

विद्युत उपकरणों के लिए स्थापना विनिर्देश

SPECIFICATION FOR ELECTRICAL EQUIPMENT INSTALLATION

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Abbreviations:

AC	:	Alternating Current
ACDB	:	AC Distribution Board
AL	:	Aluminium
BIS	:	Bureau of Indian Standards
CCoE	:	Chief Controller of Explosives
CD	:	Compact Disc
CEA	:	Central Electricity Authority
CIMFR	:	Central Institute of Mining and Fuel Research
CT	:	Current Transformer
CTC	:	Carbon Tetrachloride
CU	:	Copper
DC	:	Direct Current
DCDB	:	DC Distribution Board
DGMS	:	Directorate General of Mines and Safety
Ex(d)	:	Flameproof
FRP	:	Fibre Reinforced Plastic
HV	:	High Voltage
IR	:	Insulation Resistance
IS	:	India Standard
LV	:	Low Voltage
HMI	:	Human Machine Interface
MV	:	Medium Voltage
OISD	:	Oil Industry Safety Directorate
OSR	:	Oil Surge Relay
OTI	:	Oil Temperature Indicator
PF	:	Power Factor
PI	:	Polarisation index
PRV	:	Pressure relief Valve
PT	:	Potential Transformer
SLD	:	Single Line Diagram
UPS	:	Uninterrupted Power Supply
VRLA	:	Valve Regulated Lead Acid
WTI	:	Winding Temperature Indicator

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1.0 SCOPE

This specification defines the requirements for the installation, field inspection, testing and commissioning of electrical equipment, forming part of electrical power distribution and utilisation system, including Communication and Fire alarm system.

2.0 CODES AND STANDARDS

- 2.1** The work shall be carried out in the best workmanlike manner in conformity with this specification, EIL Installation Standards, layout drawings and to the following specifications/ codes of practice of Bureau of Indian Standards and OISD standards.

SP-30 (BIS)	National Electrical Code.
IS:7816	Guide for testing Insulation resistance of rotating machines.
IS:10028 (Part-2)	Code of practice for selection, Installation and maintenance of transformers; Part 2 : Installation.
OISD 137	Inspection of Electrical Equipment.
OISD 147	Inspection and safe practices during electrical installations

- 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 INSTALLATION OF EQUIPMENT

Prior to start of installation of the electrical equipment, Contractor shall verify that equipment and complete materials have been received. Handling, shifting to required site location, installation, testing and commissioning of all electrical equipment shall be done by contractor with utmost care. Manufacturer's instructions and the requirements given in their technical manuals shall be strictly adhered. The substation/switchgear room wherein the equipment shall be installed shall be kept clean, dry and free from all debris. Panel floor cutouts not in immediate use shall be suitably covered to avoid any mishap. When handling the switchboard panels, care shall be taken to observe the correct lifting arrangements and to make sure that slings are attached to the manufacturer's designated lifting points, where applicable. No parts shall be subjected to undue strains or sudden stresses which could cause damage to the equipment.

The lifting position mark indicated on packing casing shall be adhered to strictly, for keeping it in required vertical position.

Contractor shall check and report to the Engineer-in-charge about any damaged item and / or missing component for getting the same replaced as per specifications. During installation, all accessories and loose items shall also be inspected by the contractor before their assembly/mounting.

3.1 Switchboards and Bus Ducts

- 3.1.1 The term switchboard here includes all HV / MV/ LV switchboard panels, motor control centers, power and lighting distribution boards, UPS panels, ACDB, Battery charger panels, DCDB etc.

The switchboard panels shall be handled with care, avoiding any impact to the equipment. Dragging of the panels directly on floor shall be avoided. Roller bars may be used for shifting of panels. Use of a crane and trailer shall be made for handling of equipment. The switchboard panels shall be properly supported on the truck or trailer by means of ropes to avoid any chance of tilting. The switchboards shall be lifted after ensuring that panel supports, nuts and bolts are all intact and tightened. While lifting the panels in packed conditions, utmost care shall be taken to avoid any damage to insulators, bushings, metering and protective equipment and if specified in the tender document tyre mounted hydraulic trolley shall be used.

The panels shall be preferably kept inside the packing cases till foundations are ready. Proper rain/sun/dust protection shall be ensured till switchboards are installed.

- 3.1.2 The switchboard panels shall be installed on prepared foundations or floor cutouts. Steel base channels shall be welded to inserts provided in floor slab. Cross members shall be provided at the junctions of each shipping section and other places as required.. It shall be ensured that the base plate level of HV switchboard shall match with the finished floor level.

The foundation pockets and the grouted bolts shall be cured for a minimum period of 48 hours. Proper level of base frames shall be maintained throughout and shall be checked with water level/spirit level. Steel Shims shall be provided below base frame wherever required.

- 3.1.3 The switchboard panels shall be taken out from the packed cases and shifted one by one to their proper place. All the panels shall be assembled, aligned and leveled. Alignment of panels shall be checked in both longitudinal and lateral directions. It shall be ensured that panel to panel coupling bolts, bus bar links etc. fit properly without any strain on any part. No new holes for jointing of the panels other than those recommended by the vendor shall be drilled. No gaps shall be left between the panels. Gap if any found between panels shall be suitably sealed using sealing compound or T-profile. The lifting, racking in and out operation of the breaker and all other motions shall be free from any obstruction.

The panels shall be checked for correct vertical position using Plumb line and spirit levels. The switchboard panels shall be tack welded at suitable intervals to base channel.

After erection of switchboard panels, all uncovered portions of floor cutouts shall be covered with 6 mm thick removable chequered plates finished with floor level. The design of the chequered plates shall be such that the maximum allowable deflection is $L/200$ (where L is the span of the chequered plates in meters) for a live load of 500 kg./sq. meters.

Additional stiffer shall be provided at the bottom if required. Suitable lifting arrangements shall be provided for chequered plates. The chequered plates shall be painted with a coat of red oxide zinc chromate primer after proper surface preparation as per specifications. Where specified, panels' cutouts provided for future use shall be filled with lean concrete.

- 3.1.4 After completion of Installation of switchboards, all the cubicles, switchboard components such as switches, starters, CT and PT chambers, bus bar chamber shall be cleaned and checked for tightness of all the components.

