

STANDARD SPECIFICATION FOR ELECTRICAL (GENERAL) WORKS

**EASTERN RAILWAY / HOWRAH DIVISION
ELECTRICAL (GENERAL) DEPARTEMENT**

PART - I : LOW TENSION (LT)

PART - I (LT)

Chapter I	: General
Chapter II	: Wiring and Accessories
Chapter III	: LT Panel
Chapter IV	: LT Cable

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Part - I **Chapter - I**

Technical

1. Jointing of cable in wiring system inside the conduit should not be allowed. Jointing / terminating of cable in wiring system inside the JB / SB with adhesive insulating tape should not be allowed. Instead of adhesive tape connector should be used.
2. Terminal connection of cable in MCBs, MCCBs, switches, MCB DBs & other items where necessary, suitable size and capacity of socket / lug of Copper / Aluminium as per requirement should be used.

General

1. Wiring / rewiring work to be done by skilled workmen.
2. In case of any accident during execution of work Railway authority will not be responsible / liable.
3. During execution of work, proper tools and tackles should be used by workmen.
4. During execution of work, proper safety aspect should be strictly followed as per electricity rule.
5. Damaged surface during execution of work should be repaired / make good by the firm.
6. Released materials if any during execution should be handed over to respective Sr.SEE(G).

Part - I
Chapter - II

WIRING AND ACCESSORIES

2.1 This chapter covers detailed specification of following schedule items :

1.	Wiring of Light points, fan points, plug points 6A/16A for indoor applications including PVC pipe, pvc Casing-Capping and concealed type of wiring
2.	Wiring of main, sub-main
3.	Fixing of indoor fittings
4.	Fixing of Fans

2.2 GENERAL CONDITIONS :

- a. Before starting wiring work approval of site supervisors shall be obtained regarding layout, no. of points to be wired and location of switchboards etc.
- b. All wiring shall be done with HRFR (Heat resistant fire retardant) grade, single core, PVC insulated cooper conductor of 1100V grade, conforming to IS 649-1990 of different sizes mentioned in the schedule.
- c. All switchboards shall be of PVC box/MS/GI box type and no wooden switchboards shall be used.
- d. The wiring shall be done from a distribution system through main and/or branch distribution boards. The system design and location of boards will be properly worked out and approved by site supervisor.
- e. Each main distribution board and branch distribution board shall be controlled by an incoming circuit breaker/linked switch with fuse. Each outgoing circuit shall be controlled by a circuit breaker/switch with fuse.
- f. For non-residential buildings, as far as possible, DBs shall be separate for light and power.
- g. Only MCCB/MCB/HRC fuse type DBs shall be used. Rewireable type fuses shall not be used.
- h. Three phase DBs shall not be used for final circuit distribution as far as possible.
- i. 'Power' wiring shall be kept separate and distinct from light wiring, from the level of circuits(Sub-main), i.e., beyond the branch distribution boards. Conduits for light/power wiring shall be separate.
- j. Essential/non-essential/UPS distribution each will have a completely independent and separate distribution system starting from the main, switchboard up-to final wiring for each system.
- k. Generally, no switchboard will have more than one source of incoming supply.
- l. Each MDB/DB/Switch Board will have spare outgoing ways for future expansion

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2.3 MAKE OF COMPONENTS OF WIRING :

The materials used for wiring shall be of following make only :

Wires/Cables	HRFR grade Copper	Anchor/KDK/Havells/Finolex/Gloster/KEI/ Polycab/RR Kabel
Switches/sockets/ceiling rose	Modular/piano	Anchor/Crabtree or as per scope of work
Conduits	As per IS	ISI marked or as per scope of work
Switch boxes etc.		ISI marked or as per scope of work
Indication lamps	LED type	Binay/ISI marked or as per scope of work
MCBs/ELCB/RCCB		L&T/Siemens/ABB/Schneider or as per scope of work

2.4 WIRING :

2.4.1 Main & Sub-main wiring :

- a. **Main wiring:** Main wiring shall mean the wiring from one main/distribution switchboard to another.
- b. **Sub-main wiring:** Sub main wiring shall mean the wiring from the distribution board to the 1st tapping point inside the switch box, from where point wiring starts.

2.4.2. Measurement of sub main and main wiring :

- a. Main and sub-main wiring shall be measured on linear basis along the run of the wiring. The measurement shall include all lengths from end to end of conduit or channel as the case may be, exclusive of interconnections inside the switchboard etc.
- b. The length of sub main wiring with two wires shall be measured from the distribution board to the nearest switch box from which the point wiring starts.
- c. When wires of different circuits are grouped in a single conduit/ channel, the same shall be measured on linear basis depending on the actual number and sizes of wires run and not by length of conduit.
- d. Conduit carrying main will not carry sub-main/point wiring. Similarly conduit carrying sub-main wiring will not carry main/point wiring. Conduit carrying point wiring will not carry sub-main/main wiring.

2.4.3 Point wiring:

2.4.3.1 Definition : A point (other than plug point) shall include all work necessary in complete wiring to the following outlets from the controlling switch or MCB:

- a. Ceiling rose or connector (in the case of points for ceiling/exhaust fan points, prewired light fittings, and call bells).

b. Ceiling rose (in case of pendants except stiff pendants).
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c. Backplate (in the case of stiff pendants).

d. Lamp holder (in the case of goose neck type wall brackets, batten holders and fittings which are not prewired).

2.4.3.2 Scope :

Point Wiring shall include :

- a. Conduit/channel as the case may be, accessories for the same and wiring cables between the switch box and the point outlet, loop protective earthing of each fan/light fixture.
- b. All fixing accessories such as clips, screws, Phil plug, rawl plug etc. as required.
- c. Metal or PVC switch boxes for control switches, regulators, sockets etc, recessed or surface type, and phenolic laminated sheet covers over the same.
- d. Outlet boxes, junction boxes, pull-through boxes etc. but excluding metal boxes if any, provided with switchboards for loose wires/conduit terminations.
- e. Control switch or MCB, as specified.
- f. 3 pin or 6 pin socket, ceiling rose or connector as required.
- g. Connections to ceiling rose, connector, socket outlet, lamp holder, switch etc.
- h. Bushed conduit or porcelain tubing where wiring cables pass through wall etc.

2.4.3.3 Measurement of point wiring:

These shall be measured on unit basis by counting.

2.4.3.4 Point wiring for plug points:

- a. The 6 A plug point and 16 A plug point wiring shall be measured on unit basis.
- b. 16A plug points shall be mounted on separate board. 6 A plug point can be mounted on light/fan point switch board or separately. Not more than 1(one) 6A plug point will be allowed on common switch board.
- c. The 6A plug point wiring shall include, controlling switch, socket and necessary wiring from sub main including earthing of third pin.
- d. The 16A plug point wiring shall include separate board as approved consisting of controlling switch, socket, MCB/fuse kitkat, earthing and indication lamp

2.4.3.5 PF shed, Concourse and other big halls/sheds requiring Group Control of Light and fan : Wiring is required at PF sheds, concourse and other big halls/sheds shall be treated as sub main wiring except that junction box shall be provided at the point where fitting/fan is to be provided. This shall be controlled by MCB in DB or separate control as required at site.

2.4.4 System of wiring :

- a. Wiring shall be done only by the looping system. Phase/live conductors shall be looped at the switch box. For point wiring, neutral wire/earth wire looping for the 1st point shall be done in the switch box; and neutral/earth looping of subsequent points will be made from point outlets.

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- b. In wiring, no joints in wiring will be permitted anywhere, except in switch box or point outlets, where jointing of wires will be allowed with use of suitable connector.
- c. The wiring throughout the installation shall be such that there is no break in the neutral wire except in the form of linked switchgear.
- d. Colour coding:- Following colour coding shall be followed in wiring:-

Phase Red/Yellow/Blue.(Three phase wiring)

Live Red (Single phase wiring)

Neutral Black

Earth Green/Yellow-green.

- e. Termination of Sub main circuit into switchboard:- Sub-main (Circuit) will consist of phase/neutral/earth wire. Sub-main (Circuit) will terminate in a switch board (first tapping point, where from point wiring starts) in following manner:-
 - i. Phase wire terminated in phase connector. Neutral wire terminated in neutral connector. Earth wire terminated in earth connector.
 - ii. The switchboard will have phase neutral and earth terminal connector blocks to receive phase/ neutral/earth wire.

