230	260	270	290	320								
			t3		10	12	16	16	20	20	25	25	25	28	32	36	36	36	40	45	45	50	56								
	VII		L						350	400	400	500	550	600	750	950	1050	1100	1200	1350	1500	1750	1900								
	VIII		L												350	400	450	500	550	600	650	700	750								
			C												160	200	200	200	240	240	240	260	280								
M30	V		G		150	150	150	200	300	300	300	450	450	450	450	500	500	550	600	650	750	800	800								
			H		210	225	235	290	400	410	415	580	585	600	610	675	690	745	805	875	985	1050	1075								
	V & VI		W		80	80	90	100	100	100	100	110	110	140	160	200	210	220	230	260	270	290	320								
			t3		10	12	16	16	20	20	20	25	25	28	32	36	36	36	40	45	45	50	56								
	VII		L						275	325	325	375	425	500	600	750	850	975	1000	1075	1225	1375	1525								
	VIII		L												300	350	400	450	500	550	600	650	700								
			C												125	160	160	160	185	185	200	240	240								

GRADE OF CONC.	BOLT TYPE	DIMENSIONS MM		BOLT DIA (ø) IN MM																		
				10	12	16	18	20	22	24	27	30	33	36	39	42	45	48	52	56	60	64
M35 & M40	V	G		150	150	150	200	300	300	300	450	450	450	450	450	500	550	600	600	700	750	750
		H		210	225	235	290	400	410	415	580	585	600	610	625	690	745	805	825	935	1000	1025
	V & VI	W		80	80	90	100	100	100	100	110	110	140	160	200	210	220	230	260	270	290	320
		t3		10	12	16	16	20	20	20	25	25	28	32	36	36	36	40	45	45	50	56
	VII	L						250	275	300	350	400	450	550	675	775	875	900	975	1100	1250	1375
	VIII	L												300	350	400	450	500	550	600	650	700
		C												125	160	160	160	185	185	200	240	240
M20, M25, M30, M35, & M40	V & VI	E		50	60	70	75	80	90	95	105	110	120	130	140	150	155	165	180	190	200	215
	V , VI , VII & VIII	K		50	50	50	50	50	80	80	80	80	80	80	100	100	100	100	125	125	125	150
		THREADED (T) LENGTH	SINGLE NUT	40	45	55	60	60	65	70	75	80	90	95	100	105	110	120	125	135	140	150
			DOUBLE NUT	50	60	70	75	80	90	95	105	110	120	130	140	150	155	165	180	190	200	215
	VII	t3						16	16	16	16	16	16	16	16	16	16	20	20	20	20	20
	VIII	t3												16	20	20	20	25	25	25	28	32
	VII & VIII	G		150	150	150	150	300	300	300	450	450	450	450	450	450	450	450	450	450	450	600
	IX	L		80	100	150	170	200														
M20&25	XII	L		185	220	310	335	385	435	460	535	590	660	720								
M30		L		150	150	200	225	250	275	300	350	375	425	450								
M35&M40		L		150	150	175	200	225	250	275	300	350	375	400								

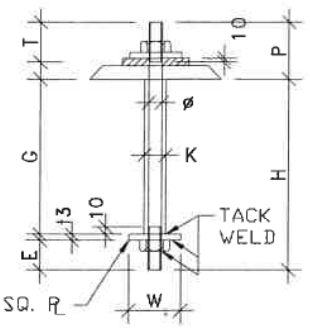
NOTES :-

1. BOLTS SHALL BE MARKED ON THE DRAWING AS UNDER :

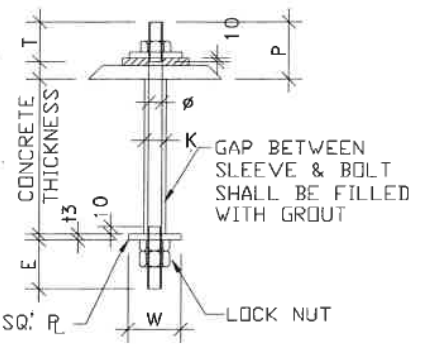


e.g.6-IV-M27-N1-200

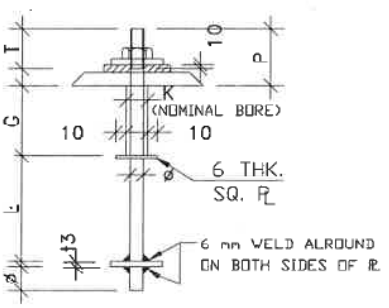
2. BOLTS SHALL BE TURNED FROM M.S. ROUNDS CONFORMING TO IS:2062 GRADE-E250 QUALITY A/BR/BO.
3. NUTS AND WASHERS SHALL CONFORM TO IS:1363.
4. THREADING SHALL BE COARSE CONFORMING TO IS:1367 AND IS:4218.
5. ANCHOR BOLTS SHALL BE SET ACCURATELY AND HELD IN POSITION BY TEMPLATE BEFORE CONCRETING.
6. 6 THK. SQ. PLATE AT THE BOTTOM OF SLEEVE SHALL BE TACK WELDED WITH BOLT AND SLEEVE FOR BOLT TYPE III, IV, VII AND VIII.
7. SLEEVE SHALL BE M.S. TUBES (MEDIUM) AS PER IS:1239.
8. REFER DESIGN DRAWINGS FOR PROJECTION (P) OF BOLT ABOVE TOP OF ROUGH CONCRETE AND NUMBER (A) OF BOLTS.
9. ANCHOR BOLTS SHALL BE TEMPERED BEFORE MACHINING IF MADE BY FORGING. THE FORGING TEMPERATURE SHALL BE ABOVE 900° C BUT LOWER THAN SUPER HEATING TEMPERATURE.

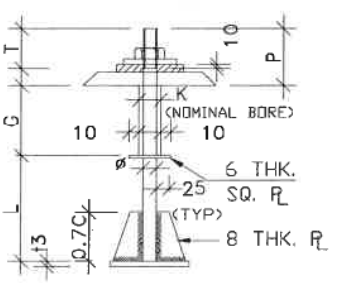


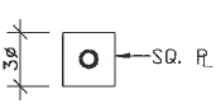
TYPE – V



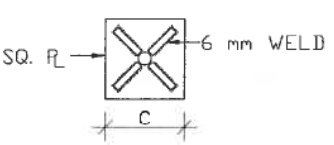
TYPE – VI



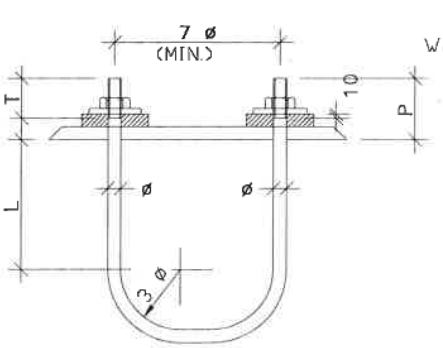




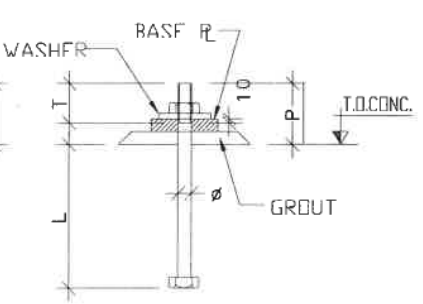
TYPE – VII



TYPE – VIII

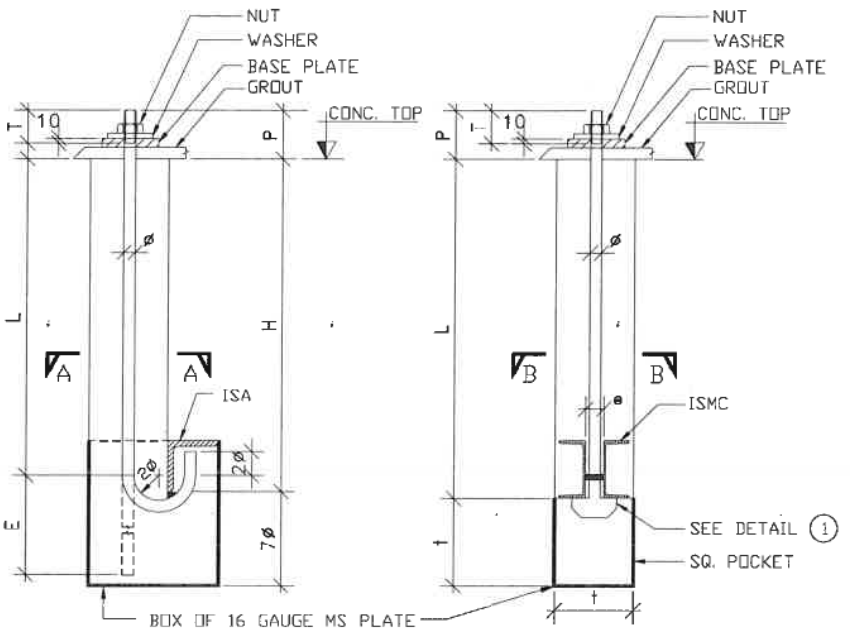


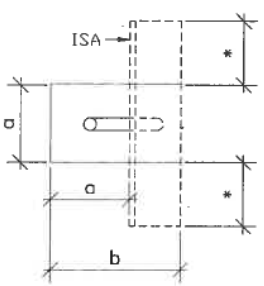
TYPE – IX



TYPE – XII

GRADE OF CONC.	BOLT TYPE	DIMENSIONS MM		BOLT DIA (ø) IN MM																		
				20	22	24	27	30	33	36	39	42	45	48	52	56	60	64				
M20, M25, M30, M35 & M40	X	a		150	160	180	200	220	240	260	280	300										
		b		250	290	310	330	370	390	460	480	500										
		L		600	700	800	900	1000	1100	1200	1300	1400										
		E		220	220	240	270	300	330	360	390	420										
		H		640	744	848	954	1060	1166	1272	1378	1484										
		ISA		100x100 X10	130X130X10			150X150X12		200X200X16												
		THREADED LENGTH (T)	SINGLE NUT	60	65	70	75	80	90	95	100	105										
			DOUBLE NUT	80	90	95	105	110	120	130	140	150										
	XI	h				18		20		25		30		30		30		30				
		k				18		22		25		30		35		40		50				
		c				24		30		36		42		48		56		64				
		q				65		75		85		95		110		125		140				
		r				1.6		1.6		2.0		2.0		2.0		3.0		3.0				
		f				140		150		170		190		210		220		240				
		e				30		35		42		50		58		65		75				
		L				800		1000		1200		1400		1600		1800		2000				
		ISMC				75x40		75x40		100x50		125x65		150x75		150x75		175x75				
		THREADED LENGTH (T)	SINGLE NUT			70		80		95		105		120		135		150				
			DOUBLE NUT			95		110		130		150		165		190		215				

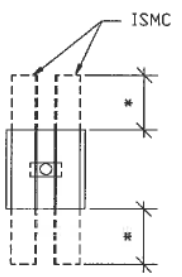




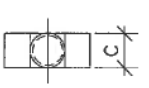
VIEW A – A

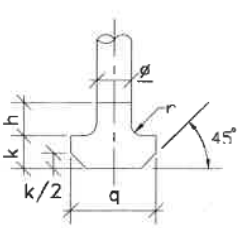
TYPE – X

(* AS PER DESIGN REQUIREMENT)



VIEW B – B





DETAIL – (1)

(FOR FORGED BOLT HEAD)

TYPE – XI

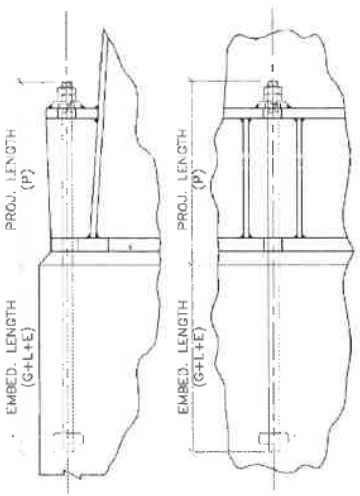


FIGURE 1: ANCHOR BOLT WITH ANCHOR CHAIR
(VERTICAL VESSELS ON SKIRT, STORAGE TANKS, ETC.)