Vacuum circuit breakers shall be checked for integrity of bottle seals. All loosely supplied items shall be fitted up. Bus bar sections or links shall be inserted and where specified, of high

voltage equipment shall be insulated. Interconnection wiring between shipping sections shall be done by contractor.

All the wiring connections shall also be checked. Contact resistance of all bus bar joints and contactors shall be checked. Insulator shall be checked for any damage. All the starters, switches, contacts shall be cleaned with CTC where required.

All the moving parts shall be checked for easy and free movement. Hinges of panel doors shall be lubricated to give free and noise less movement. All openings shall be kept completely closed to avoid ingress of any foreign particles inside the panel.

Functional scheme verification of individual feeder shall be carried out and minor wiring modifications in the panel wiring, if required shall be done as per the directions of Engineer-in-charge. Special attention shall be paid to CT circuits' polarity, wiring continuity and correctness in the protection as well as measurement circuits. Auto transfer scheme shall be simulated and verified. During the course of scheme verification tests, defective components if any shall be taken out, after bringing to the notice of Engineer-in-charge. The same shall be replaced by component supplied by owner.

- 3.1.5 Where switchboard is damp or having a low IR value due to damaged insulators/bushings/any other insulated parts, or any other reason, the entire switchboard shall be dried-up according to the instruction of the Engineer-in-charge for the IR value to improve to a safe level for commissioning. Care shall be taken to protect the surrounding insulation from direct local heating during the drying up process.
- 3.1.6 All the metering instruments, protective relays and other relays and contactors shall be tested as per manufacturer's recommendations and according to the instructions of the Engineer-in-charge. Protection relays shall be inserted and connected and settings adjusted as required by the Engineer-in-charge
- 3.1.7 All moving parts, of closing/tripping mechanism, racking in and racking out mechanism, spouts and shutter closing mechanism shall be checked for proper operation. All the auxiliary contacts of breaker shall be checked-up, cleaned and contact pressure measured.
- 3.1.8 All the control wiring, PTs, bushings, bus bars, other live parts of switchgear, incoming and outgoing cables shall be meggered.
- 3.1.9 Electrical simulation tests shall be carried out for all the protective, alarm and annunciation relays and external interfaces to ascertain proper functioning.
- 3.1.10 Safety insulation mats of approved make and of required voltage grade shall be provided in the sub-station.
- 3.1.11 **Pre-Commissioning Check List**

Before commissioning any switchboard, following points shall be checked and ensured for safe energising of the switchboard:

- i. That the installation of equipment to be commissioned is complete in all respects with its auxiliaries and all other mounting including earthing. Openings in floor within and outside panels have been sealed off. All cover and door gaskets are intact to make the enclosure vermin proof.
- ii. That all the metering instruments have been checked and found in working order. Indicating lamps are healthy and are in correct position. All power and control fuses are of proper rating.

- iii. That the polarity test and ratio test of all the PTs and CTs is complete and phase sequence of CTs conforms to the correct vector group connections. Wiring continuity and correctness are ensured in the protection and measurement circuits. Polarity of D.C. supply for all the circuits is correct.
- iv. That the high voltage tests of incoming and outgoing cables have been conducted and results are satisfactory.
- v. That all the protective relays including both conventional and microprocessor based numerical relays and thermal overload relays/electronic motor protection relays have been tested for secondary injection tests. (Primary injection tests shall be carried out for differential protection, Restricted Earth fault protection at full / reduced current to ensure correctness of complete wiring). Relay settings, status indications, fault annunciations, data logging, display of switchboard SLDs shall be verified from HMI in case the same is provided.
- vi. That IR Value has been recorded for bus bars, circuit breaker, incoming and outgoing cables, control wiring and potential transformers. Where required joint resistance of bus bars have been recorded and found to be satisfactory. All the surroundings and panels have been cleaned and temporary earth leads have been removed.
- vii. Following tests shall be ensured for all CTs
 - Insulation resistance test
 - Ratio test through primary injection
 - Polarity test
 - Knee point voltage for class PS CTs
- viii. Following tests shall be ensured for all PTs
 - Insulation resistance test
 - Ratio test through primary injection
 - Polarity test
- ix. Following tests shall be ensured for all breakers
 - Insulation resistance test
 - Breaker closing, opening sequence using 3 pole timers
 - High voltage test both in open and close condition for HV breaker
 - Contact resistance of all three poles using 100A DC Kit
- x. Following tests shall be ensured for all meters
 - Calibration of meters
 - Functional verification and settings
- xi. Following tests shall be ensured for all relays
 - Secondary injection test
 - Relay settings
 - Timing check with timers
 - Any other test recommend by the supplier
- xii. Following tests shall be ensured for all bus bars
 - Tightness of all nuts/bolts using Torque wrench
 - IR value
 - Contact resistance using 100A DC Kit
 - Cleaning of bus bar chamber using vacuum cleaner
 - Conducting jelly shall be applied on AL/CU joints as per manufacturer's recommendations
 - HV test in case of HV switchboard

- xiii Following tests/Checks shall also be performed on the switchboards
- Functional verification of individual feeders including all spare feeders
 - Simulation test for under voltage tripping of related feeders such as motor feeder, capacitor feeders etc
 - Verification of control supply schemes
 - Stability test for all differential protections
 - Simulation test for bus auto/manual change over scheme
 - Checks for all panel illuminations, indicating lamps, sockets
 - All upstream and down stream interlocks

3.1.12 Bus Ducts

The bus ducts as per issued drawings will be supplied in parts and all the parts shall be assembled and the bus bar connections shall be made at site. The insulators in bus ducts shall be inspected for any possible damage during transit and the defective ones shall be replaced. The insulators shall be cleaned. Contact surface of bus bars, bus bar bolts and nuts shall be thoroughly cleaned. Petroleum jelly shall then be applied and bolted connection made. The bus duct enclosure shall be checked for earth continuity and then earthed at two places. The bus duct shall be properly supported between switchgear and transformer. The opening in the wall where the bus duct enters the switchgear room shall be completely sealed to avoid rain water entry. Expansion joints, flexible connections etc. supplied by the manufacturer of the bus duct shall be properly connected. The bus duct levelling shall be checked with spirit level and pendulum weight.