2.4.5 Run of wiring :

- a. The type of wiring shall be as specified in the tender documents/detailed at site namely, surface conduit/concealed conduit, MS/PVC, channel (Casing/Capping).
- b. Surface wiring shall run as far as possible along the walls and ceiling, so as to be easily accessible for inspection.
- c. Above false ceiling, in no case, open wiring shall be allowed. Wiring will be done in recessed conduit or surface steel conduit.
- d. In concealed conduit system, routes of conduit will be planned, so that various inspection boxes provided don't present a shabby look. Such boxes can be provided 5 mm above plaster level, and they can be covered with plaster of paris with marking of junction boxes.
- e. Generally conduits for wiring will not be taken in floor slabs.

2.4.6 Passing through walls or floors :

When wiring cables are to pass through a wall, these shall be taken through a protection (steel/PVC) pipe or porcelain tube of suitable size such that they pass through in a straight line without twist or cross in them on either end of such holes. The ends of metallic pipe shall be neatly bushed with porcelain, PVC or other approved material.

All floor openings for carrying any wiring shall be suitably sealed after installation.

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2.4.7 Joints in wiring :

- a. No bare conductor in phase and/or neutral or twisted joints in phase, neutral, and/or protective conductors in wiring shall be permitted.
- b. There shall be no joints in the through-runs of cables. If the length of final main or sub-main is more than the length of a standard coil, thus necessitating a through joint, such joints shall be made by means of approved mechanical connectors in suitable junction boxes.
- c. Termination of multi stranded conductors shall be done using suitable crimping type thimbles.

2.4.8 Capacity of Circuits (Sub-main) :

- a. Lighting circuit from each sub main shall feed light/fan/call bell points. Each circuit shall not have more than 800 Watt connected load or more than 10 points. However, in case of CFL points where load per point may be less, number of points may be suitably increased.
- b. Power sub main circuit will have only one 16A outlet per circuit. Not more than 3 Nos. 6A outlets outlet shall be allowed from one sub-main.
- c. All Loads more than 1 KW each shall be controlled by suitably rated MCB and cable size shall be decided as per calculations.

2.4.9 Plug Points (Socket outlets):

- a. Socket outlets shall be 6Amp 3 pin, 16 Amp 3 pin or 16/6 Amp 6 pin. 5 pin socket outlets will not be permitted. The third pin shall be connected to earth through protective (loop earthing) conductor, 2 pin or 5 pin sockets shall not be permitted to be used.
- b. Conductors connecting electrical appliances with socket outlets shall be of flexible type with an earthing conductor for connection to the earth terminal of plug and the metallic body of the electrical appliance.
- c. Sockets for the power outlets of rating above 1KW shall be normally of industrial type unless otherwise specified at site with associated plug top and controlling MCB.
- d. Where specified, shutter type (interlocking type) of sockets shall be used.
- e. Every socket outlet shall be controlled by a switch or MCB, as specified. The control switch/MCB shall be connected on the 'live' side of the line.
- f. 5A/6A and 15A/16A socket outlets shall be installed after site approval from site supervisor.
- g. Bathroom – Normally no socket outlet is permitted for connecting a portable appliance. MCB/IC switch may be provided above 2 m for fixed appliances like geyser etc., and at least 1 m away from shower.
- h. Normally the control switches for the 6A and ,16A socket outlets shall be kept along with the socket outlets.

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2.4.10 Cables for Wiring:

- a. Copper conductor cable only will be used for submain/main/point wiring.
- b. Minimum size of wiring:

Light/Fan/calbell point Wiring:	1.5 sq.mm.
Power Wiring/Sub-main:	4.0 sq.mm.
Main wiring	10.0 sq. mm
- c. Insulation: Copper conductor cable shall be PVC insulated, Fire retardant, (HRFR) grade type conforming to BIS Specification.

2.4.11 Wiring Accessories :

- a. **Control switches for point:** Control switches (single pole switch) carrying not more than 16A shall be **normally modular** type. Switches of piano type/modular type of specified make shall be used as per direction of site supervisor. Quarters Type-III and above, air-conditioned rooms, offices of supervisor and officers and public image area shall be provided with modular switch only. Modular type switches of specified make along with matching mounting boxes shall be used. Modular type sockets, stepped type fan regulators shall be used. All such boxes, switches and accessories shall be of same make of modular switch manufacturer. Double pole MCB in proper enclosure as power out let for window type AC units, geysers etc shall be provided.
- b. **Switch Box:** Switch box shall be hot dip galvanized, factory fabricated. Suitable in size for surface/ recess mounting and suitable in size for accommodating the required number of switches and accessories (where required to be used for applications other than modular switches/ sockets).
Switch box also can be of non-metallic material. The technical sanctioning authority will approve specified makes of reputed quality and specifications.
- c. **Switch box covers** (for application other than modular type): Phenolic laminated sheets of ivory white shade shall be used for switch box covers. These shall be of 3mm thick synthetic phenolic resin bonded laminated sheet as base material and conforming to grade P-I of IS: 2036 - 1974.
- d. **Ceiling rose:**
 - i. A ceiling rose shall not be used on a circuit, the voltage of which normally exceeds 250V.
 - ii. Only one flexible cord shall be connected to a ceiling rose.

2.4.12 Attachment of fittings and accessories :

- a. Conduit wiring system: All accessories like switches, socket outlets, call bell pushes and regulators shall be fixed in flush pattern inside the switch/regulator boxes. Accessories like ceiling roses, brackets, batten holders etc. shall be fixed on outlet boxes. The fan regulators may also be fixed on outlet boxes, if so directed by the Engineer- in-charge.
- b. Aluminium alloy or cadmium plated iron screws shall be used to fix the accessories to their bases.

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- c. The switch box/regulator box shall normally be mounted with their bottom 1.25m from floor level, unless otherwise directed by the site- in-charge.
- d. Fixing to walls and ceiling: Wooden plugs for fixing to wall/ceiling will not be allowed. Fixing will be done with the help of PVC sleeves/Rowel plugs/ dash fasteners as required.
- e. Drilling of holes shall be done by drilling machines only. No manual drilling of hole will be allowed

2.5 CONDUIT SYSTEM :

2.5.1 Conduit Wiring System with Rigid Non-Metallic (PVC) Conduits /Casing & Capping

- a. Rigid non-metallic (PVC) conduits are used for surface, recessed and concealed conduit wiring. Cable trunking and ducting system of insulating material are used for surface wiring.
- b. **Type and size** :All non-metallic conduits used shall conform to accepted standards (IS : 2667, IS:3419, IS:9537 Pert-I II III). The conduit may be either threaded type or plain type in accordance with accepted standards (IS : 2667, IS:3419, IS:9537 Pert-I II III) and shall be used with the corresponding accessories.. The interior of the conduits shall be free from obstructions. The rigid conduit pipes shall be ISI marked
- c. The conduits shall be circular in cross-section. The conduits shall be designated by their nominal outside diameter. The dimensional details of rigid non-metallic conduits are given in Table-III
- d. **Bunching of cables** :The number of insulated cables that may be drawn into the conduits are given in Table I and Table 2.
- e. **Conduit joints** :Conduits shall be joined by means of screwed or plain couplers depending on whether the conduits are screwed or plain. Where there are long runs of straight conduit, inspection type couplers shall be provided at intervals. For conduit fittings and accessories reference may be made to the good practice (IS : 2667, IS:3419, IS:9537 Pert-I II III).
- f. **Fixing of conduits** : Conduit pipes shall be fixed by heavy gauge saddles, secured to suitable PVC plugs with screws in an approved manner at an interval of not more than 600mm, but on either side of couplers or bends or similar fittings, saddles shall be fixed at a distance of 300 mm from the centre of such fittings except that the spacing between saddles or supports is recommended to be 600 mm for rigid non-metallic conduits.
- g. **Bends in conduits** : Wherever necessary, bends or diversions may be achieved by bending the conduits or by employing normal bends, inspection bends, inspection boxes, elbows or similar fittings.
- h. Conduit fittings shall be avoided, as far as possible, on outdoor systems.

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- i. **Outlets** :In order to minimize condensation or sweating inside the conduit, all outlets of conduit system shall be properly drained and ventilated, but in such a manner as to prevent the entry of insects.
- j. Heat may be used to soften the conduit for bending and forming joints in case of plain conduits. As the material softens when heated, sitting of conduit in close proximity to hot surfaces should be avoided.
- k. **Fixing of conduit in chase (concealing in plaster of wall)** :The conduit pipe shall be fixed by means of stapples or by means of non-metallic saddles placed at not more than 80 cm apart or by any other approved means of fixing. Fixing of standard bends or elbows shall be avoided as far as practicable and all curves shall be maintained by sending the conduit pipe itself with a long radius which will permit easy drawing in of conductors. At either side of bends, saddles/stapples shall be fixed at a distance of 15 cm from the centre of bends.
- l. **Inspection boxes (for concealed wiring)**:Suitable inspection boxes to the nearest minimum requirements shall be provided to permit periodical inspection and to facilitate replacement of wires, if necessary. The inspection/junction boxes shall be mounted flush with the wall or ceiling concrete. Where necessary deeper boxes of suitable dimensions shall be used. Suitable ventilating holes shall be provided in the inspection box covers, where required.