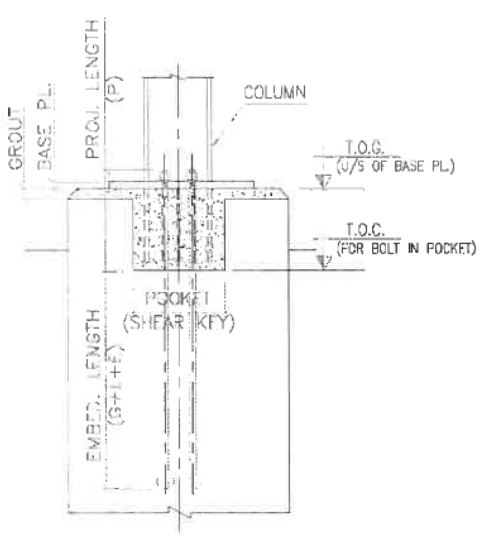


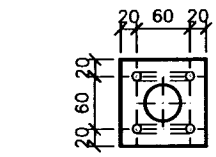
FIGURE 2: ANCHOR BOLT WITH POCKET IN PEDESTAL

NOTES:-

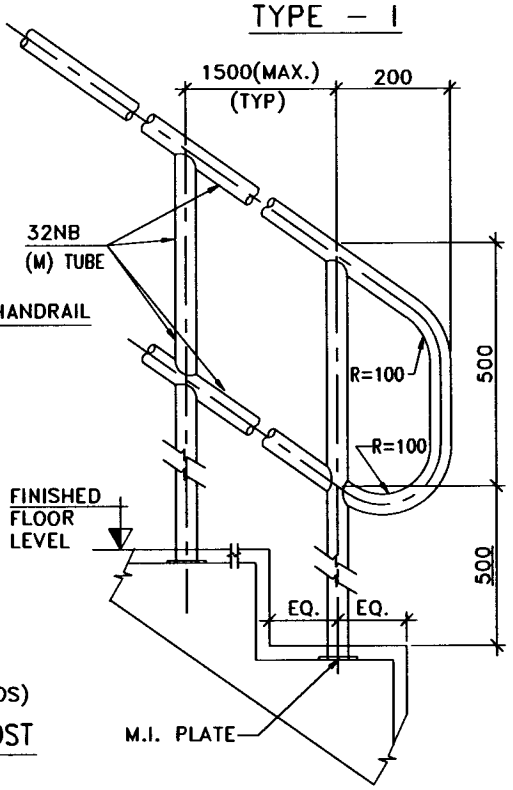
1. ALL HANDRAILS AND UPRIGHT SHALL BE AS PER RESPECTIVE TYPE.
2. ALL FILLET WELDS OF 3mm (MINIMUM) THICKNESS SHALL BE CONTINUOUS UNLESS NOTED OTHERWISE.
3. JOINTS IN HANDRAILS SHALL BE PROVIDED AT SUITABLE LOCATIONS, WELDED AND GROUND FLUSH.
4. FOR ADDITIONAL TYPE OF UPRIGHT FIXING DETAILS REFER EIL STD. 7-68-0061.
5. ALL M.S. TUBES SHALL CONFORM TO IS:1239.
6. FABRICATION OF TOP RAIL, INTERMEDIATE FLAT AND TOE PLATE SHALL ONLY BE STARTED AFTER TAKING ACTUAL DIMENSIONS AT SITE.
7. ADJUSTMENT IN SPACING OF VERTICAL POST SHALL BE DONE AT EITHER END OF PLATFORM.

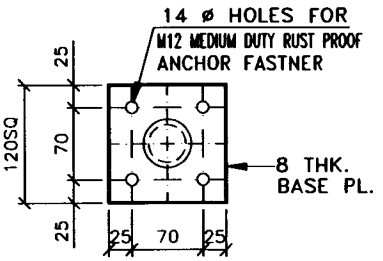
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
8	28.09.2020	REAFFIRMED & ISSUED AS STANDARD	JG	AVM	AS	SM
7	16.12.2014	REVISED & ISSUED AS STANDARD	V.P.SINGH	V GOEL	PK MITTAL	S CHANDA

TYPE – I

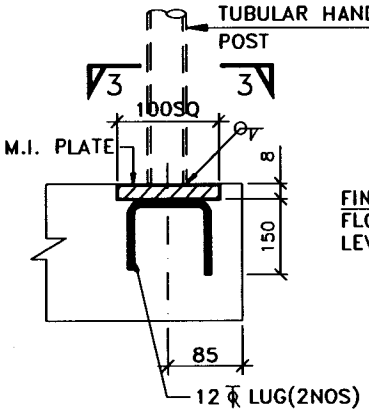


VIEW 3–3

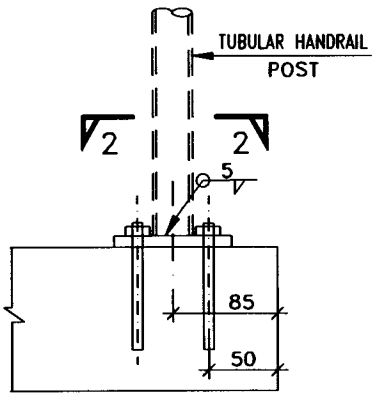




VIEW 2–2

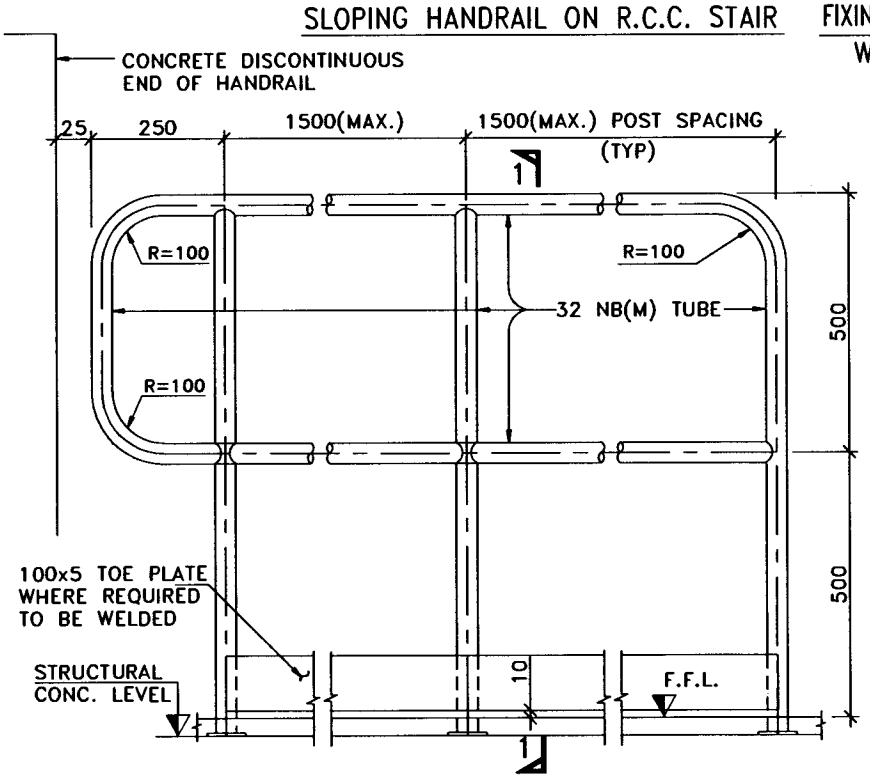


FIXING DET OF TUB. POST
WITH M.I.PLATE (ALT–I)