Pre-commissioning check list

Before commissioning any bus duct, following points shall be checked and ensured for safe energising of the bus ducts

- All joints are tightened using torque wrench
- Cleaning of bus duct chamber with vacuum cleaner
- Silica gel breather shall be connected if supplied. If required, silica gel shall be reactivated as per the instruction of engineer in charge.
- Space heater circuit shall be checked and tripping through thermostat shall be ensured
- Contact resistance shall be measured for all phases/neutral using 100A DC kit
- High voltage test in case of HV bus ducts

3.2 Transformers

Transformers on receipt at site shall be unloaded by means of crane or lifting devices of adequate capacity. All lifting lugs shall be used to avoid unbalanced lifting and undue stresses on lugs. Lifting lugs if any provided for partial lifting (e.g. for active part, conservator) etc. shall not be used for lifting complete transformer. Parts other than those identified for lifting of the transformer shall not be used for lifting. While slinging, care shall be taken to avoid slings touching other parts.

- 3.2.1 Before lifting transformer, it shall be ensured that all cover bolts are tightened fully. In case when it is necessary to use jacks for lifting, projections provided for the purposes of jacking shall be used. Lifting jacks shall not be used under the valves or radiator tubes. For transporting transformers from stores to site, the transformers shall be loaded on a suitable capacity truck or trailer. The transformers shall be properly supported by steel ropes and stoppers on the trailer to avoid tilting of the transformers in transit due to jerks and vibrations. At no instance, the transformer shall be kept on bare ground. Where it is not possible to

unload the transformer directly on a foundation, it shall be unloaded on a properly built wooden sleeper platform. A transformer shall never be left without putting stoppers to the wheels.

3.2.2 Transformers shall be examined, for any sign of damage in transit. Particular attention shall be given to the following in this regard.

- i. Dents on tank wall or cooling tubes, radiators
- ii. Damage to protruding parts like valves, sight glass etc.
- iii. Loosening of bolts due to vibration in transit.
- iv. Cracked or broken bushings.
- v. Oil leakage particularly along welds.

If any thing adverse is noted, the same shall be brought to the notice of Engineer- in- charge.

3.2.3 Contractor shall examine the transformer base, oil pit, fire walls and foundations made by the civil contractor. It shall be ensured that oil spills can not propagate along cable trenches. Any discrepancy noted will be brought to the notice of Engineer- in- charge. Transformers shall be placed on channels or rails over concrete foundations. The transformers shall be levelled, aligned and checked for free movement on the channels or rails. Stoppers shall be provided to the transformers immediately to prevent any movement. Normally transformers upto 1000 kVA rating shall be received duly fitted with radiator tubes, conservator tanks, valves, wheels and other accessories. While the transformers of above 1000 kVA rating may be supplied with loose accessories. All the accessories like radiators, cooling fans, valves, conservator tanks, explosion vent pipe, bushings and other devices which are supplied in different packages shall be checked for any transit damage and cleaned thoroughly before fixing on the transformer. All loosely supplied parts shall be assembled as per manufacturer's instruction manuals/ drawings and documents. All the connections for CTs bushings and other wiring shall be checked for tightness and correctness before replacing the lid or tightening all the bolts. Gravels shall be filled in the transformer bay, soak pit as per requirement.

3.2.4 Topping of transformer with oil

Before topping up with oil, transformer shall be fitted with all accessories such as valves, gauges, thermometers etc. Oil samples shall be taken from each drum and tested for determination of dielectric strength. Any sign of leakage of the barrel or of its having been opened shall be recorded and reported. It is necessary to filter the oil before the transformers are filled. It shall be ensured in oil filling operation that no air pockets are left in the tank and that no dust or moisture enters the oil. All air vents shall be opened. Oil shall be filled through a streamline oil filter using metal hose. To prevent aeration of the oil, the transformer tank shall be filled through the bottom drain valve. In a transformer with conservator tank, the rate of oil flow shall be reduced when the level is almost upto the bottom of the main cover to prevent internal pressure from rupturing the pressure relief-pipe diaphragm. Sufficient time shall be allowed for the oil to permeate the transformers and also for the locked -up air bubbles to escape. Any air accumulation in the buchholz relay shall be released.

3.2.5 Transformer Oil

- i. Sample of oil from the transformer shall be taken from the bottom of the tank.
- ii. **Testing of Oil**
For dielectric test, the oil shall be tested as described in IS: 335. The oil shall also be tested for acidity in accordance with the methods prescribed.

3.2.6 Drying out of the transformers, if required, shall be carried out and record maintained in accordance with IS: 10028. Normally a streamline filter shall be used for drying-up. IR value

versus time of both windings along with OTI/WTI and filtrations machine temperature curve for IR value Vs time shall also be plotted and recorded during the drying-up process.

Precautions when drying

- i. The maximum sustained temperature to which transformer oil may be subjected shall be limited to 80⁰ C.
- ii. The transformer shall be carefully monitored throughout the drying out process and all observations shall be carefully recorded.
- iii. Drying out shall be continued so that the insulation resistance as prescribed in the standard code of practice is attained and the value remains constant for more than 12 hours. However, a minimum number of cycles shall be done for each transformer as found necessary by the Engineer-in-charge. Generally a Megger reading of 2 megohms / kV at 60⁰ C temperature. with a 5 kV Megger may be a rough indication for stopping the dehydration.

3.2.7 The following work on transformers shall be performed by the contractor if specifically called for:

- i. Before finally commissioning the transformer it may sometimes be desired to run it for a few hours on short-circuit, applying a low voltage, approximately equal to the impedance voltage of the transformer. During this process, regular readings of the insulation resistance of the winding to earth and winding to winding and temperature against time shall be recorded.
- ii. Testing of radiator tubes for any leakage and rectifying these by welding / brazing.