Table 1
Maximum No. of single core cables in Rigid metallic/non metallic conduit

Size of wires		Size of conduit (dia in mm)						
mm ²	no. & dia	16	20	25	32	40	50	60
1.5	1/1.4	3	5	10	14			
2.5	3/1.06	2	5	8	12			
4	7/0.85	2	3	8	10			
6	7/1.06		2	5	8			
10	7/1.40			3	5			
16	7/1.70				3	6		
25	7/2.24				2	6		
35	7/2.50					4	6	7
50	19/1.80					3	5	6

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Table 2
Maximum Number of Single-Core Cables that can be Drawn into Casing and Capping

Size of wires		Size of Casing					
Mm ²	no. & dia	10/15mm x 10 mm	20mm x 10 mm	25mm x 10mm	30mm x 10mm	40mm x 20mm	50mm x 20mm
1.5	1/1.4	3	5	6	8	12	18
2.5	3/1.06	2	4	5	6	9	15
4	7/0.85	2	3	4	5	8	12
6	7/1.06		2	3	4	6	9
10	7/1.40		1	2	3	5	8
16	7/1.70			1	2	4	6
25	7/2.24				1	3	5
35	7/2.50					2	4
50	19/1.80					1	3
70						1	2

2.5.2 Surface Conduit Wiring System with Rigid Steel Conduits (MS/GI pipe) :

- a. Type and size of conduit - All conduit pipes shall conform to accepted standards (IS : 2667, IS:3419, IS:9537 Pert-I II III), finished with galvanized or stove enamelled surface. All conduit accessories shall be of threaded type and under no circumstance pin grip type or clamp type accessories be used. No steel conduit less than 16 mm in diameter shall be used. The number of insulated conductors that can be drawn into rigid conduit are given in Tables 1 and 2.
- b. Conduit joints - Conduit pipes shall be joined by means of screwed couplers and screwed accessories only. In long distance straight runs of conduit, inspection type couplers at reasonable intervals shall be provided or running threads with couplers and jam-nuts (in the latter case the bare threaded portion shall be treated with anti-corrosive preservative) shall be provided.
- c. Protection of conduit against rust - The outer surface of the conduit pipes, including all bends, unions, tees, conduit system shall be adequately protected against rust particularly when such system is exposed to weather. In all cases, no bare threaded portion of conduit pipe shall be allowed unless such bare threaded portion is treated with anti-corrosive preservative or covered with suitable plastic compound.
- d. Fixing of conduit - Conduit pipes shall be fixed by heavy gauge saddles, secured to suitable wood plugs or other plugs with screws in an approved manner at an interval of not more than 1 m, but on either side of couplers or bends or similar fittings, saddles shall be fixed at a distance of 300 mm from the centre of such fittings.
- e. Bends in conduit - All necessary bends in the system including diversion shall be done by bending pipes; or by inserting suitable solid or inspection type normal bends, elbows or similar fittings; or fixing cast iron, thermoplastic or thermosetting plastic material inspection boxes whichever is more suitable. .

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- f. Erection and earthing of conduit - The conduit of each circuit or section shall be completed before conductors are drawn in. The entire system of conduit after erection shall be tested for mechanical and electrical continuity throughout and permanently connected to earth conforming to the requirements as already specified by means of suitable earthing clamp efficiently fastened to conduit pipe in a workman like manner for a perfect continuity between each wire and conduit.
- g. Inspection type conduit fittings, such as inspection boxes, draw boxes, bends, elbows and tees shall be so installed that they can remain accessible for such purposes as to withdrawal of existing cables or the installing of traditional cables.

2.5.3 Conduit accessories

- a. The conduit wiring system shall be complete in all respect including accessories.
- b. Rigid conduit accessories shall be normally of grip type.
- c. Flexible conduit accessories shall be of threaded type.
- d. Bends, couplers etc. shall be solid type in concealed type of works, and may be solid or inspection type as required, in surface type of works.
- e. Saddles for fixing conduits shall be heavy gauge non-metallic type with base.
- f. The minimum width and the thickness of the ordinary clips or girder clips shall be as per Table IV.
- g. For all sizes of conduit, the size of clamping rod shall be 4.5 mm (7 SWG) diameter.

2.5.4 Outlets :

- a. The switch box shall be made of either rigid PV C molding, or mild steel, or cast iron on all sides except at the front. The regulator boxes shall however be made only of mild steel or cast iron.
- b. PVC boxes shall comply with the requirements laid down in IS: 14772-2000. These boxes shall be free from burrs, fins and internal roughness. The thickness of the walls and base of PVC boxes shall not be less than 2 mm. The clear depth of PVC boxes shall not be less than 60 mm.

2.5.5 Installation of Conduit system :

2.5.5.1 Common aspects for both concealed and surface conduit works :

- a. The erection of conduits of each circuit shall be completed before the cables are drawn in.
- b. All joints shall be sealed/cemented with approved cement. Damaged conduit pipes/fittings shall not be used in the work. Cut ends of conduit pipes shall have neither sharp edges nor any burrs left to avoid damage to the insulation of conductors while pulling them through such pipes.
- c. The supervisor-in-charge, with a view to ensuring that the above provision has been carried out, may require that the separate lengths of conduit etc. after they have been prepared shall be submitted for inspection before being fixed.

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- d. Bends in conduit : All bends in the system may be formed either by bending the pipes by an approved method of heating, or by inserting suitable accessories such as bends, elbows or similar fittings, or by fixing non-metallic inspection boxes, whichever is most suitable. Where necessary, solid type fittings shall be used.
- e. Radius of bends in conduit pipes shall not be less than 7.5 cm. No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet.
- f. Care shall be taken while bending the pipes to ensure that the conduit pipe is not injured, and that the internal diameter is not effectively reduced.
- g. Outlets : All switches, plugs, fan regulators etc. shall be fitted in flush pattern. The fan regulators can be mounted on the switch box covers, if so stipulated in the tender specifications, or if so directed by the supervisor-in-Charge.
- h. Painting :After installation, all accessible surfaces of metallic accessories shall be painted.

2.5.5.2 Additional requirements for concealed conduit work :

- a. Making chase :The chase in the wall shall be neatly made and of ample dimensions to permit the conduit to be fixed properly. For new construction it shall be buried under plaster and shall be neatly finished.
- b. Fixing conduits in chase :The conduit pipe shall be fixed by means of staples, or by means of non-metallic saddles, placed at not more than 60 cm apart, or shall be fixed by any other approved means of fixing.
- c. At either side of the bends, saddles/staples shall be fixed at a distance of 15 cm from the center of the bends.

2.6 FANS, REGULATORS AND CLAMPS :

- a. Ceiling Fans: All ceiling fans shall be wired to ceiling roses or to special connector boxes, and suspended from hooks or shackles, with insulators between hooks and suspension rods. There shall be no joint in the suspension rod.
- b. For wooden or steel joists and beams, the suspension shall consist of GI flat of size not less than 40 mm x 6 mm, secured on the sides of the joists or beams by means of two coach screws of size not less than 5 cm for each flat. Where there is space above the beam, a through-bolt of size not less than 1.5 cm dia, shall be placed above the beam from which the flats are suspended. In the latter case, the flats shall be secured from movements by means of another bolt and nut at the bottom of the beam. A hook consisting of MS rod of size not less than 1.5 cm dia shall be inserted between the MS flat through oval holes on their sides. Alternatively, the flats may be bent inwards to hold tightly between them by means of a bolt and nut, a hook of 'S' form.
- c. In the case of 'I' beams, flats shall be shaped suitably to catch the flanges and shall be held together by means of a long bolt and nut.
- d. For concrete roofs, a 12 mm dia. MS rod in the shape of 'U' with their vertical legs bent horizontally at the top at least 19 cm on either side, and bound to the top

reinforcement of the roof shall be used.