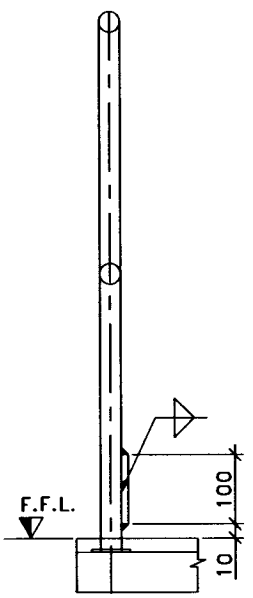


FIXING DET OF TUBULAR POST
WITH ANCHOR FASTNER
ALT–II

SLOPING HANDRAIL ON R.C.C. STAIR



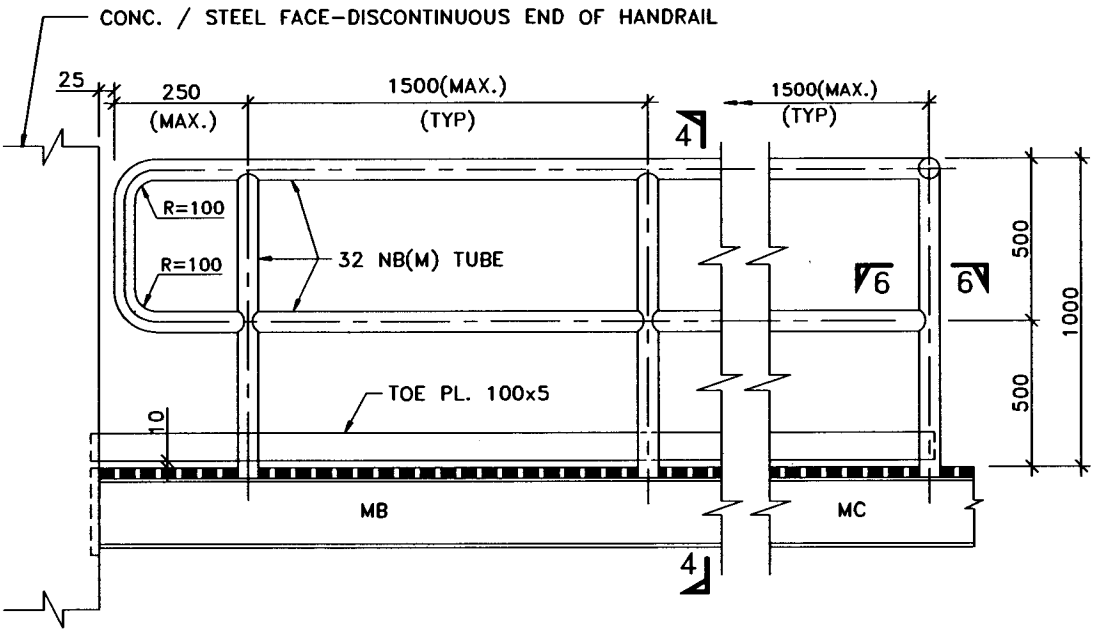
HORIZONTAL HANDRAIL ON R.C.C. PLATFORM



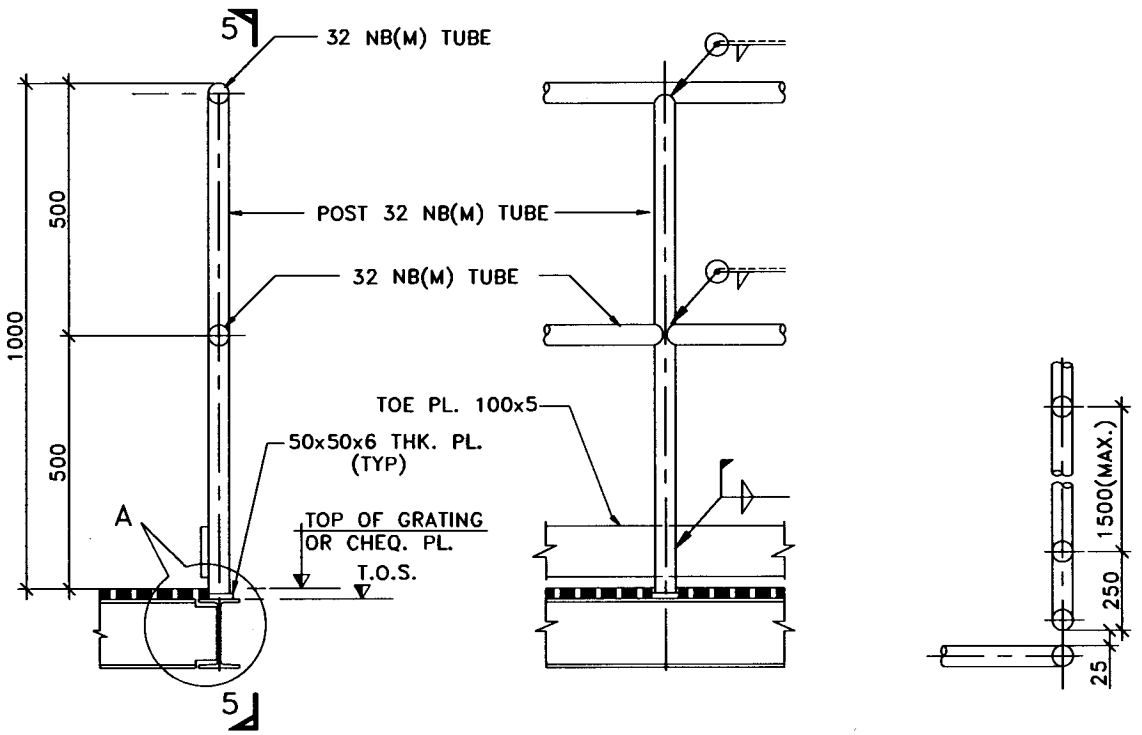
SEC. 1–1

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
8	28.09.2020	REAFFIRMED & ISSUED AS STANDARD	JG	AVM	AS	SM
7	16.12.2014	REVISED & ISSUED AS STANDARD	V.P.SINGH	V GOEL	PK MITTAL	S CHANDA

TYPE – II



HORIZONTAL HANDRAIL ON STEEL PLATFORM



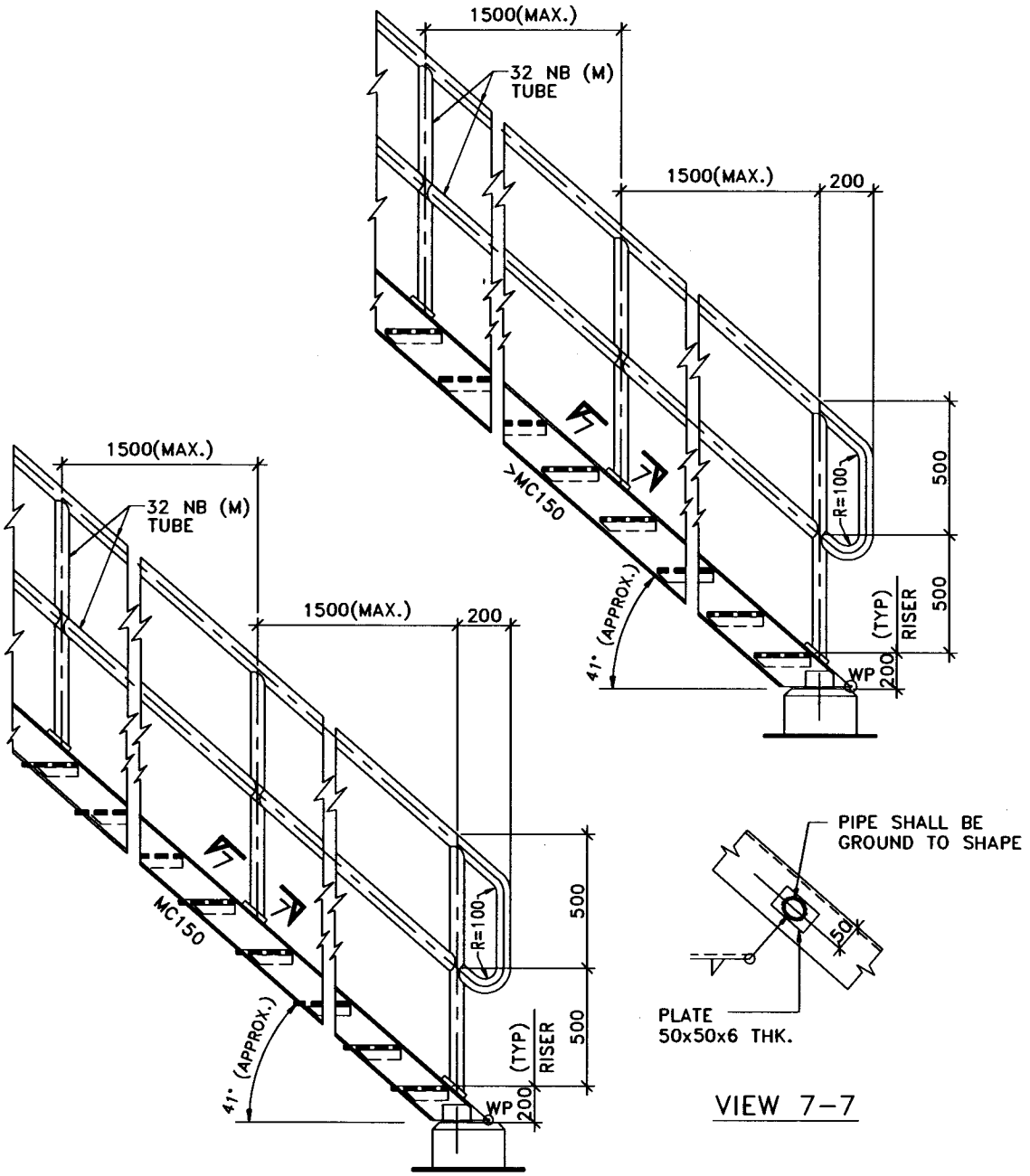
SECTION 4–4
(FOR DETAIL (A) REFER PAGE 8 OF 8)

VIEW 5–5

VIEW 6–6
(AT CORNER)

Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by: Stds. Committee Convenor	Approved by: Stds. Bureau Chairman
8	28.09.2020	REAFFIRMED & ISSUED AS STANDARD	JG	AVM	AS	SM
7	16.12.2014	REVISED & ISSUED AS STANDARD	V.P.SINGH	V GOEL	PK MITTAL	S CHANDA

TYPE – II



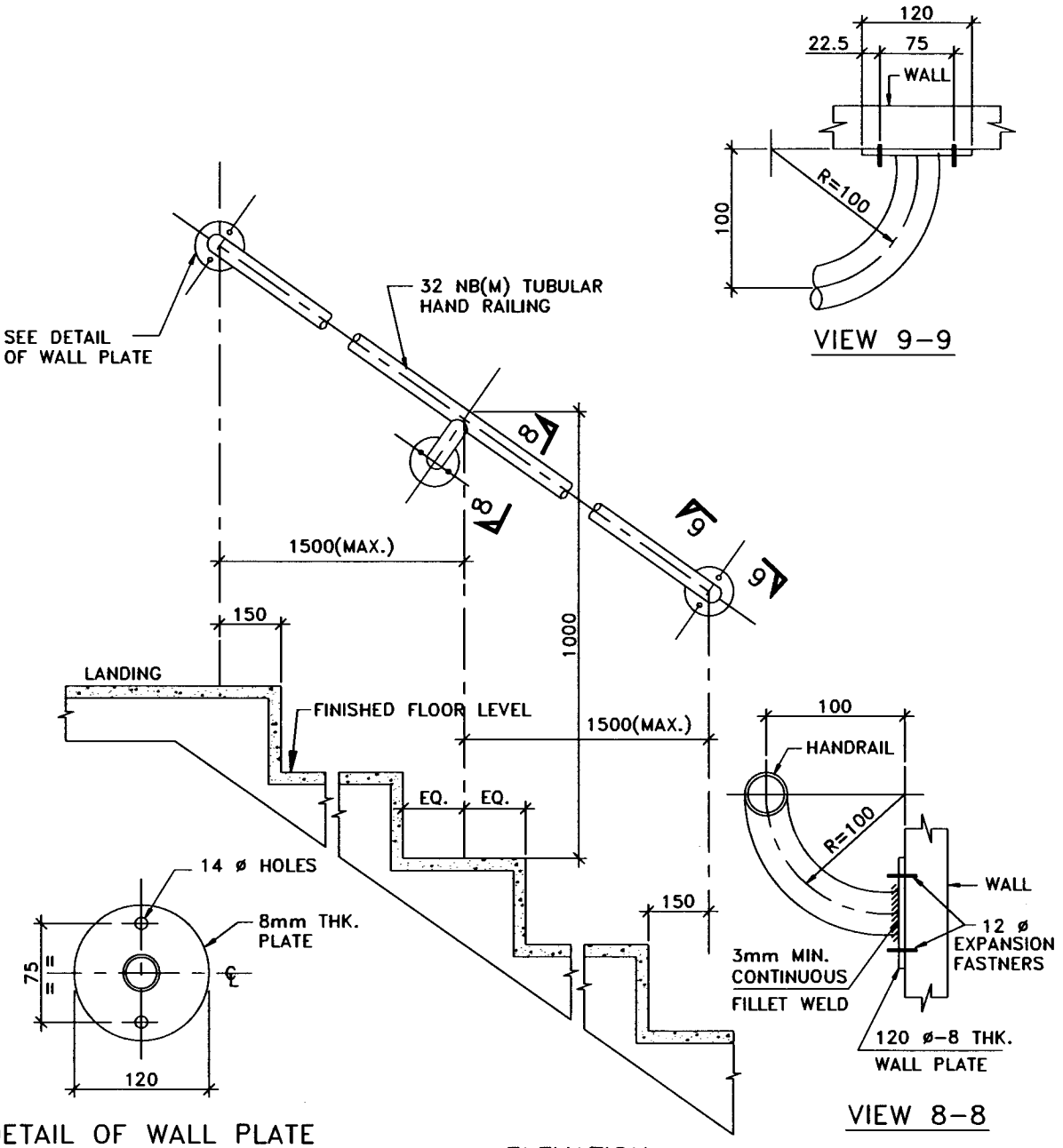
VIEW 7–7

SLOPING HANDRAIL ON STEEL STAIR

WHEREVER HIGHER SIZE OF STRINGER BEAMS ARE REQUIRED AS PER DESIGN SIMILAR G.A. BE FOLLOWED FOR THE SAME.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
8	28.09.2020	REAFFIRMED & ISSUED AS STANDARD	JG	AVM	AS	SM
7	16.12.2014	REVISED & ISSUED AS STANDARD	V.P.SINGH	V GOEL	PK MITTAL	S CHANDA