3.2.8 Pre-commissioning Check List

Before commissioning of any transformer, the following points shall be checked for safe energisation of the transformer:

- i. All the accessories have been fixed properly and transformer body and neutral are properly earthed. The transformer dehydration is over and results are satisfactory and approved by the Engineer-in-charge. In case transformers are idle for more than one month after dehydration, transformer oil has been given at least two circulations.
- ii. Oil level, in the transformer conservator tank and all the bushings is upto the marked point and the oil has been tested for dielectric strength and acidity.
- iii. Silicagel is in reactivated condition. The breather pipe is clear from any blocking and contains oil upto the proper level.
- iv. The explosion vent diaphragm does not have any dents. Accumulation of any oil and air had been released.
- v. Operation of off-load and on-load tap changers on all the tap positions is satisfactory. The mechanical parts of the on-load tap changer are lubricated. Motor IR value has been taken and found satisfactory. Tap position mechanical indicator on the transformer and tap position indication meter on the control panel are reading the same tap positions. Tap changer limit switches are operating satisfactorily on the maximum and minimum tap positions. On-load tap changer contact pressure and resistance is as per manufacturers recommendations. Oil level of tap changer tank is upto the required level and oil has been tested for dielectric strength. The tap setting on which the off load tap switch is locked shall be recorded. Generally the off-load tap switch shall be kept on nominal tap.

- vi. Buchholz relay has been tested and checked up for any friction in the movement, and floats are free. All the other protective relays, alarm and annunciation relays have been tested.
- vii. Metering equipment has been tested and polarity test of PT's and transformer winding is satisfactory. Phase sequence and connections have been checked for proper vector group.
- viii. Ratio test and winding resistance on all the tap positions is satisfactory.
- ix. Gaps of arcing horns for the bushings where provided are in order and earth connections for the surge diverters have been checked.
- x. Winding and oil temperature thermometer pockets contain oil and the winding and oil temperature settings on dial gauges are in order.
- xi. Transformers fitted with fans for forced air cooling have been checked up for starting and stopping of the fans both in manual and auto mode and air-displacement has been verified.
- xii. Simulation tests for all external interface connection alarm, annunciation and trip circuits have been checked and are in order.
- xiii. Insulation resistance of all the control circuits and IR value of the transformer windings and all the incoming and outgoing cables have been checked.
- xiv. Valves in the cooling system and valve between the buchholz relay and the conservator tank are in open position.
- xv. Setting of all the protective relays is at the desired value and DC Trip supply is healthy.
- xvi. Magnetic, current and magnetic balance test have been conducted
- xvii. Simulation test for WTI,OTI,PRV,OSR
- xviii. Settings of WTI/OTI as per the instruction of the manufacturer
- xix. Earth resistance value for the neutral earthing

3.2.9 Observations after Commissioning

After switching on the transformer the following points shall be observed and recorded.

- i. The inrush magnetizing current and no-load current.
- ii. Alarm, if any, or if any relay flag has operated.
- iii. Voltage and current on all the three phases.
- iv. Transformer hum or abnormal noise.
- v. Circulation of oil and leakages.
- vi. Record current, voltage, cooling air temperature, winding temperature and oil temperature readings, hourly for 24 hours.
- vii. Cable end boxes for any over-heating.

3.3. HV and MV MOTORS

3.3.1 All the motors generally would be erected by the mechanical contractor.

3.3.2 Electrical contractor shall keep the motor space heater energised as per the directions of Engineer-in-charge. Electrical contractor shall measure the insulation resistance of motor windings and PI in case of HV motors. Insulation resistance of the motors shall be measured between the winding of the machine and its frame by means of a 500 / 1000 V Meggar in case of 415 V motors. A minimum value of 1 megohm for 415 V motors shall be considered a safe value. In case of lower I.R. Value, the insulation value shall be improved by any of the following methods as directed by the Engineer-in-charge.

- i. Blowing hot air from external source.
- ii. Putting the motor in oven.
- iii. Placing heaters or lamps around and inside after making suitable guarding and covering arrangements so as to conserve the heat.

In case the insulation is low, the following method of drying has to be adopted, after consultation with Engineer-in-charge. During drying the temperature rise of winding shall not exceed the permissible value for the class of insulation used.

- i. By locking the motor so that it can not rotate and then applying such a low voltage to the stator terminals so as to pass full load current in the stator keeping the stator winding temperature below 90°C . In this case a close watch shall be kept for any possible overheating and I.R. Values vs. temperature shall be plotted and heating continued till I.R. value becomes steady.
- ii. By blasting hot air from external source, Maximum temperature of winding while drying shall be 70°C to 80°C (thermometer) or 90°C to 95°C by resistance method. Heating shall be done slowly first till steady temperature of winding is reached after 4 to 5 hours, and for large machines after 10 hours. A record has to be kept for drying process, with half an hour readings and, till steady temperature is reached. In case it is essential, the drying process can be supplemented by blower.

- 3.3.3 It shall be ensured that the motor leads are correctly connected in the terminal box, as indicated in the 'Name Plate'. The covers of all terminal boxes shall be properly fixed, the gaskets intact. The control circuit shall be tested for proper functioning as per circuit diagram.
- 3.3.4 In case of synchronous machines, slip rings and brush gear shall be polished and brushes shall be fixed in their holders with clearance and pressure as recommended by the manufacturers.
- 3.3.5 Before commissioning, the ventilation and cooling system of the motor must be inspected. In case of motor with forced ventilation the air inlet shall be examined to ensure that it is free from moisture and any foreign material. It shall also be ensured that recommended flow and pressure of air is available to produce the required cooling effect.
- 3.3.6 The motor control gear shall also be carefully examined, the over-load settings may be reduced or time lags bypassed from protective gear to ensure rapid tripping of switchgear in event of faults. The direction of rotation of a new motor specially of large capacity, and phase sequence of supply shall be kept in view while joining and connecting to the motor terminals
- 3.3.7 Finally the motor shall be started on no-load after decoupling, and shall be allowed to run for a minimum period of 4 hours, or for a time as instructed by Engineer-in-charge. Attention shall be given to the proper running of the bearings, vibration or unusual noises if any. Voltage, starting current, no load current, stator winding and bearing temperature shall be recorded after every 1 hour during this test. Direction of rotation shall be checked and recorded. Normally the motors run in clockwise direction as viewed from the driving end with reference to the phase sequence R, Y, B.
- 3.3.8 After switching off the motor, the insulation resistance of the motor shall be recorded under hot and cold conditions.
- 3.3.9 If the no load test run is found satisfactory, the motor shall be allowed to run for 8 hours and all readings shall be recorded.
- 3.3.10 The following work on motors, may be performed by the contractor if specifically called for.