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- e. In buildings with concrete roofs having a low ceiling height, where the fan clamp as mentioned above cannot be used, or wherever specified, recessed type fan clamp inside metallic box shall be used.
- f. Canopies on top of suspension rod shall effectively hide the suspension.
- g. The leading in wire shall be of nominal cross sectional area not less than 1.5 sq. mm. and shall be protected from abrasion.
- h. Unless otherwise specified, all ceiling fans shall be hung 2.75m above the floor.
- i. In the case of measurement of extra down rod for ceiling fan including wiring, the same shall be measured in units of 10 cm. Any length less than 5 cm shall be ignored.
- j. The wiring of extra down rod shall be paid as supplying and drawing cable in existing conduit.
- k. Exhaust Fans: Exhaust fans shall be erected at the places indicated by the Supervisor-in-charge. For fixing an exhaust fan, a circular opening shall be provided in the wall to suit the size of the frame, which shall be fixed by means of rag bolts embedded in the wall. The hole shall be neatly plastered to the original finish of the wall. The exhaust fan shall be connected to the exhaust fan point, which shall be wired as near to the opening as possible, by means of a flexible cord.
- l. Exhaust fans for installation in corrosive atmosphere, shall be painted with special PVC paint or chlorinated rubber paint.
- m. Installation of exhaust fans in kitchens, dark rooms and such other special locations need careful consideration; any special provisions needed shall be specified.
- n. Regulators: The metallic body of regulators of ceiling fans/exhaust fans shall be connected to earth by protective conductor.

2.7 WIRING OF DISTRIBUTION BOARDS :

- a. All connections between pieces of apparatus or between apparatus and terminals on a board shall be neatly arranged in a definite sequence, following the arrangements of the apparatus mounted thereon, avoiding unnecessary crossings.
- b. Cables shall be connected to a terminal only by soldered or welded or crimped lugs using suitable sleeve, lugs or ferrules unless the terminal is of such a form that it is possible to securely clamp them without the cutting away of cables stands. Cables in each circuit shall be bunched together.
- c. All bare conductors shall be rigidly fixed in such a manner that a clearance of at least 25 mm is maintained between conductors or opposite polarity or phase and between the conductors and any material other than insulation material.
- d. A pilot lamp shall be fixed and connected through an independent single pole switch and fuse to the bus-bars of the board.
- e. In a hinged type board, the incoming and outgoing cables shall be fixed at one or more points according to the number of cables on the back of the board leaving

suitable space in between cables, and shall also, if possible, be fixed at the corresponding points on the switchboard panel. The cables between these points

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shall be of such length as to allow the switchboard panel to swing through on angle of not less than 90°. The circuit breakers in such cases shall be accessible without opening the door of distribution board. Also, circuit breakers or any other equipment (having cable size more than 1.5 sq. mm multistrand wire) shall not be mounted on the door.

- f. Wires terminating and originating from the protective devices shall be properly lugged and taped.

2.8 MARKING OF SWITCH BOARDS :

Each main board/submain board shall be marked indicating rating of each incoming/outgoing switch and the details of load/area it feeds. Detail/size of incoming and outgoing cable also shall be marked indicating from where the incoming cable has originated.

2.9 EARTHING REQUIREMENTS :

- a. A protective (earth) conductor shall be drawn inside the conduit in all distribution circuits to provide for earthing of non-current carrying metallic parts of the installation. These shall be terminated on the earth terminal in the switch boxes, and/or earth terminal blocks at the DB's
- b. Every sub-main will have earth continuity conductor to run along with sub-main wiring. In case of 3-phase sub-main wiring two earth continuity conductors shall be provided.
- c. Every circuit will have its earth continuity conductor to run along -with circuit wiring. In case of 3-phase circuit two earth continuity conductors shall be provided.
- d. Looping of earth is allowed only in case of point wiring.

Standard specification for Electrical (General) Works

Part - I Chapter - III

LT PANELS

3.1 LT PANELS :

3.1.1 This chapter covers the detailed requirements of LT switch Panel for 415V, 3 phase 50 Hz 4 wire system. These shall be branded and/or assembled/fabricated from a factory of repute. All switchgears shall be rated at an ambient of 50° C.

3.1.2 The switch board panel shall comprise of anyone of the following types of switchgears or combination thereof as specified.

- a. Air Circuit breakers draw out or fixed type.
- b. Switch Disconnecter Fuse Units fixed type, MCCBs of suitable ratings. .MCCBs shall invariably be Current Limiting type. Features like Double Break, Positive Isolation functions shall be preferred.

3.1.3 The Panel shall be indoor type having incoming sectionalization and outgoing switchgears as specified. The design shall be cubical type. The degree of enclosure protection shall be IP 42 as per IS:13947 (Part-I). and IP-54 for outdoors, unless otherwise specified. The panel should have adequate ventilation arrangement to dissipate heat in normal working condition.

3.1.4 General Construction : The switchboard shall be floor mounted free standing/wall mounted (as specified) totally enclosed and extensible type. The switch board shall be dust & vermin proof and shall be suitable for the climate conditions as specified. The design shall include all provisions for safety of operation and maintenance personnel The general construction shall conform to IS:: 8623/1993 for factory assembled switch board.

All the equipments will be factory fabricated in an approved factory having modern fabrication and testing process. It shall have seven tank pretreatment process comprising of degreasing, rinsing, de-rusting, rinsing, phosphatising, rinsing and passivation followed by powder coat painting having a paint thickness of 60 microns or as specified. The powder paint will be subjected to oven-heated process. All panels will be provided with suitable gasket to make it dust/vermin proof.

Standard specification for Electrical (General) Works

- 3.1.5** Cubical type panels shall be fabricated out of sheet steel not less than 2.0 mm thick. Wherever necessary, such sheet steel members shall be stiffened by angle iron frame work. General construction shall employ the principle of compartmentalization and segregation for each circuit. Unless otherwise approved, incomer and bus section panels or sections shall be separate and independent and shall not be mixed with sections required for feeders. Each section of the rear accessible type panel shall have hinged access doors at the rear. Overall height of the panel shall not exceed 2.4 meters. Operating levers, handle etc. of highest unit shall not be higher than 1.7 meters.

Multi-tier mounting of feeder is permissible. The general arrangement for multi tier construction shall be such that the horizontal tiers formed present a pleasing and aesthetic look. The general arrangement shall be approved before fabrication. Cable entries for various feeders shall be either from top or bottom. Through cable alleys located in between two circuit sections, either in the rear or in the front of the panel.

All cable terminations shall be through gland plates of minimum 3 mm thickness. There shall be separate gland plate for each cable entry so that there will not be dislocation of already wired circuits when new feeders are added. Cable entry plates shall therefore be sectionalized. The construction shall include necessary cable supports for clamping the cable in the cable alley or rear cable chamber. Cubicle panels with more than 1000 Amps Bus shall be made of tested structural modular sections.

- 3.1.6 Bus Bar and Connections :** The bus bars shall be of tinned Copper of high conductivity electrolytic quality and of adequate section. Current density shall not exceed 1.60 amps for Copper /sq. mm. The bus bar system may comprise of a system of main horizontal bus bars and ancillary vertical bus bars run in bus bar alleys on either side of which the circuit could be arranged with front access cable entries. In the case of rear access, horizontal bus system shall run suitably either at the top or bottom. All connections to individual circuits from the bus bar shall preferably be solid connections; however flexible connections shall also be permitted as per recommendations of the Panel Manufacturer. All bus bars and connections shall be suitably sleeved / insulated in approved manner. The bus bar system may comprise of a system of main/auxiliary bus bars run in bus bar alleys. For bus bar material, ratings, current density, insulation, supports, bus bar clearances and joints see para 3.4.

Standard specification for Electrical (General) Works

3.1.7 Incomer / Termination : Incomer termination shall be suitable for receiving bus trunking /underground cables. Cable terminations shall invariably be through terminal blocks (Polyamide or superior) or brought out solid terminals. Cable entries shall be provided either from the rear or from the front through cable alleys of suitable size. Removable gland plate to be provided for each cable entry. Cable support arrangement to be provided inside cable alley so that cables are neatly arranged and fixed. From each outgoing switch, insulated strip/conductor of suitable size to be provided up to suitable terminal block, which will receive incoming/outgoing cable termination. It is desirable that cables are not terminated directly to switchgear, but terminated through proper terminal blocks

Terminal block of reputed make shall be used. The housing material shall be polyamide having unbreakable and fire-retardant characteristic. All the metal parts shall be made up of copper alloy including the screws. Mounting shall be 'Din' or 'G-rail' type. Screws shall be self captive type. No protection cover is required, and the block should be touch proof.

3.1.8 Instruments : All panels shall be provided with Voltmeters, ammeters and Energy meters. Energy meters shall be provided in all incoming as well as outgoing loads of more than 200 Amps. The model for energy meter shall be as per schedule. All voltmeters and ammeters shall be flush mounted of size minimum 96 mm x 96 mm conforming to class 1.5 of IS:1248 for accuracy. All voltmeters shall be protected with MCB.