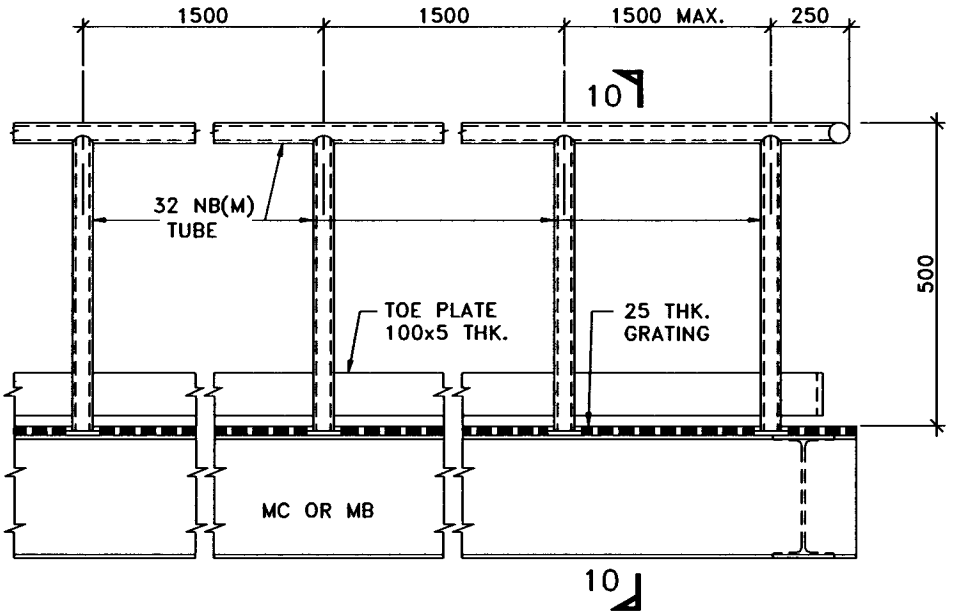
TYPE – III



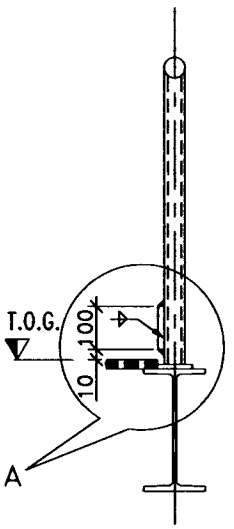
HANDRAIL FIXED TO WALL DIRECT

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
8	28.09.2020	REAFFIRMED & ISSUED AS STANDARD	JG	AVM	AS	SM
7	16.12.2014	REVISED & ISSUED AS STANDARD	V.P.SINGH	V GOEL	PK MITTAL	S CHANDA

TYPE – IV



HANDRAIL ON HORIZONTAL PLATFORM (STEEL)



SEC. 10–10

NOTE : HANDRAIL TYPE–IV SHALL BE USED OVER PIPE CROSS OVER AND LOW LEVEL PLATFORMS SUCH AS FOR VALVE OPERATION ETC. AS MENTIONED IN STD 7–68–0562 & 0563.

(FOR DETAILS Ⓐ REFER PAGE 8 OF 8)

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
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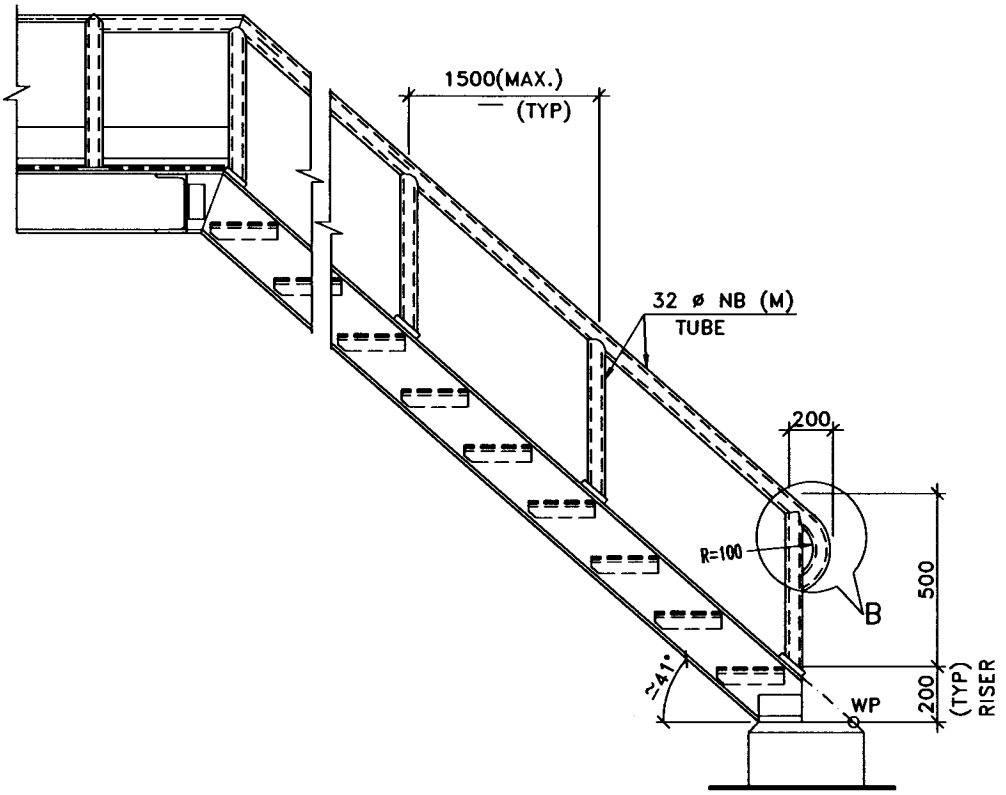
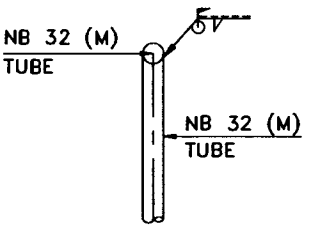
8	28.09.2020	REAFFIRMED & ISSUED AS STANDARD	JG	AVM	AS	SM
7	16.12.2014	REVISED & ISSUED AS STANDARD	V.P.SINGH	V.P.SINGH	PK MITTAL	S CHANDA

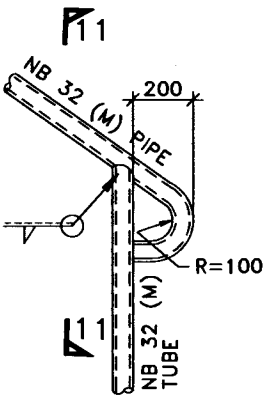
TYPE – IV



SLOPING HALF HANDRAIL ON STEEL STAIR

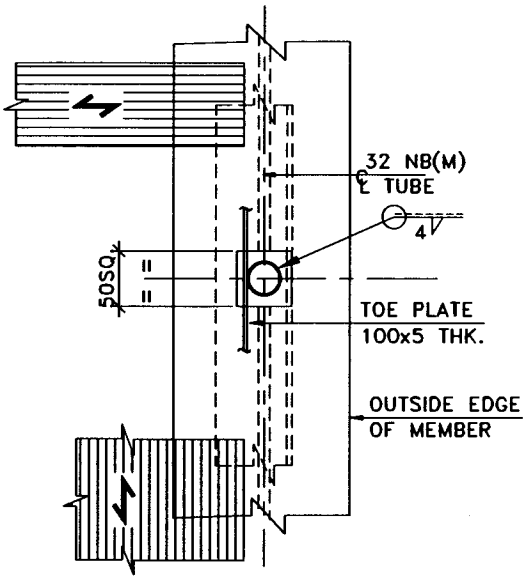


SEC. 11–11

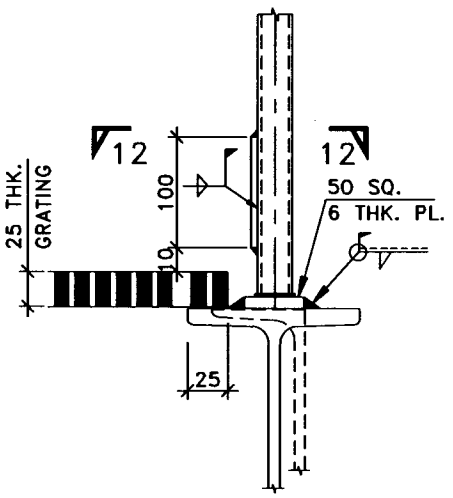


DETAIL – (B)

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
8	28.09.2020	REAFFIRMED & ISSUED AS STANDARD	JG	AVM	AS	SM
7	16.12.2014	REVISED & ISSUED AS STANDARD	V.P.SINGH	V GOEL	PK MITTAL	S CHANDA