- i. The proper level of bearing oil has to be checked. The condition of grease in bearings shall be checked and in case it is necessary, complete replacement of bearing with specified grade of grease after proper cleaning of the bearing shall have to be done. Wherever external greasing facility exists, the condition of grease may be checked by pumping some new grease of specified grade at start. If the grease coming out is deteriorated grease shall be replaced.
- ii. All the motors, motor exciter set and induction generators directly coupled or coupled through reduction gears shall be checked for abnormal vibration, if any Large rated HV motors with journal type bearings are liable to get damaged from shock, rough handling during transit. Any minor defect in a race or roller may give rise to considerable amount of vibration and noise. Contractor shall check and bring to the attention of Engineer-in-charge any defect noticed in this regard.
- iii. Due care shall be taken to avoid any damage to bearing insulation wherever provided.

3.4. Batteries/Battery charger

Battery (Lead acid, Nickel Cadmium or VRLA type as specified) shall be erected on stands and insulators supplied by the manufacturer of the batteries. The installation shall be done as per the layout drawings and manufacturer's instructions. Electrolyte if required / as applicable shall be filled as per manufacturer's instructions. Interrow connections shall be made with the leads supplied by the manufacturer. Functional check shall be done on the battery charger including battery charging and discharging, recharging as per the recommendation of the manufacturer.

3.5. Neutral Earthing Resistor

The neutral earthing resistor shall be inspected for any damage to the resistor grid and other components. The resistor shall be levelled and installed. All covers etc. shall be checked for tightness to ensure that the enclosure of the resistor is dust, vermin and weatherproof. Earthing conductors shall be taken from the out end terminal of the resistor, for connection to earth electrodes and to the main grid. Check such as IR, operation of space heater, earth resistance shall be done before the commissioning.

3.6 Welding Receptacles

The welding receptacles shall be erected on steel/concrete structures as per the drawings. In isolated places a separate support shall be fabricated and installed.

3.7 Push Button/Control Stations

The push buttons / control stations shall be installed near to the motors to be controlled. Individual channel supports shall be installed as per EIL standard. If control stations for hazardous areas are to be supplied by contractor, these shall be of Ex (d) type, tested by CIMFR and approved by CCoE or other applicable certifying authorities. All outdoor push buttons / control stations shall preferably have integral canopies for additional weather protection. The canopy shall be made of 2 mm thick galvanized sheet steel or FRP where these are not integral with the equipment.

3.8 Gang operated Isolators/outdoor Disconnectors

The isolators shall be transported to site in the dismantled condition. All the insulators may be also supplied loose. The contractor shall inspect, clean, assemble and install the isolator on the base structure previously fabricated, erected and levelled by him. The operating mechanism

shall be installed on the structure and connected to the isolator poles. The operating mechanism shall be tested by slowly bringing the isolator to the closed position and carrying out the necessary adjustment as per the manufacturer's instructions. The earthing switches, frames and operating handle etc. shall be earthed.

3.9 Contractor shall provide the following items in substation, as per CEA Regulations.

3.9.1 Fire buckets filled with clean dry sand and ready for immediate use for extinguishing fires and fire extinguisher (carbon dioxide, dry chemical extinguisher etc.) suitable for dealing with electric fires shall be conspicuously marked and kept.

3.9.2 First aid boxes containing ointments and medicines for immediate treatment of injuries (As prescribed by Indian Red Cross Society or equivalent).

3.9.3 Instructions of restoration of persons suffering from electric shock in English, Hindi and local language of the district shall be affixed in a conspicuous place.

3.9.4 Danger boards (HV., MV.) shall be provided on transformer bay gate, switchboards, entrance to switchgear room and at other places as required by Engineer-in-charge.

3.10 The Communication system and Fire alarm system panels and equipment shall be installed complying to manufacturer's instructions. The location of field station (call back station unit, break glass unit, telephone set etc.) shown on the drawing are indicative. The exact location shall be decided at site by contractor in consultation with Engineer-in-charge. Correct type of equipment with regard to hazardous protection as specified on drawing shall be adhered to by contractor, for installation.

4.0 EQUIPMENT COMMISSIONING

4.1 Field inspection, testing and commissioning of the complete electrical installation shall be carried out as per EIL specification no. 6-51-0087.

After the equipment is installed properly in accordance with drawings and specifications, contractor shall carry out all pre-commissioning checks and tests as per EIL format in the presence of Engineer-in-charge and test readings shall be recorded and furnished to EIL in triplicate.

4.2 All equipment layout drawings shall be marked by the Contractor for "AS BUILT STATUS" and two sets of hard copies shall be submitted to EIL.

5.0 LIST OF CONSTRUCTION EQUIPMENT

The contractor shall have all necessary construction equipment, tools and tackles and testing instruments to carry out the erection works and to commission the system as specified. These shall include but not be limited to the following, and these shall be brought to site by contractor before the start of work.

5.1 Equipment

- i. Portable grinder.
- ii. Portable welding machine.
- iii. Portable gas cutting / welding set.
- iv. Pipe threading machine.
- v. Pipe bending machine (hydraulic).

- vi. Portable drill machine suitable to take up drilling for different sizes as per requirement.
- vii. Dewatering pump sets (diesel driven).
- viii. Power Hacksaw.
- ix. Conduit dye set.
- x. Hydraulic crimping machine with round/hexagonal dye set.
- xi. Hand crimping tool.
- xii. Portable electric blowers, vacuum cleaners.
- xiii. Miscellaneous items such as slings, pulleys, tarpaulins, wooden sleepers, ladders. etc. as required.
- xiv. Safety belts, safety goggles, and gloves.
- xv. Separate tool kit for each Electrician.
- xvi. Hydraulic/Hand held grease gun