3.1.9 Indicating Lamps : On all the incomers & outgoing of more than 100Amps , ON/OFF indicating LED lamps shall be provided and shall be suitable for operation on AC supply. Phase indicating LED lamps shall be suitably colored. For less than 100 A outgoing ON indication LED shall be provided.

3.1.10 Small Wiring : All small wiring for Controls. Indication etc. shall be of with suitable FRLS/HFFR (halogen free fire retardant) copper conductor cables. Wiring shall be suitably protected within switch board. Runs of wires shall be neatly bunched, suitably supported and clamped. Means shall be provided for easy identifications of the wires. Where wires are drawn through steel conduits, the works shall conform to chapter 2 of this specification. Identification ferrules shall be used at both ends of the wires. All control wiring meant for external connections are to be brought out of terminal board.

3.1.11 Earthing : 2 Nos. 20x3 mm copper strip for LT panel upto 400 Amp. capacity or 2 Nos. 20x5 mm copper strip for LT panel of higher capacity shall be fixed all around the panel connected to 2 Nos. earth bus copper strips connected to incoming earth conductors.

Standard specification for Electrical (General) Works

3.1.12 Air Circuit Breaker : All Air Circuit Breakers shall be 3/4 pole with minimum 50 KA breaking capacity conforming to IS: 13947 (Part-II). Rated current shall be as per capacities specified. Normally ACBs will be draw-out type unless otherwise specified. The equipment shall be complete with the following: -

- a. Necessary circuit breaker carriage with 3 position (isolate, test, service) for draw out mechanism.
- b. Necessary mechanism interlock and automatic safe shutters gear with arrangement for pad locking.
- c. Necessary independent manual spring mechanism with mechanical On/Off indication as well as electrical On/Off indication.
- d. ACB shall be provided with microprocessor based releases having built in overload, short circuit & earth fault protection. Microprocessor release shall be EMI(electromagnetic induction)/EMC(electro magnetic compatible) certified.
- e. Necessary set of auxiliary switches.
- f. Necessary identification, metering requirements as specified i.e. ON/OFF indication lamps, selector switches, fuses, ammeter, voltmeter etc.
- g. In case of 4 pole breaker neutral shall be fully rated for entire range.
- h. ACB terminals shall be suitable/suitably brought out for direct aluminum termination as per IS 13947 Part-II.
- i. Operational manual shall be supplied with each ACB.
- j. One set of special tools/fixtures required for the maintenance of ACB shall also be supplied.
- k. Manufacturer's Test certificate for all ACBs shall be supplied and produced during testing.
- l. ACB should have the unique feature of $I_{cu} = I_{cs} = I_{cw} = 50 \text{ KA}$ for 1 sec. across the entire range.
- m. Electrical and Mechanical life (operation cycle) should not be less than 20000.

3.1.13 MCCB : All MCCBs shall be current limiting type, with features of load line reversibility and suitable for Horizontal/Vertical mounting. without any de-rating. Beyond 300Amps capacity MCCBs shall have positive isolation and preferably double break / contact repulsion & double insulation features. The MCCBs shall invariably be used with terminal spreaders. Normally MCCBs shall be of fixed type(non-draw out) unless otherwise specified. MCCB should have adjustable overload (80-100%) and short circuit (6-10 In) setting and unique feature of $I_{cs} = 100\% I_{cu}$ for entire range with minimum breaking capacity 35 KA at 415V, 50 Hz.

3.1.14 Test at manufacturers work :

All routine tests shall be carried out and test certificates produced to the department.

3.1.15 Installation : The installation work shall cover assembly of various sections of the panels lining up, grouting the units etc. In the case of multiple panel switch boards after connecting up the bus bars etc., all joints shall be insulated with necessary insulation tape or approved insulation compound. A common earth bar as per

section 7 of these specifications shall be run inside at the back of switch panel connecting all the sections for connection to frame earth system. All protection and

Standard specification for Electrical (General) Works

other small wirings for indication etc. shall be completed before calibration and commissioning checks are commenced. All relays, meters etc. shall be mounted and connected with appropriate wiring.

3.1.16 Testing and commissioning :

Commissioning checks and tests shall include all wiring checks and checking up of connections. Relay adjustment/setting shall be done before commissioning in addition to routine Megger tests. Checks and tests shall include the following: -

- a. Tightening of all nuts and bolts.
- b. Closing any left out holes to ensure the entire panel is insect proof.
- c. Megger testing. When measured with 500V Megger the insulation resistance shall not be less than 100 mega ohms.
- d. Earth testing.
- e. Operation checks and lubrication of all moving parts.
- f. Interlock function checks.
- g. Continuity checks of wiring, fuses etc. as required.
- h. Trip tests and protection gear test.

3.2 PRE WIRED DB :

Pre wired DBs manufactured by reputed switchgear manufacture shall have following features:

- a. Phase/neutral/earth terminal blocks for termination of incoming & outgoing wires.
- b. Din Channel for mounting MCB 's.
- c. Arrangement for mounting incomer MCB/ RCCB/ RCBO/ MCCB as required.
- d. Copper Bus bar.
- e. Earthing terminals.
- f. Wiring from MCB's to phase terminal block.
- g. Interconnection between terminal block/incoming switch/bus bar/neutral terminal block/earth terminal connector with specified size of FRLS pre insulated copper conductor cable duly fitted with copper lugs/ thimbles.
- h. Terminal blocks should be suitable for termination of conductor/ cable of required size but minimum rated cross section of the terminal blocks should be 6 sq.mm.
- i. Terminal block shall be made of flame retardant polyimide material.
- j. Colored terminal blocks and FRLS wires for easy identification of RYB Phases, Neutral and Earth.
- k. Prewired DB shall be provided with a detachable cassette for safe removal of MCBs, RCCBs. Terminal connectors from the DB without loosening the internal cable connections of phase and neutral circuits.
- l. The pre wired DB shall have peel able poly layer on the cover for protection from cement, plaster, paints etc during the construction period.

Standard specification for Electrical (General) Works

- m. Detachable plate with Knock out holes shall be provided at the top/bottom of board. Complete board shall be factory fabricated and pre-wired in factory ready for installation at site. The box and cover shall be fabricated from 1.6mm sheet steel, properly pretreated, phosphotized with powder coated finish. Where specified it shall be of double door construction provided with hinged cover in the front.

3.3 RISING MAINS :

The rising mains used in building 2 storied and above for indoor applications to avoid rising cable system

- a. The rising main shall comprise of sheet metal enclosure, bus bars, tap-off points, tap off boxes, end feed units, fire barriers, expansion joints, thrust pads, end covers and fixing brackets etc.
- b. The rising main shall conform to IS 8623 and IE 439 and shall be suitable for 415~ 3 phase, 50 Hz supply and insulation of rising mains shall be capable of withstanding the voltage of 660 volt A.C. Degree of IP protection and short circuit rating shall be specified.
- c. Tap-off arrangements shall be provided on the rising mains with tap off boxes.
- d. The enclosure shall be made from sheet steel of 1.6 mm thickness.

3.4 BUS BARS :

- a) Bus bars shall be made of wrought aluminum or aluminum, alloy, or electric grade copper, confirming to relevant Indian Standard, as specified. The ratings of the bus bars shall be 100A, 200A, 300A, 400A, 500A, 600A, or 800A as specified.
- b) Bus bars shall be of sufficient cross-section so that a current density of 130A/sq.cm (800A/sq.inch) is not exceeded at nominal current rating for aluminum bus bars, and 160A/sq.cm (1000A/sq.inch) for copper bus bars. The minimum sizes of sections of bus bars are given in Table 3.1.
- c) The cross section of the neutral bus bar shall be the same as that of the phase bus bar for bus bars of capacities upto 200A; for higher capacities, the neutral bus bar must not be less than half the cross section of that of the phase bus bar.
- d) Insulation: Each bus bar shall be suitably insulated with PVC sleeves/tapes.
- e) Bus bar support insulators shall be class F insulators made of non-hygroscopic, non-combustible, track resistant and high strength FRP/ SMC/DMC material, and shall be of suitable size and spacing to withstand the dynamic stresses due to short circuit currents. The spacing between two insulators should not exceed 250 mm.
- f) Bus bar Clearances: The minimum clearance to be maintained for enclosed indoor air insulated bus bars shall be as follows:
 - Phase to earth 26 mm min.
 - Phase to phase 32 mm min

- g) Bus bar joints shall be thoroughly cleaned and a suitable oxidizing grease shall be applied before making the joint.