VIEW 12–12



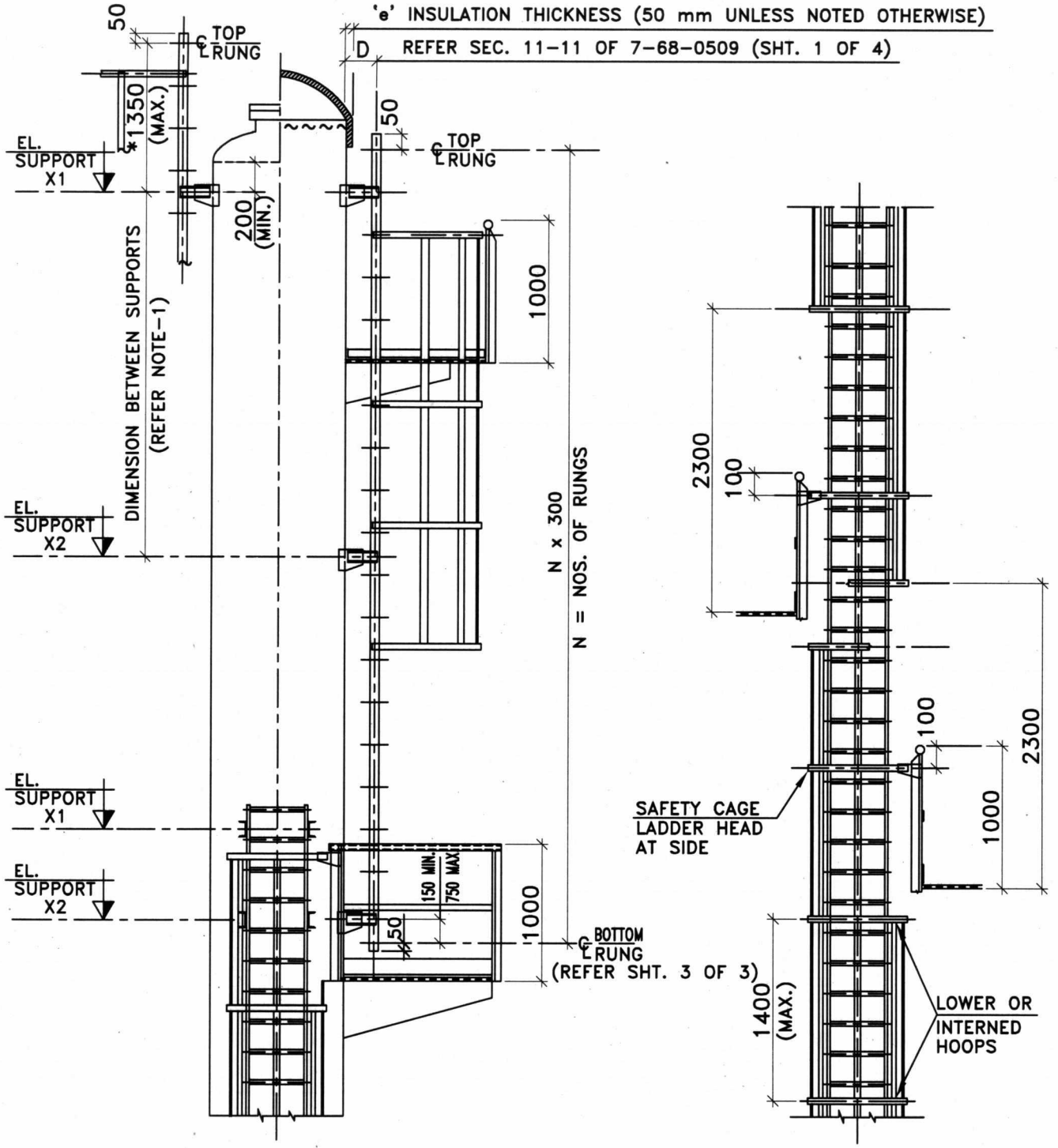
DETAIL – (A)

CONNECTION DETAILS
(FOR TYPE II & IV)

NOTE : CHEQUERED PLATES / GRATINGS SHALL BE SUITABLY NOTCHED TO ACCOMMODATE THE TUBE IN CASE OF BEAM MC100 OR MC125.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
8	28.09.2020	REAFFIRMED & ISSUED AS STANDARD	JG	AVM	AS	SM
7	16.12.2014	REVISED & ISSUED AS STANDARD	V.P.SINGH	V GOEL	PK MITTAL	S CHANDA

DETAILS OF STEEL LADDER



LADDER FOR SIDE ENTRY

LADDER FOR SIDE ENTRY

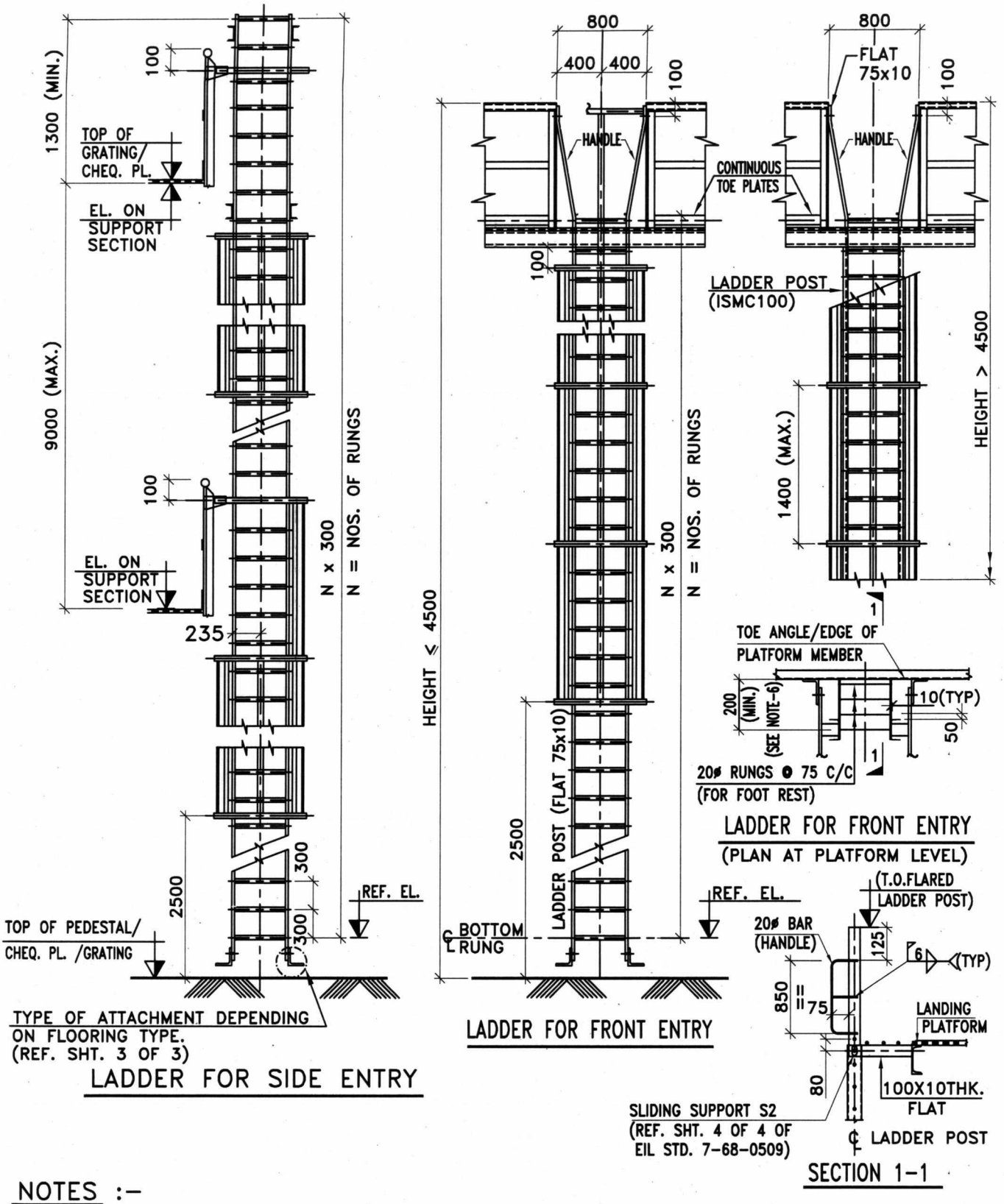
VESSEL DIA (mm)	DISTANCE 'D' (mm)
UPTO 800	200 + e
> 800 ⩽ 3200	260 + e
> 3200 ⩽ 8000	275 + e

* MC100 SHALL BE ADOPTED FOR DISTANCE MORE THAN 1350 UPTO 2000

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
9	14.12.23	REVISED AND ISSUED AS STANDARD	JITENDER GUPTA	AMARJEET	ANURAG SINHA	MAINAK NANDI
8	01.08.19	REAFFIRMED AND ISSUED AS STANDARD	JG	AVM	RAJANJI SRIVASTAVA	S.CHANDA

Approved by

DETAILS OF STEEL LADDER

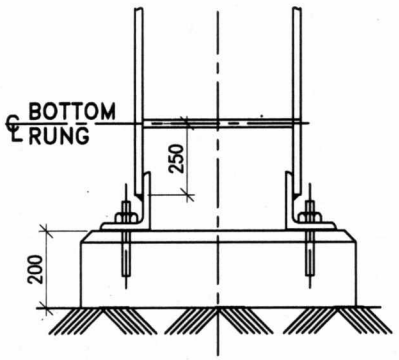


NOTES :-

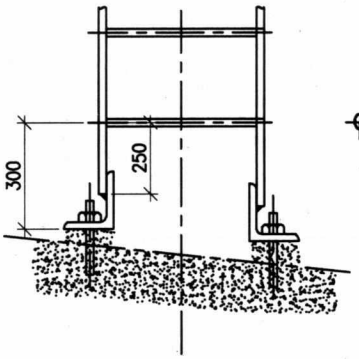
1. LADDER POSTS SHALL BE OF FLAT (75x10) UPTO 3.60m (MAX.) BETWEEN SUPPORTS AND ISMC 100 UPTO 7.0m (MAX.) BETWEEN SUPPORTS.
2. RUNGS SHALL BE 20 ø. FOR STEEL LADDER JOINT DETAILS, REFER EIL STD. 7-68-0509.
3. SUPPORT TYPE 'X1' CORRESPONDS TO FIXED SUPPORT AND 'S2/X2' CORRESPONDS TO SLIDING SUPPORT. FOR EACH LADDER, ONLY ONE FIXED SUPPORT SHALL BE PROVIDED. REMAINING SUPPORT(S) SHALL BE OF SLIDING TYPE.
4. SUPPORT ELEVATION X1, X2 CORRESPOND TO ℄ OF BOLT HOLES.
5. SUPPORTS 'X1' IS CAPABLE TO SUSTAIN A LOAD FOR 9000 mm LONG LADDER ONLY.
6. LADDER SHALL BE GIVEN SUITABLE SLOPE (MAX.6°),IF NECESSARY,TO AVOID FOULING WITH ANCHOR CHAIRS.