5.2 Test Instruments

- i. Insulation tester 1000 V hand driven.
- ii. Insulation tester 2500 V motor/hand driven.
- iii. Insulation tester 5000 V motor/hand driven
- iv. Phase sequence indicator.
- v. Earth Resistance tester.
- vi. Single phase variac
- vii. 3 phase variac of adequate capacity.
- viii. Secondary and primary injection testing kit.
- ix. Multimeter, both analogue and digital
- x. Portable Ammeters, Wattmeters, P.F. meters.
- xi. Portable Voltmeters.
- xii. Clip on meters of different ranges.
- xiii. Tacho-meter.
- xiv. Kelvins double bridge for measurement of very low resistance.
- xv. D.C. high -pot test kit.
- xvi. A.C. high -pot test kit.
- xvii. Oil filtration machine of adequate capacity.
- xviii. Lux Meter to measure illumination levels.
- xix. Breaker timing 3 pole kit
- xx. Timers
- xxi. 100A DC milli volt drop(Contact resistance) kit
- xxii. Vibration measuring Instrument
- xxiii. Thermo meters

विद्युत संस्थापनों के साइट निरीक्षण, परीक्षण व कमीशनिंग के लिए विनिर्देश

SPECIFICATION FOR FIELD INSPECTION, TESTING AND COMMISSIONING OF ELECTRICAL INSTALLATIONS

3	10.6.14	REAFFIRMED & ISSUED AS STANDARD SPECIFICATION	AKG	SA	BRB	SC
2	03.03.09	REVISED & ISSUED AS STANDARD SPECIFICATION	RKS	NS	JMS	ND
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Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

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

Electrical Standards Committee

Convenor: Mr. BR Bhogal

Members: Ms. S. Anand
Mr. Parag Gupta
Mr. M.K. Sahu
Mr. A.K. Chaudhary (Inspection)
Ms. N.P. Guha (Projects)

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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 CCoE/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. 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

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 the 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

3.12.6 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

3.12.7 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.

Rated Voltage of Cable (kV) U_0 / U^*	TEST VOLTAGE (kV) BETWEEN		Duration (Minutes)
	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_0 : 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.

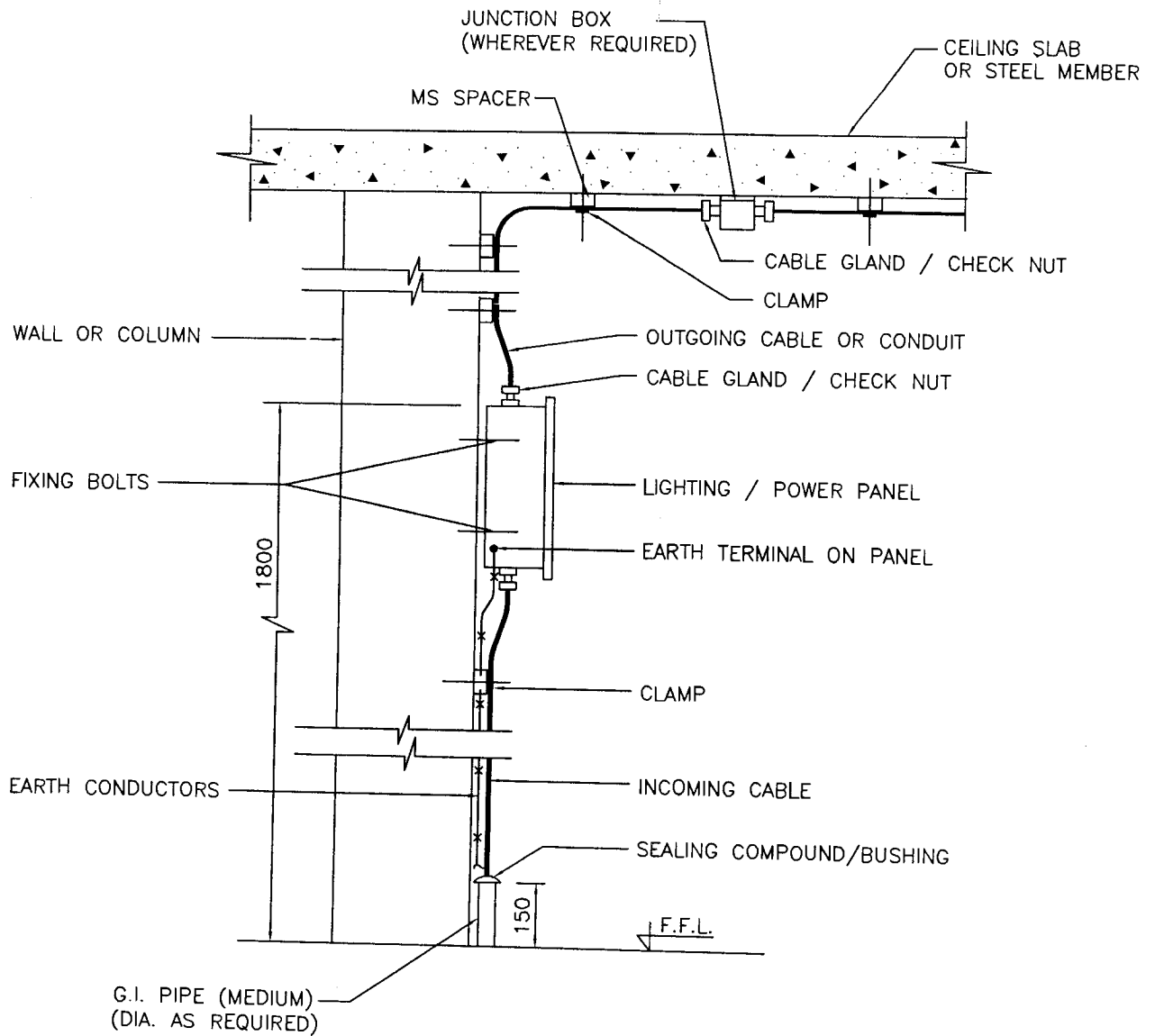
Rated Voltage (rms Value in kV)	Rated 1 Min. Power Frequency Withstand Voltage (rms Value in kV)		Duration in Minutes
	To Earth, Between Poles and Across Open Switching Device	Across the Isolating Distance	
U			
3.6	10	12	1
7.2	20	23	1
12	28	32	1
24	50	60	1
36	70	80	1
72.5	140	160	1

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.