Standard specification for Electrical (General) Works

- h) High tensile bolts, plain and spring washers shall be provided to ensure good contact at the joints.
- i) The overlap of the bus bars at the joints shall be not less than the area of the cross section of the bus bars.
- j) The bus bar clamps and insulators shall be designed to withstand the forces due to short circuit current. They shall also permit free vertical movement of the bus bars during expansion and contraction.

3.5 BUS TRUNKING :

These are generally provided for interconnections between the transformers of 400 KVA and above and DG sets 300 KVA and above and their switch board panels, and also for interconnections between large switch board panels where specified, thereby avoiding use of large sizes of cables for such interconnections.

TABLE 3.5

Current Ratings in Amps	Copper Section (mm)	Aluminum section (mm)
100	20 x 3	20 x 5
200	25 x 5	30 x 5
300	40 x 5	50 x 5
400	50 x 5	50 x 6
500	60 x 5	75 x 6
600	75 x 6	80 x 6
800	100 x 6	100 x 6

Standard specification for Electrical (General) Works

Part - I **Chapter - IV**

LT CABLES

4.1.0 SPECIFICATION OF CABLE :

Cross linked polyethylene (XLPE) insulated, PVC outer sheathed, armoured with galvanized round steel wire or steel strip and with stranded Aluminium conductor suitable for rated voltage at 1100 volts grade and conforming to IS 7098 (Pt.-I) of 1988 with latest amendments.

4.2.0 SERVICE CONDITION :

- 4.2.1** The cables will be used for LT power supply to various LT loads, viz. Ventilation, Air conditioning, lighting, pump etc. The cables will be laid mostly on galvanized mild steel cable hanger / support / in RTS Tunnel, wall and partly in cable Tunnel / Ducts. Galvanized down rod should be used for cable hanger. Cable may also be laid underground or in prepare cable trenches at some places. Suitable earthing strip will run along the cable alignment for earthing of hangers, racks and supports. This earthing strips will be connected to earth electrodes.
- 4.2.2** The system of supply will be 50 Hz, 415V, 3 Ph, 4 wire and the voltage variation upto $\pm 5\%$ is likely between the phases at the sub-station bus-bars. Depending upon the voltage drop due to the loads and distance of the feeding points during normal and emergency, the feeder may consist of more than one cable in parallel. The supplier shall indicate the continuous current rating, overload rating, short circuit current rating and group rating factors etc.
- 4.2.3** The cables are intended to be used in moist tropical climate and in areas subjected to heavy seepage of water, acidic in nature in some cases. The maximum temperature will be 45°C in shade and maximum relative humidity may reach 100% (Approx). The ground temperature and thermal resistivity of soil will be 30°C and 150°C cm/w respectively.
- 4.2.4** On account of movement of trains in the vicinity of cable alignment, the cables are likely to be subjected to vertical and horizontal vibrations. The outer sheath is expected to absorb the effect of vibration and air thrust due to piston action.
- 4.2.5** The cables will be laid in vertical, horizontal and inclined alignment.

Standard specification for Electrical (General) Works

4.3.0 GOVERNING SPECIFICATION :

- 4.3.1** The cable shall comply with IS specification No. IS-7098 (Pt.-I), IS-8130-1984 and in the manner altered, amended or supplemented by the latest revision of these specification and also the relevant provisions of the latest Indian Electricity Rules wherever applicable.
- 4.3.2** The minimum permissible bending radius of the cable shall be 12 D where D is the overall diameter of the cable.
- 4.3.3** The cable shall be used in the vicinity of AC traction system and part of the same also be in constant contact with under ground seepage water (Acidic in nature, in some cases). Further, cables will be laid in the subway where non inflammable materials should be used to eliminate fire hazards.

4.4.0 COLOUR & IDENTIFICATION MARKS :

- 4.4.1** Colour of outer sheath , of all sizes of LT cables shall be BROWN for easy identification, as per this specification .
- 4.4.2** The words “EASTERN RAILWAY – HOWRAH” shall be embossed on the cable along with usual markings of type, voltage & size at a regular interval of 2 meters.

4.5.0 ARMOURING :

- 4.5.1** The cable is likely to be subjected to the longitudinal stress which may occur during installation and also while in service in the vertical portions of the alignment. The cables shall, therefore, have single round galvanized steel wire Armour of suitable dimension to withstand the longitudinal stress as stated above.

4.6.0 TESTS :

- 4.6.1** The routine tests are to be conducted at manufacturer's works in presence of purchaser's representative. The contractor shall make all arrangements for conducting the tests free of cost including provision of additional lengths as may be required for testing.
- 4.6.2** Type tests : The manufacturer's test certificate as per IS : 7098 Pt.-I, IS-9130-1984 shall be furnished.

4.7.0 DRUM SCHEDULE :

- 4.7.1** The cables shall generally be supplied in lengths not less than 250 / 500 meters in each drum.

Standard specification for Electrical (General) Works

- 4.7.2** The length of cable on each drum shall however be so adjusted that the number of joints in the feeder are minimum as essential. The Tenderer should therefore assess the actual length required for the route of laying of the cable before ordering on the manufacturer. Prior approval for the size of the drum, length of cable in each drum and number of drums is to be obtained from the purchaser before manufacture.

4.8.0 PACKING AND MARKING :

- 4.8.1** The cable shall be wound on drums of suitable size for easy handling and maneuvering within the subway and station building. The drums should be suitably packed and marked and be robust in construction.

- 4.8.2** The marking of the drums shall have the following information :

- a) Trademark, if any.
- b) Name of manufacturer.
- c) Nominal cross sectional area of the conductor of the cable.
- d) Number of cores.
- e) Type of cable and voltage grade.
- f) Length of cable on the drum.
- g) Gross weight (Approx)
- h) Drum number according to drum schedule.
- i) Direction of rolling.
- j) ISI mark of inspection.
- k) Date / Year of manufacture.

STANDARD SPECIFICATION FOR ELECTRICAL (GENERAL) WORKS

**EASTERN RAILWAY / HOWRAH DIVISION
ELECTRICAL (GENERAL) DEPARTEMENT**

PART - II : HIGH TENSION (HT) and EARTHING

PART - II

(HT & Earthing)

Chapter I	: General
Chapter II	: Transformer
Chapter III	: High Voltage Switchgear Panel
Chapter IV	: Earthing
Chapter V	: Compact Sub-station

Standard specification for Electrical (General) Works

Part - II Chapter - I

GENERAL

1.0 This part covers technical specifications for 6 KV/11 KV equipments required for the distribution network.

2.0 This specification is for general guidance and actual equipment shall meet the requirement of detailed technical specification in Part-III or tender schedule in addition to provisions of this chapter.

3.0

LIST OF INDIAN STANDARDS

A. Technical Definitions:

1.	Fundamental definitions	IS 1885 (Part-I)
2.	Secondary cells and batteries	IS:1885 (Pt-viii)
3.	Electrical Power system Protection	IS:1885 (Pt-X)
4.	Electrical measurement	IS:1885 (Pt-XI)
5.	Switchgear and Control gear	IS:1885 (Pt-XVII)
6.	Overhead transmission and distribution of electrical energy	IS:1885 (Pt-XXX)
7.	Cables, conductors and accessories for electrical supply	IS:1885 (Pt-XXXII)
8.	Transformers	IS:1885 (Pt-XXXVIII)

B. Graphical Symbols

9.	Guide for preparation of diagrams, charts & tables for electro technology. Definitions and classifications (Superseding IS:2032 (Part1962)	IS :8270 (Pt-I) 1976
10.	Item designation	IS :8270 (Pt-II) 1976
11.	General requirements for diagrams	IS :8270 (Pt-III) 1977

12.	Circuit diagrams	IS :8270 (Pt-IV) 1977
13.	Inter connection diagrams and table	IS :8270 (Pt-V) 1976

Standard specification for Electrical (General) Works

C. Conductors & Power cables

14.	PVC insulated cable for working voltages up to and including 1100 volts (Second revision) (Super ceding IS: 3035 Part I 1965)	IS: 694/1990
15.	PVC insulated (Heavy duty) dielectric cables for voltage upto & including 1100 volts (Second revision)	IS: 1554 (Part-I) 1988
16.	For working voltage from 3.3 KV upto and including 11 K V	IS: 1554 (Pt-II) 1988
17.	Recommended current ratings for cables: Paper insulated lead sheathed cables.	IS: 3961 (Pt-I) 1967
18.	PVC insulated and PVC sheathed heavy duty cables.	IS: 3961 (Pt-II) 1967
19.	Application guide for non linear resistor type surge arrester for alternating current system (First revision)	IS: 15086 (Pt-5)
20.	Recommended short circuit ratings of high voltage PVC cable	IS: 5819-1970
21.	Conductors for insulated electric cables and flexible cords.	IS: 8130/1984
22.	Busbar trunking system (Air insulated & sand witch insulated type).	IS: 8623 Pt-I & II, IEC 60439-Pt-I & II