DETAILS OF STEEL LADDER

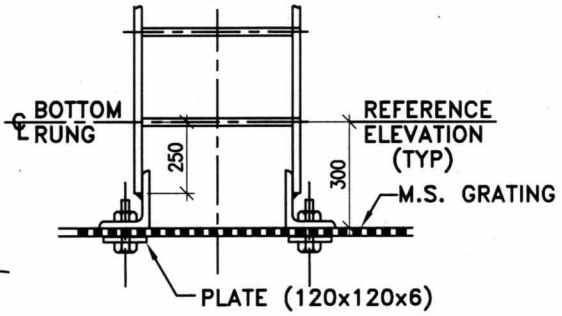
TYPE OF ATTACHMENT	NATURE OF SUPPORT SECTION	REMARKS
A1, A2	SITE WITHOUT PAVING	
B1, B2	CONCRETE FLOOR	A1, B1, C1, D1 : FIXED TYPE
C1, C2, D1, D2	CHEQUERED PLATE / GRATING FLOORING	A2, B2, C2, D2 : SLIDING TYPE



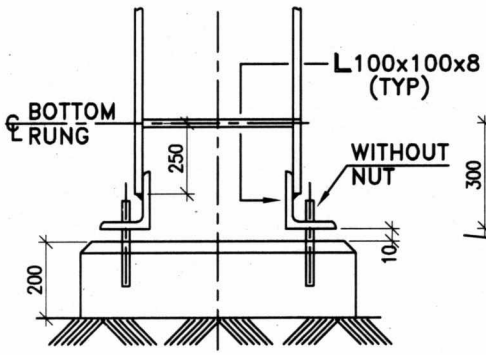
TYPE – A1



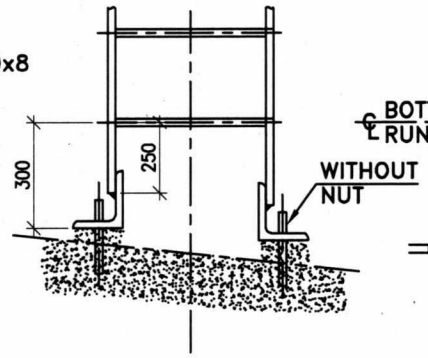
TYPE – B1



TYPE – C1



TYPE – A2



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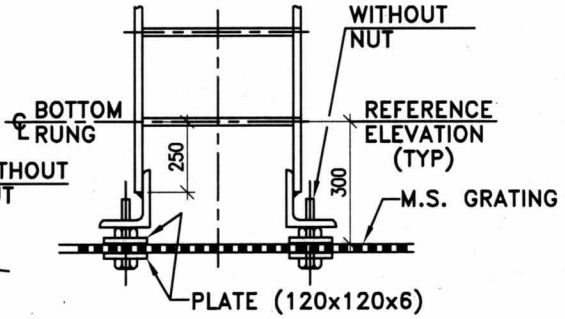

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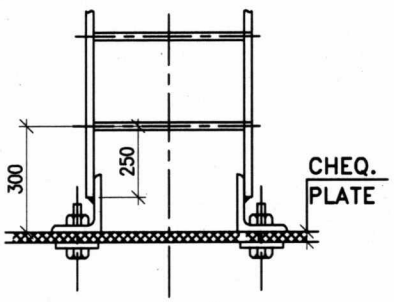
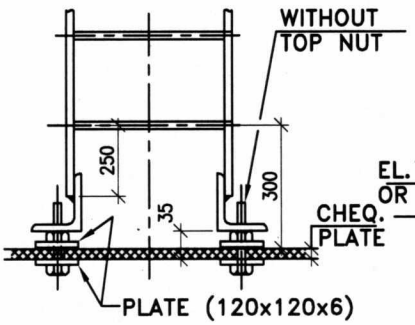
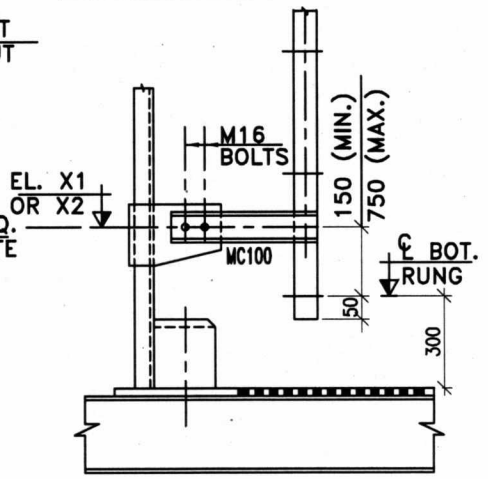


TYPE – D1

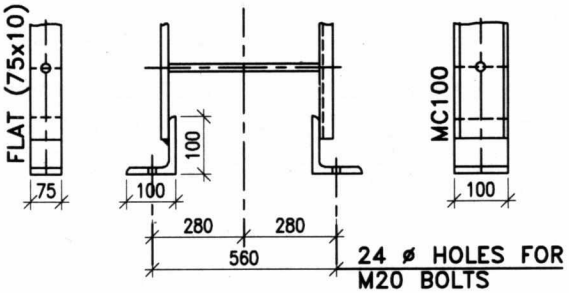


TYPE – D2



TYPE – E

(FREE)



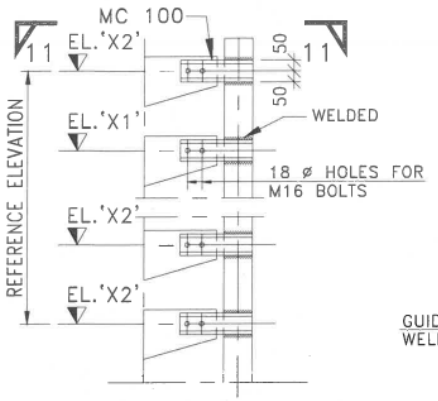
LADDER BOTTOM DETAILS

NOTE :-

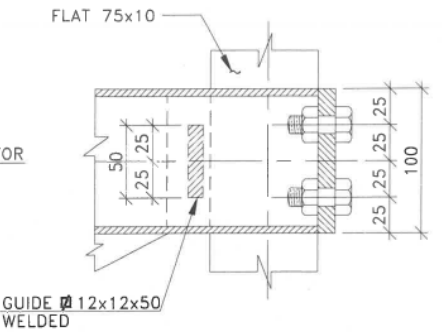
IN CASE OF TOWERS BOTTOM RUNG SHALL BE 300 mm FROM FGL /HPP.

TYPE OF ATTACHMENT AT BASE

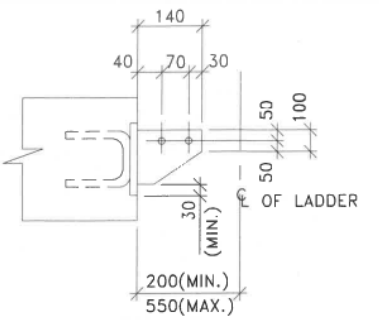
STEEL LADDER JOINT DETAILS



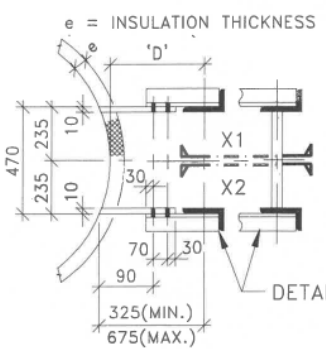
LADDER ATTACHMENT TO VESSELS



SECTION 12–12

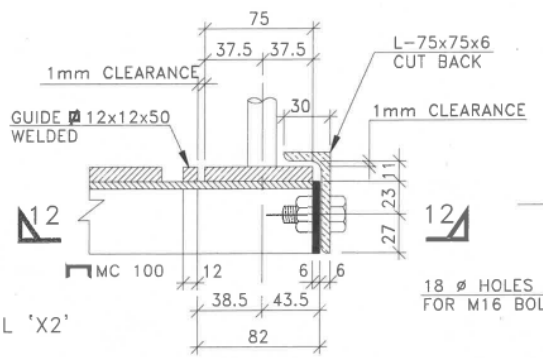


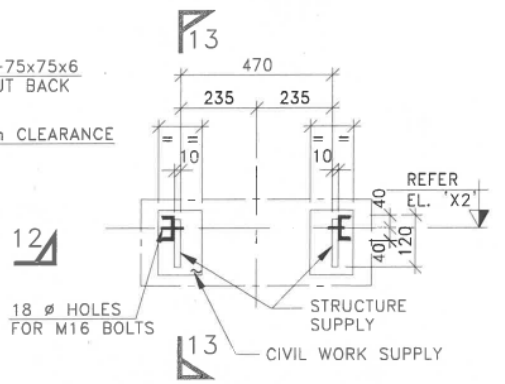
SECTION 13–13



DETAIL 'X2'

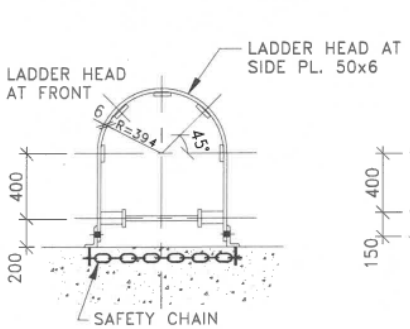
(FOR LADDER POST FLAT 75x10)



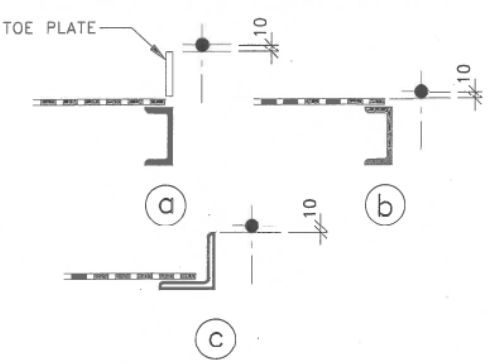


LADDER ATTACHMENT TO CONCRETE

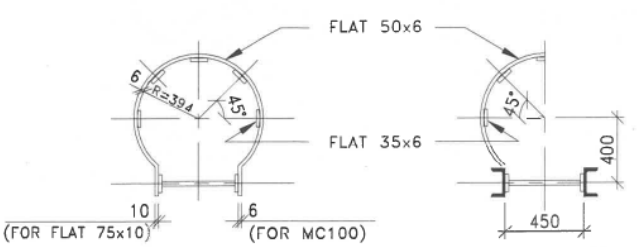
SECTION 11–11



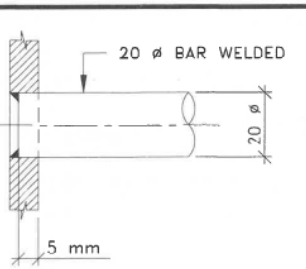
SAFETY CAGE HOOP DETAILS



LOCATION OF RUNG FOR LADDER



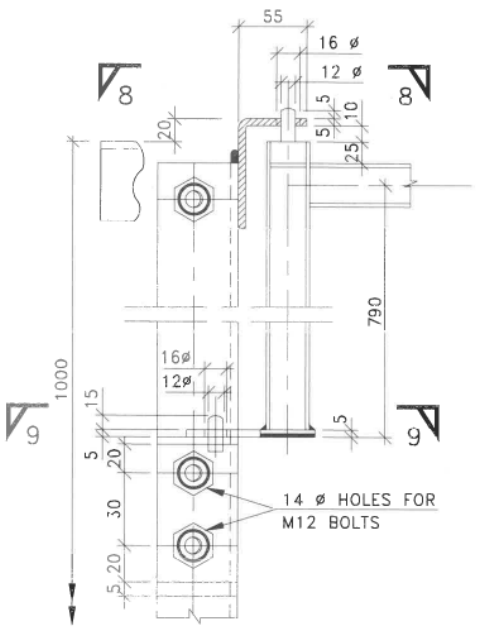
LOWER AND INTERMEDIATE CAGE



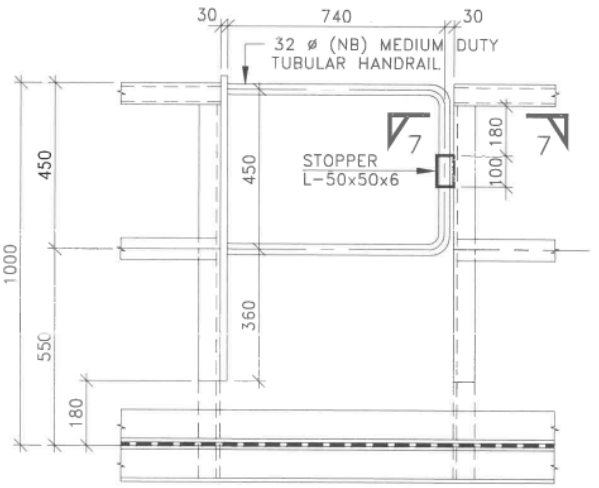
ATTACHMENT OF BAR

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
8	03.04.25	REAFFIRMED AND ISSUED AS STANDARD	SHUBHAM	SUDIP PAUL	ANURAG SINHA	MAINAK NANDI
7	01.08.19	REAFFIRMED AND ISSUED AS STANDARD	JG	AVM	RAJANJI SRIVASTAVA	R.K.TRIVEDI