- 3.14 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

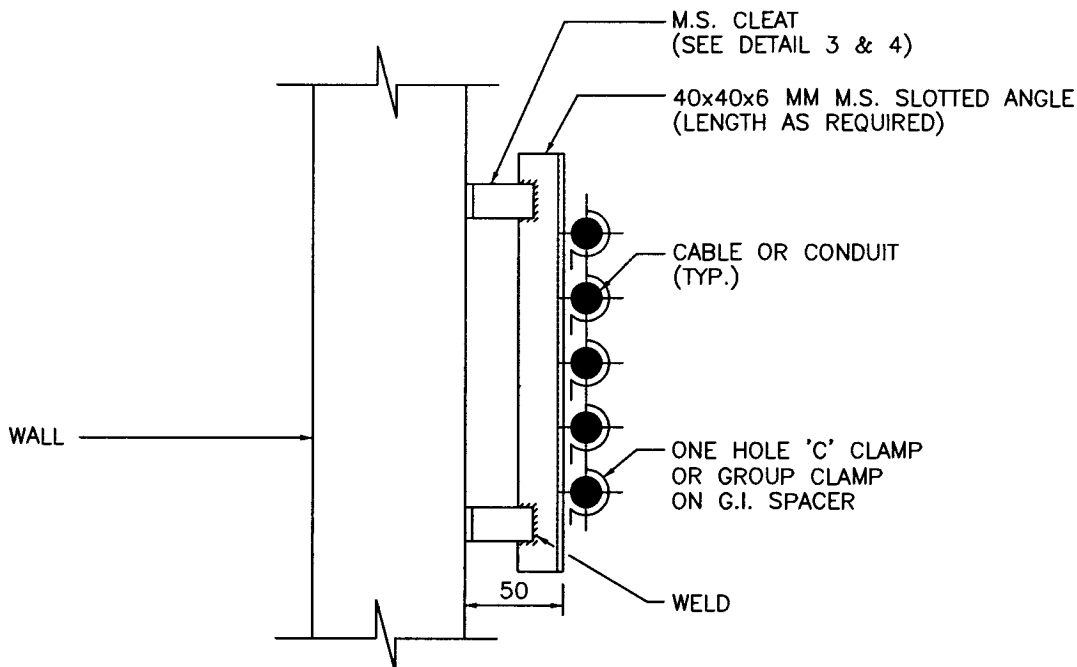
Contractor shall keep up-to-date records of all activities carried out and test results. Field inspection / test reports shall be submitted to EIL / Owner by the contractor in bound volumes (triplicate copies).



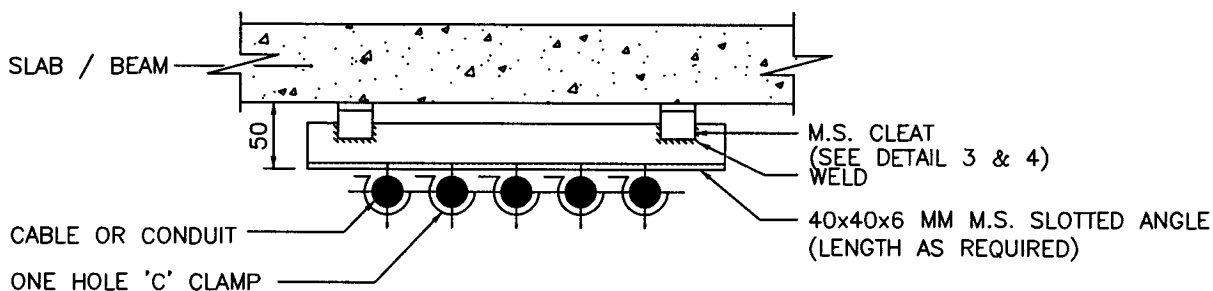
NOTES:-

1. ALL DIMENSIONS ARE IN MM.

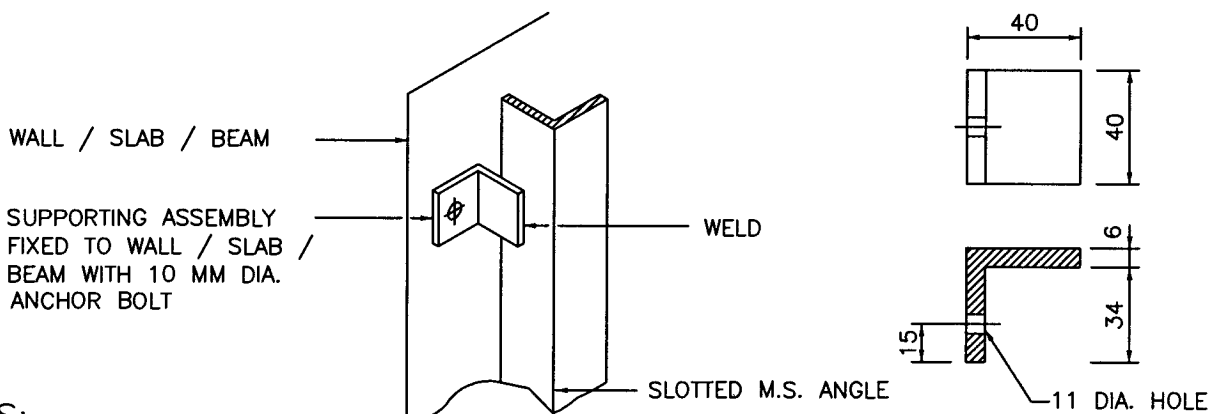
4	17.07.13	REAFFIRMED & ISSUED AS STANDARD	BP	FA/SA	UAP/JMS	DM
3	15.12.08	REAFFIRMED & ISSUED AS STANDARD	BP	RKS/NS	JMS	VC
Rev. No.	Date	Purpose	Prepared by	Checked by	Convenor	Stds. Bureau Chairman
Approved by						
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DETAIL-1
SUPPORT ON WALL