D. Electrical Installation Codes & Practices

23.	Installation & Maintenance of Transformers	IS: 10028 (Pt-II & III)
24.	Insulating oil in service, maintenance and supervision code of practice for Earthing	IS: 1866 2000
25.	Guide for short circuit calculations	IS: 13234
26.	Electrical wiring installation (system voltage not exceeding 650 volts)	IS: 732 1989
27.	Paper insulated power cables (Up to and including 33 KV (first revision)	IS: 1255 1983

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E. Switchgear & Control gear

28.	Degree of protection provided by the (enclosure for low voltage switchgear and control gear)	IS:13947 Pt-I
29.	HRC cartridge fuse links up to 650 volts.	IS: 9224 Pt-II
30.	Circuit breaker AC requirements & tests for voltages not exceeding 1000 volts a.c. or 1200volts d.c.	IS:13947 Pt-II
31.	Circuit Breaker General and definition. Section 2- Voltages above 1000 volt a.c.	IS: 13118-1991
32.	Circuit Breaker Type tests & Routine test for voltage above 1000 volt a.c.	IS: 13118-1991
33.	Heavy duty air break switches and composite units of air break switches & fuses for voltages not exceeding 1000 volts.	IS: 4064
34.	General requirements for switch gear, control gear for voltage not exceeding 1000 volt's.	IS: 13947 Pt-I
35.	Factory built assemblies of switch gear and control gear for voltages upto & including 1200 VDC	IS: 1000 or 8263/1993
36.	Particular requirements for bus bar trunking system (Bus ways)	IS: 8263 Pt-II
37.	High-voltage alternating current circuit breakers	IS:13118-1991 IEC : 60056
38.	High Voltage Switches - Part I : Switches for Rated Voltages Above 1 K v and Less Than 52 Kv	IS: 9920-2002
39.	A.C. Metal Enclosed Switchgear and Control gear for Rated Voltages Above 1 Kv and Up to and including 52 K v	IS: 3427-1997
40.	Electrical Measuring Instruments and their Accessories	IS: 1248

F. Transformers & Reactors

41.	Dry type power transformer	IS:11171-1985
	Power transformer	
42.	(i) General	IS: 2026 (part-I)-1977
43.	(ii) Temperature rise	IS: 2026 (part-II)-1977
44.	(iii) Insulation level and di-elec~ric tests	IS: 2026 (part-III)-1981
45.	Distribution transformers	IS:1180/1989
46.	Gas operated relays	IS:3637/1966
47.	Power transformers fittings and accessories	IS:3639/1966
48.	Guide for loading of oil immersed transformers	IS:6600/1972

49.	Current transformers Part I to III	IS:2705/1992
50.	Voltage transformers Part I to III	IS:3156/1992
51.	Outdoor type three-phase distribution transformers	IS:2099/1986

Standard specification for Electrical (General) Works

G. Chemicals

52.	Colours for ready mixed paints and enamels (Third revision)	IS:5/1994
53.	Ready mixed paint brushing zinc chrome priming (lind revision)	IS:104/1979
54.	Enamel, synthetic exterior (a) under coating (b) finishing (1 51 revision)	IS:2932/2003

H. Insulating Liquids

55.	Specific resistance (resistivity) or electrical insulating liquids, methods of tests for	IS:6103/1971
56.	Electric strength of insulating oils, methods for determination of	IS:6792/1992
57.	New insulating oils for transformers and switchgears (2nd revision)	IS:335/1993
58.	Insulating Mats	IS:15625/2006

I. Safety Equipments

59.	CO2 based Fire Extinguishers	IS:2878/1976
60.	Chemical based Fire Extinguishers	IS:2171/1976
61.	HCFC Blend-A Extinguishing System	IS:15505/2004

Standard specification for Electrical (General) Works

Part - II Chapter - II

TRANSFORMERS

2.1 This section covers the detailed requirements regarding supply, installation, testing, Commissioning and handing over of transformers required for the sub-station. The specification covers both oil cooled, as well as, dry type transformers. There are two types of dry type transformers viz. vacuum pressure impregnated (VPI) dry type transformers and cast resin dry type transformers. Only cast resin dry type transformers shall be used for capacity of 500 KVA or more.

2.2 OIL COOLED TRANSFORMERS :

Oil cooled transformers shall be used only in substations located in separate single or two storied service buildings outside the main building structure and there shall be adequate distance between the adjoining buildings and substation such that fire tender is able to pass between the two structures. (NBC-2005 Part-8. Section 2 clause 4.2.1 j).

2.2.1 The oil filled Transformers shall comply with the following Indian Standards as amended up to date:

IS 2026	Part I to V transformers
IS 335	Transformer oil
IS 10028 (Pt I & II)	Installation & Maintenance of transformer
IS 2099	Bushings
IS 2705	Current Transformers
IS 6600	Guide for loading of Oil immersed transformers

2.2.2 Insulation Oil : Insulation oil shall conform to IS 335. Transformer oil to be supplied with initial fill of filtered oil.

2.2.3 General Requirements :

The transformer shall be indoor or outdoor type as specified. Unless otherwise specified the transformer in addition shall have thermal and dynamic ability to withstand external short-circuit as per clause 9 of IS 2026 (Part I) 1977.

2.2.4 Temperature Rise ambient temperatures assumed for the purpose of this specification are as follows: -

- a. Maximum ambient air temperature 50° C.
- b. Maximum daily average ambient air temperature 40° C.

The temperature rise at the above conditions shall be as follows: -
By resistance method 55° C
By thermometer 50° C.

Standard specification for Electrical (General) Works

2.2.5 Tap Changing Device :

Tap changing device shall be provided on H. V side, circuit type, externally hand operated with necessary indications for tap position and locking arrangement at any of the tapping positions. It shall be designed for bi-directional operation and shall be of self positioning type and shall have the following steps: -

(+/-)2.5%, (+/-) 5%, -7.5%

Note: Tap changing device shall normally be off load type unless otherwise specified.

2.2.6 Vector Group :

In case of step down transformers, the winding connections shall conform to vector group dyl II unless otherwise specified.

2.2.7 Cooling :

Unless otherwise specified, the transformer shall be oil immersed natural air-cooled type (ONAN).

2.2.8 Accessories :

The transformer shall be a single tank type with termination on bushings or cable end boxes as specified both on HV and LV side.

The transformer shall be complete with following fittings:-

- a. Oil conservator with oil level indicator. minimum level marking and drain plug.
- b. Off circuit type tap changer with position indicator and locking arrangement.
- c. Thermometer pocket with plug.
- d. 100 mm dial type thermometer with metal guard. Dial type thermometer shall have max. temperature indicator and resetting device.
- e. Lifting lugs
- f. Bidirectional rollers
- g. Rating diagram and terminal marking plate
- h. Explosion vent
- i. Additional Neutral separately brought out on a bushing for earthing.
- j. Earth terminals (2 Nos.) for body earthing.
- k. Valves for filtration, drainage and filling etc. with necessary plugs.
- l. Radiator Assembly
- m. Silica gel breather with transparent(acrylic) container.
- n. Air release plug.
- o. First filling of oil to IS 335/1993 including make-up fill during installation.
- p. Facility to connect up Buchholtz relay for all transformers of capacity 750 KV A and above.

- q. Inspection covers on tank cover for access to terminal connections for all transformers.
- s. Necessary hardware, clamps, lugs etc. for termination on BV/MV etc. for all transformers.

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2.2.9 Explosion Vent :

Explosion vent or pressure relief device shall be provided of sufficient size for rapid release of any pressure that may be generated within the tank and which might result in damage to the equipment. The device shall operate at a static pressure less than the hydraulic test pressure for transformer tank. Means shall be provided to prevent the ingress of moisture and of such a design to prevent gas accumulation.

2.2.10 Rating and Diagram Plate :

The following plates shall be fixed on transformer in clearly visible position :-

- a. A rating plate of weather proof material bearing the data specified In the appropriate clauses of IS: 2026/1977.
- b. A diagram plate showing the internal connection and also the voltage vector relationship of the several windings in accordance with IS: 2026-1977 and a plan view of the transformer giving the correct physical relationship of the terminals.

The lettering and color combination of plates shall be such that it is clearly visible from a distance of 30 cm with naked eye.