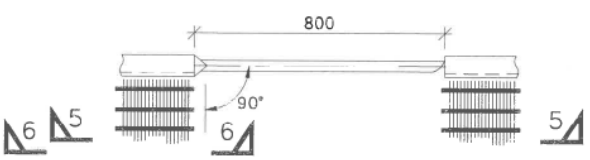
Approved by



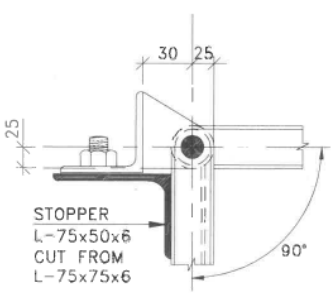
SECTION 6-6



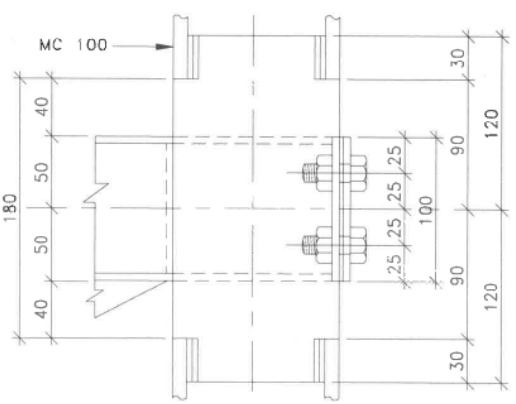
SECTION 5-5



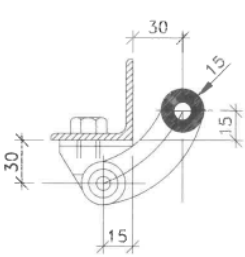
AUTOMATIC BARRIER



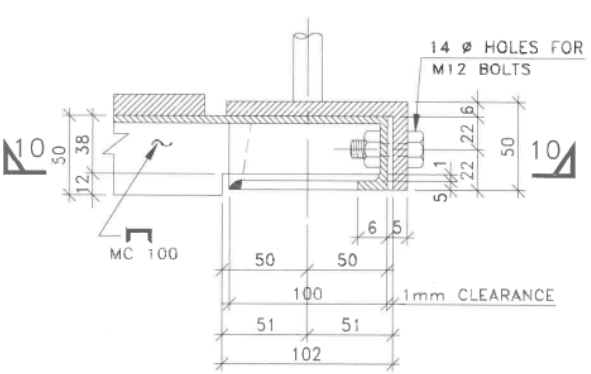
SECTION 8-8



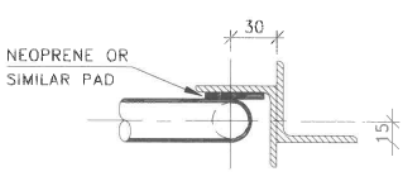
SECTION 10-10



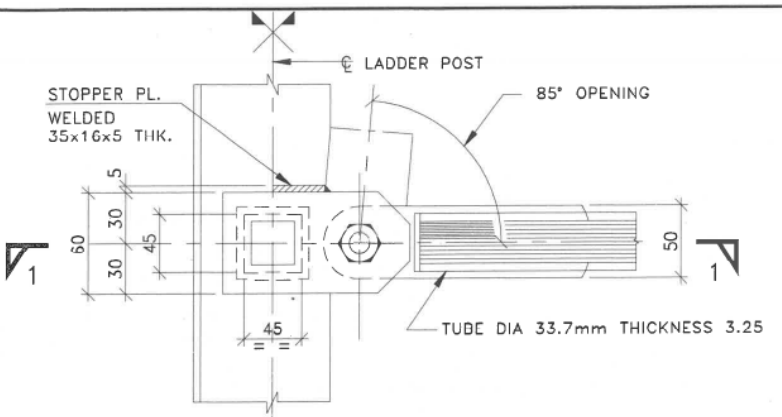
SECTION 9-9



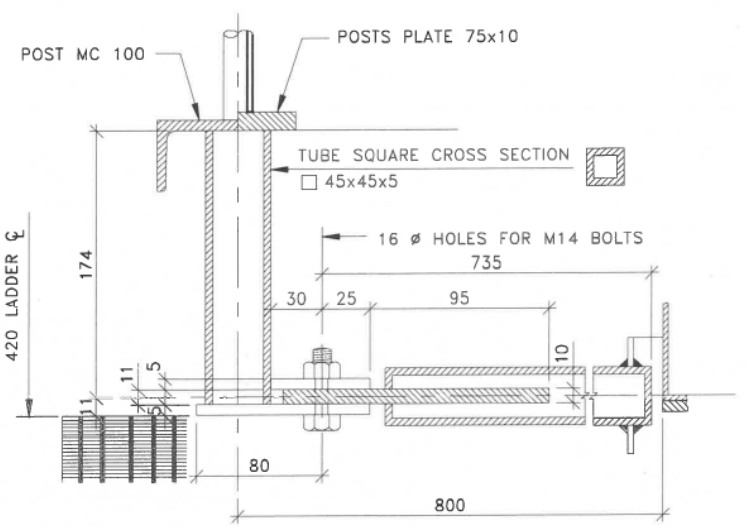
DETAIL 'X2'
(FOR LADDER POST MC 100)