DETAIL-2
SUPPORT ON SLAB / BEAM



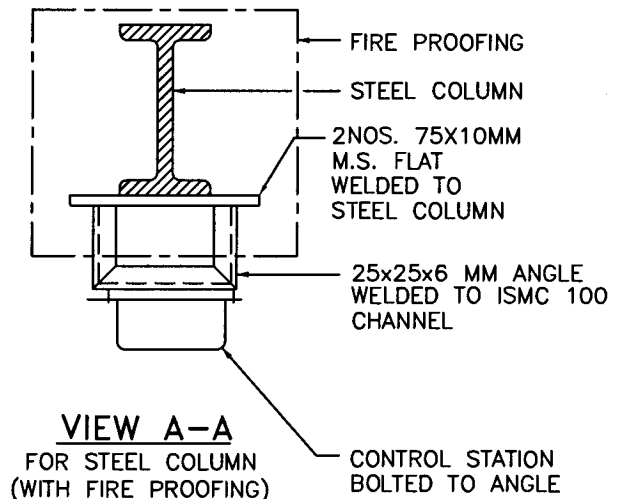
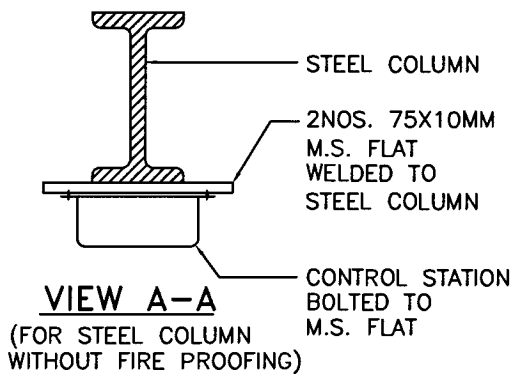
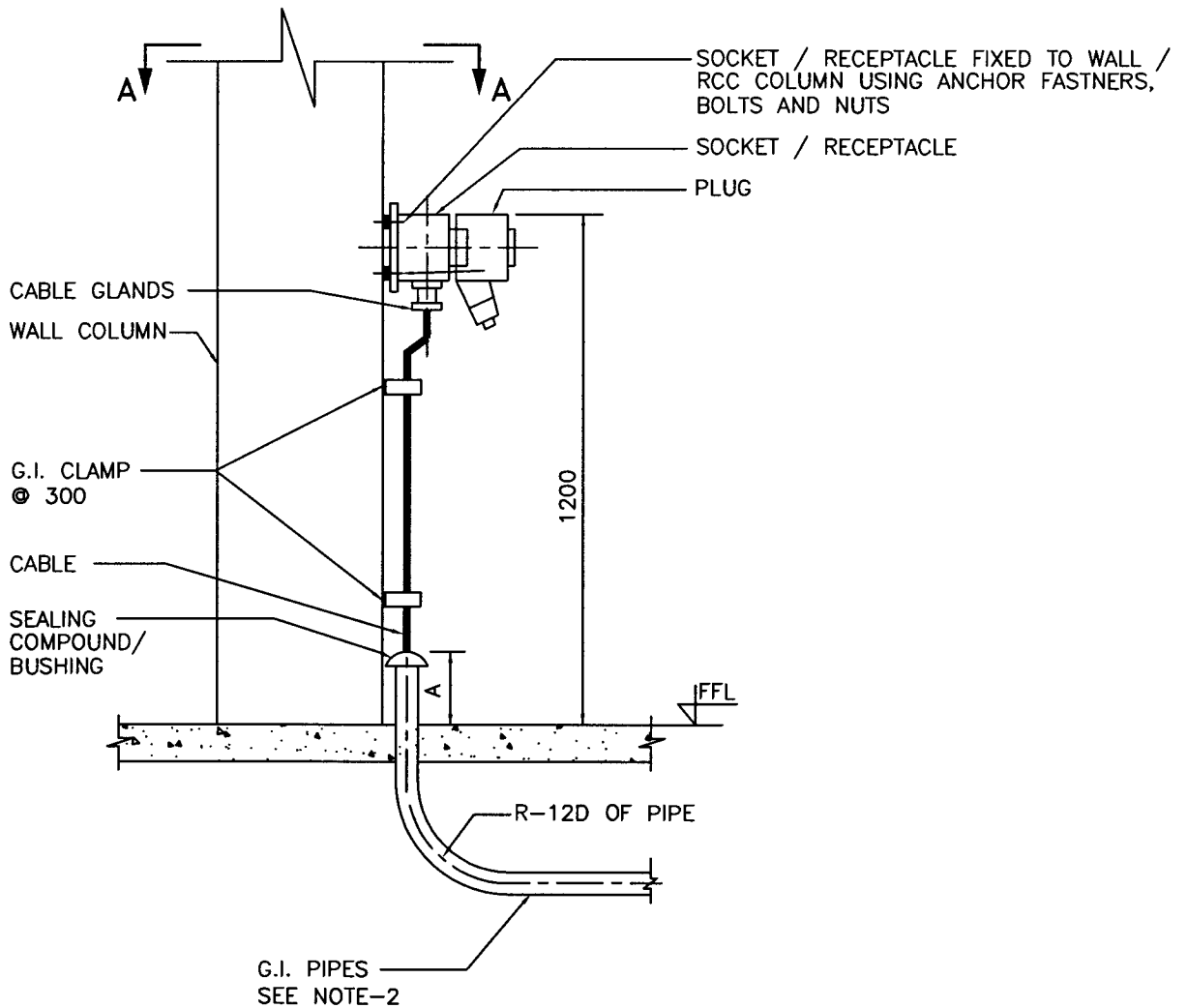
NOTES:-

1. ALL DIMENSIONS ARE IN MM.

DETAIL-3

DETAIL-4
M.S. CLEAT

4	21.11.13	REAFFIRMED & ISSUED AS STANDARD	BP	FA/SA	UAP/JMS	SC
3	15.12.08	REAFFIRMED & ISSUED AS STANDARD	BP	RKS/NS	JMS	VC
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Approved by						



A = $\begin{cases} 150 \text{ MM (MIN.) FOR INDOOR LOCATIONS.} \\ 300 \text{ MM (MIN.) FOR OUTDOOR LOCATIONS.} \end{cases}$

NOTES:—

1. ALL DIMENSIONS ARE IN MM.
2. QUANTITY AND SIZE OF PIPE SLEEVES SHALL BE AS PER LAYOUT DRAWINGS.

4	21.11.13	REAFFIRMED & ISSUED AS STANDARD	BP	FA/SA	UAP/JMS	SC
3	13.02.09	REAFFIRMED & ISSUED AS STANDARD	BP	RKS/NS	JMS	VC
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