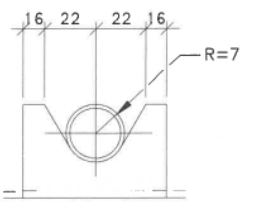
SECTION 7-7



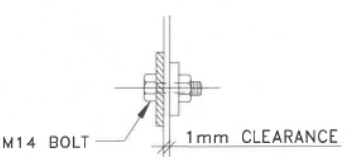
SAFETY BAR INSTALLATION ON LADDER POSTS



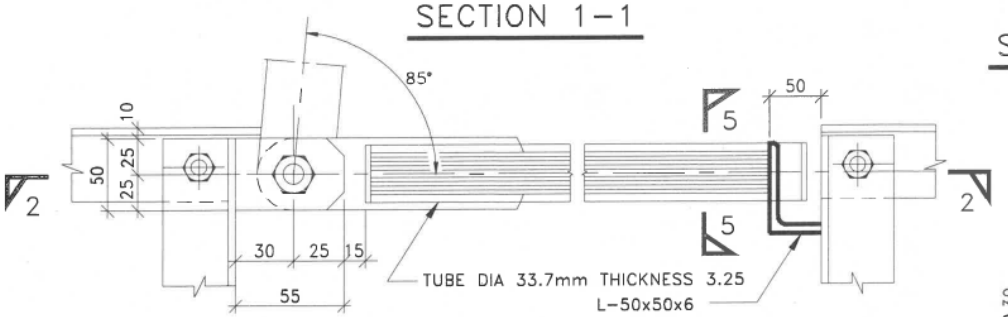
SECTION 1–1



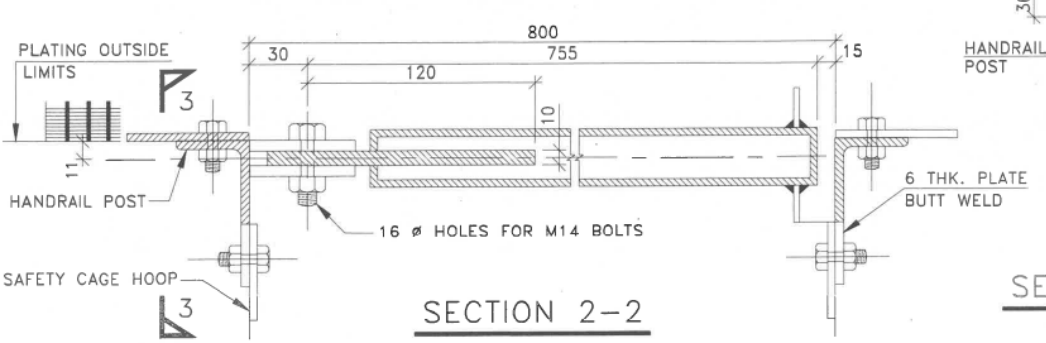
SECTION 5–5



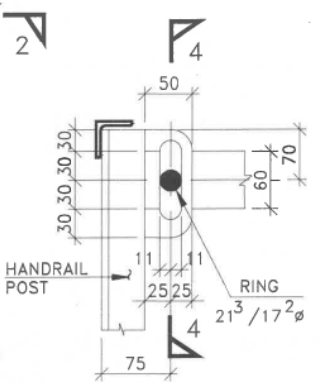
SECTION 4–4



SAFETY BAR INSTALLATION ON HANDRAIL POSTS

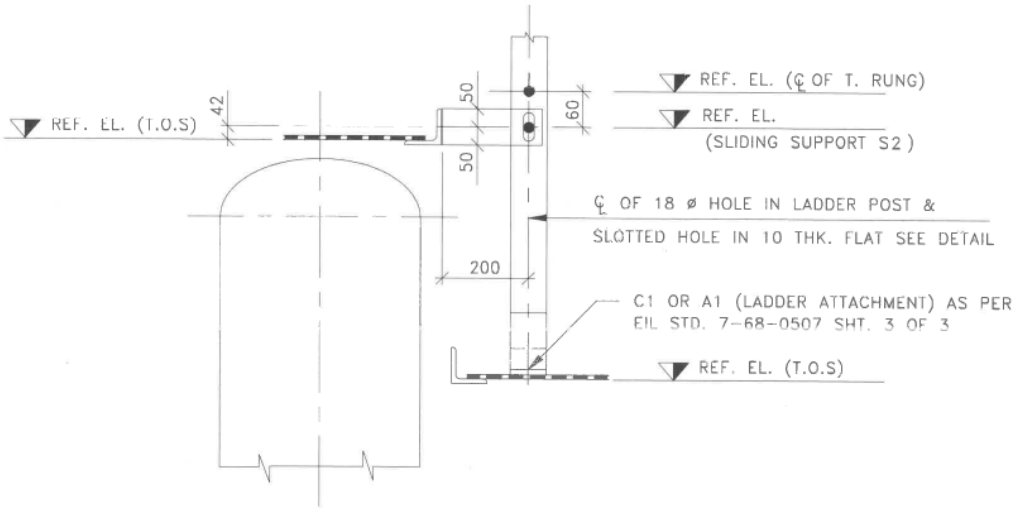


SECTION 2–2



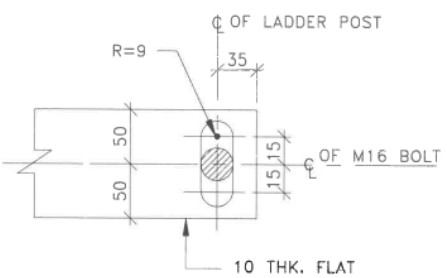
SAFETY CAGE HOOP ATTACHMENT TO HANDRAIL POST

SECTION 3–3



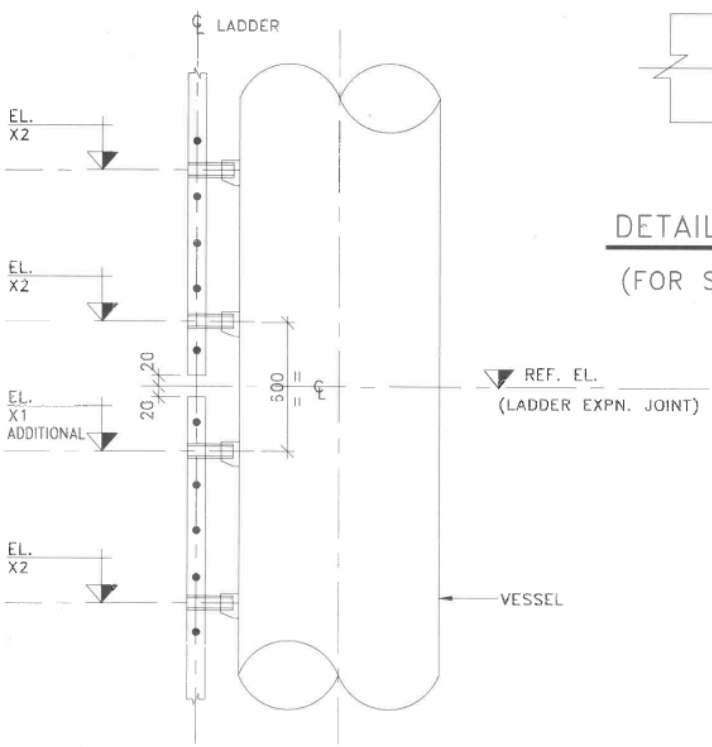
SLIDING CONN. DET. OF LADDER

(WITH TOE ANGLE OF PLATFORM ON THE HEAD OF VESSEL)



DETAIL OF SLOTTED HOLE

(FOR SLIDING SUPPORT S2)

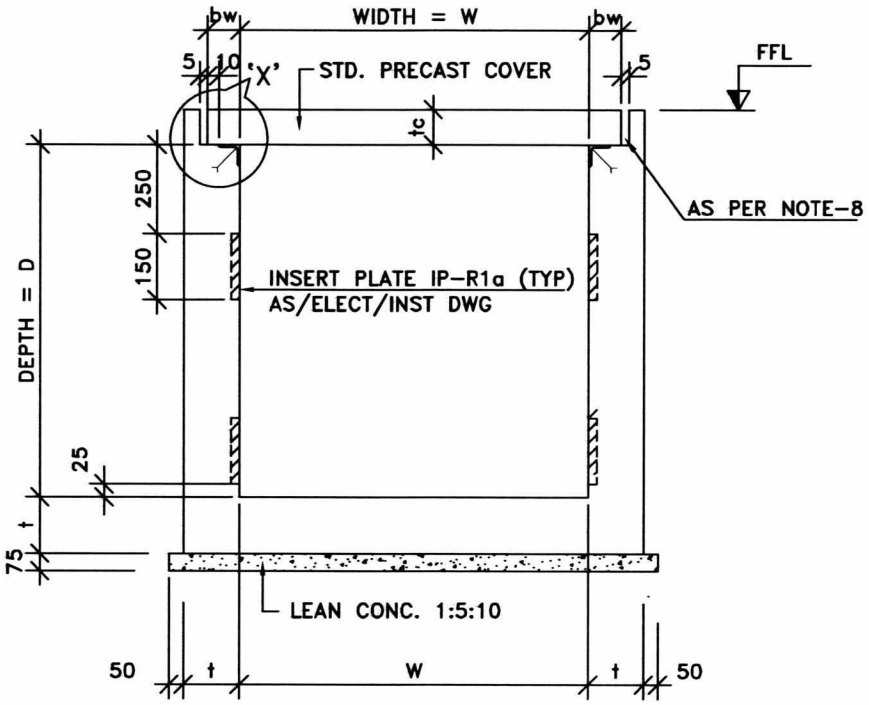


DET. OF LADDER EXPANSION JOINT

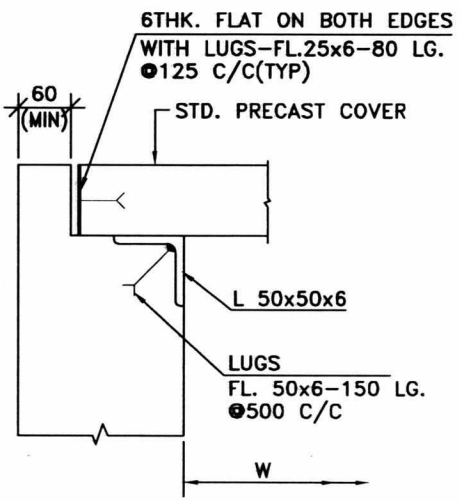
(WHEN DISTANCE BETWEEN TOP AND BOT. MOST SUPPORT ⩾ 9000)

NOTES :-

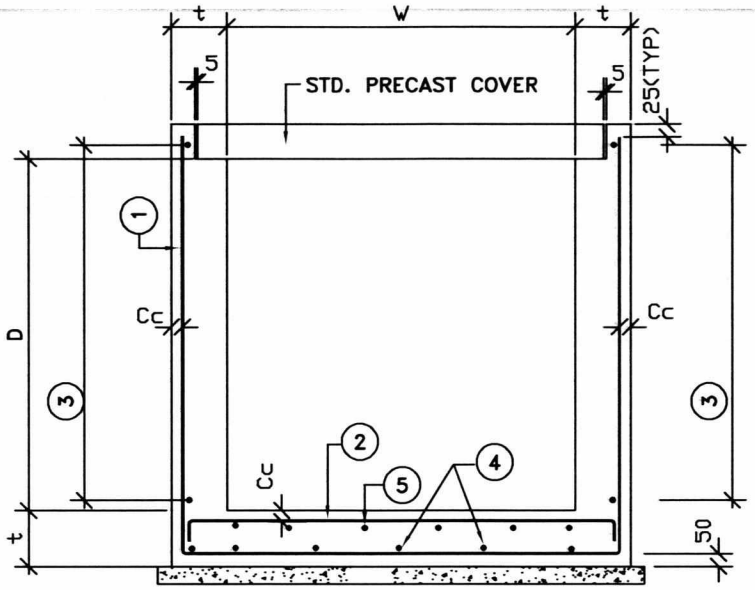
1. ELECTRICAL DEPTT. & INSTRUMENTATION DEPTT. WILL PROVIDE FOLLOWING INFORMATION ON THEIR DRAWINGS WHICH WILL BE ISSUED FOR CONSTRUCTION:
   a) LAYOUT AND SIZE OF THE CABLE TRENCH.
   b) TYPE OF COVER REQUIRED i.e. PRECAST RCC / CHEQUERED PLATE.
   c) LIVE LOAD ON THE COVERS IF MORE THAN AS DEFINED IN TABLE 2.
   d) INSERT PLATE REQUIREMENT AND ITS SPACING.
   e) LAYOUT AND SIZE OF OPENING FOR PANELS. (SHEET 15 OF 16)
2. GRADE OF CONCRETE AND REBARS FOR CABLE TRENCH & PRECAST COVER SHALL BE AS PER GENERAL NOTES OF THE PROJECT. HOWEVER, M25 AS MINIMUM GRADE OF RCC AND FE500D AS MINIMUM GRADE OF REINFORCEMENT HAS BEEN CONSIDERED IN DESIGN.
3. R.C.C. CABLE TRENCHES ARE DESIGNED FOR A SURCHARGE LOAD OF 1 T/M^2 .
4. STRUCTURAL STEEL FOR PRECAST COVER SUPPORTS INCLUDING INSERT PLATES IS ALSO IN THE SCOPE OF CIVIL CONTRACTOR.
5. ALL OTHER STRUCTURAL STEEL WORKS INCLUDING CHEQUERED PLATE SHALL BE UNDER THE SCOPE OF ELECTRICAL CONTRACTOR.
6. STRUCTURAL STEEL SHALL CONFORM TO MINIMUM E250 GRADE A/BR/B0 AS PER IS 2062. CHEQUERED PLATE SHALL CONFORM TO IS 3502.
7. Cc STANDS FOR CLEAR COVER. CLEAR COVER SHALL BE 30MM MINIMUM, UNLESS NOTED OTHERWISE. IN CASE CLEAR COVER IS MORE FOR A PROJECT, THE ELEMENT THICKNESS SHALL BE INCREASED ACCORDINGLY.
8. 5MM GAP TO BE FILLED WITH 1:3 CEMENT MORTAR.



TYP. SECTION OF CABLE TRENCH

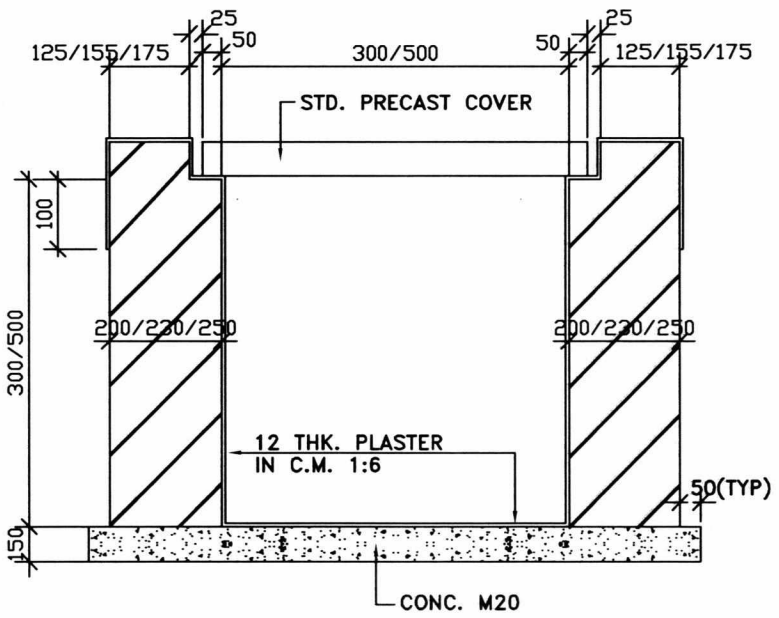


DETAIL – 'X'
(TYP.)



CABLE TRENCH SECTION WITH R.C.C.

(FOR DETS OF R/F BARS ① TO ⑥ REFER TABLE-1 SHT 5 OF 16)



CABLE TRENCH SECTION WITH BRICK MASONRY

(IN C.M. 1:6)