2.2.11 Joints & Gaskets

All gaskets used for making oil tight joints shall be of proven material such as granulated cork bonded with synthetic rubber gaskets or synthetic rubber or other proven material.

2.2.12 Gas and Oil Actuated (Buchholtz) Relay

Buchholtz Relay shall be provided for transformers of capacity 750 KYA and above. The design of the relay mounting arrangements, the associated pipe work shall be such that mal-operation of the relays shall not take place under normal service. The pipe work shall be so arranged that all gas arising from the transformer shall pass through the gas and oil-actuated relay. The oil circuit through the relay shall not form a delivery path in parallel with any circulating oil pipe, nor shall it be tied into or connected through the pressure relief vent, Sharp bends in the pipe work shall be avoided.

All wiring connections, terminal boards, fuses and links etc. connected with gas actuated relays shall be suitable for tropical atmosphere. Any wiring liable to be in contact with oil shall have oil resistant insulation and the bared ends of stranded wire shall be sealed together to prevent seepage of oil entering connection boxes used for cables or wiring.

2.2.13 Cable Box

Cable box shall not be mounted on the tank covers. It shall be feasible to remove the tank covers for inspection during maintenance etc. without recourse to breaking the joints or disturbing the cables already terminated. Necessary removable links in oil approachable through inspection cover in tank cover etc. after lowering oil shall be provided for test purpose.

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2.2.14 Tests

2.2.14.1 Test at Works :

All routine and other tests prescribed by IS 2026 shall be carried out at the manufacturer's works before dispatch of the transformer in the presence of inspecting officer if required. Copies of the test certificates shall be furnished to the department. In addition to the prescribed routine tests, temperature rise test shall be invariably done on one transformer of each design. A copy of the impulse test certificate done on the same type/design of the transformer shall be furnished in accordance with IS for purpose of record. If no impulse test was done in an earlier unit of the same design and capacity, one transformer will be subjected to impulse test in presence of Inspector at the firm's/manufacturer's cost.

Copies of the certificates for pressure test, test for bushings, and type test for short circuit shall be supplied for acceptance.

2.2.14.2 Tests at Site :

In addition to tests at manufacturer's premises, all relevant pre-commissioning checks and tests conforming to IS code of practice No. 10028 (Part II & III) shall be done before energisation. The following tests are to be particularly done before cable jointing

- a. Insulation test between HV to earth and HV to LV with 5000 Volts Megger.
- b. Insulation test between LV to earth by 500 V Megger
- c. Di-electric strength Test on Oil
- d. Buchholtz relay operation by simulation test when fitted.

All test results are to be recorded and reports should be submitted to the department.

2.2.15 Installation and commissioning :

2.2.15.1 The transformer shall be installed in accordance with IS 10028 (Part II & III) Code of practice for Installation and maintenance of transformer. Necessary support channels shall be grouted in the flooring.

2.2.15.2 The Transformer shall be moved to its location and shall be correctly positioned. Transformer wheels shall be either locked or provided with wheel stoppers. All parts of the transformers which are supplied loose, such as conservator, radiator

banks, Buchholtz relay, dial thermometer, bushing etc. shall be fitted on the transformer. Transformer oil supplied in drums shall be topped up into the transformer after duly testing/filtering up to the correct level required.

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2.2.15.3 Wiring of devices such as Buchholtz relay, dial thermometer etc. shall be carried out as per drawings, Earthing of neutral and body of the transformer shall be done in accordance with specifications.

2.2.15.4 Drying out of transformer winding will be necessary when the di-electric strength of the oil is lower than the minimum value as per IS-I0028 or the transformer has not been energized within 6 months of leaving the works or where the radiator assembly is done at site. The transformer shall be dried out by one of the methods specified in IS -10028. Drying out with centrifugal or vacuum type filters will, however, be preferred. The contractor shall carry out the process of drying without interruption and shall maintain a log sheet indicating time, oil temperature and insulation resistance.

2.2.15.5 After complete drying out of the transformer, oil sample shall be collected by the contractor and shall be tested for dielectric strength as specified in IS:335-1993 with approved test kit.

2.2.15.6 All devices such as dial type thermometers, Buchholtz relays and main alarm and trip contacts shall be checked for satisfactory operation.

2.2.15.7 All tests specified in 3.2.14 of these specifications shall be carried out by the contractor in the presence of inspecting officer/consignee free of cost.

2.3 DRY TYPE TRANSFORMERS :

2.3.1 General Conditions :

2.3.1. 1 The Transformers shall comply with the following Indian Standards as amended up to date:

- (i) IS 11171 : 1985 - Dry type power transformers.
- (ii) IS 10028 (Part II & III) - Installation and Maintenance of Transformers.
- (iii) IS 2099 - Bushing
- (iv) IS 2705 - Current Transformers.

2.3.1.2 Constructional Features: All the MS parts shall be either Hot dipped galvanized or cold galvanized to make them corrosion free. The core shall be made up of high grade low loss cold rolled grain oriented silicon steel. Both low & high voltage windings shall be made of copper conductor. The class of winding insulation shall correspond to class 'F'. The construction of the windings of the transformer shall be such that no creepage path is found even in dusty & corrosive ambient

conditions. The core coil assembly shall be housed in a prefabricated enclosure. The enclosure shall be fabricated with mild steel CRCA sheets with adequate provision for ventilation. The enclosures shall undergo the seven tank process. Finally the external and internal surfaces of the enclosure shall be powder coated with the required paint shade.

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- 2.3.2 General Requirements :** The transformer shall be indoor or outdoor type as specified. Unless otherwise specified the transformer in addition shall have thermal and dynamic ability to withstand external short-circuit as per clause 9 of IS 2026 (Part I) 1977 and clause 5 of IS 11171-1985.
- 2.3.3** Indoor transformers shall be suitable for IP-23 protection; out door transformers shall conform to IP-33 protection.
- 2.3.4 Temperature Rise :** The reference ambient temperatures assumed for the purpose of this specification are as follows: -
- (a) Maximum ambient air temperature 50° C.
 - (b) Maximum daily average ambient air temperature 40° C.
 - (c) Maximum yearly weighted average ambient temperature 32° C.
 - (d) Class of Insulation F
- 2.3.5 Tap Changing :** Tapping range is +5% to -7.5% in 2.5 percent steps by means of OFF load tap changing links or tap switch. The device shall be provided on HV for HV Voltage to keep LV Voltage constant.
- (E) Terminal Marking Connections: Relevant provisions of IS:2026 (Part-IV)-1977 shall be applicable.
- 2.3.6 Vector Group:** In case of step down transformers, the winding connections shall conform to vector group Dy11 unless otherwise specified.
- 2.3.7 Cooling :** Unless otherwise specified the transformer cooling shall be air and naturally cooled (AN)
- 2.3.8 Accessories:** The transformer shall be with enclosure or without enclosure with HV and LV terminations as specified both on HV and LV side.
- 2.3.9 Fittings :**
- a. Off load type tap changer
 - b. RTD temperature controller
 - c. Lifting lugs
 - d. Bidirectional rollers
 - e. Rating diagram and terminal marking plate
 - f. Additional neutral separately brought out on a bushing for earthing.
 - g. Earth terminals for body earthing.
 - h. Necessary hardware, clamps, lugs etc. for termination on HV/LV.

2.3.10 Rating Plates : Same as cl. 2.2.10

2.3.11 Joints and Gaskets : same as CL. 2.2.11

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2.3.12 Tests : Same as 2.2.14 except for dielectric test for transformer oil & Buchholtz relay test

2.3.13 Installation and Commissioning:

2.3.13.1 The transformer shall be installed in accordance with IS I0028-Code of practice for Installation and maintenance of transformer. Necessary support channels shall be grouted in the flooring.

2.3.13.2 The Transformer shall be moved to its location and shall be correctly positioned. Transformer wheels shall be either locked or provided with wheel stoppers.

2. 3.13.3 Wiring of devices shall be carried out as per drawings; Earthing of neutral and body of the transformer shall be done in accordance with specifications.

2.3.13.5 All tests specified in 2.2.14 of these specifications shall be carried out by the contractor in the presence of inspecting officer/consignee free of cost.

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Part - II **Chapter - III**

HIGH VOLTAGE SWITCHGEAR PANEL

3.1 SCOPE :

These specifications cover the detailed requirements for supply, installation testing and commissioning of High Voltage Panels.

3.2 TYPE OF PANELS :

- a. Vacuum Circuit Breaker
- b. Gas filled Circuit Breaker
- c. Gas insulated compact Switchgears with Vacuum Circuit Breakers.

3.3 HT PANEL :

- 3.3.1** The Panel board shall be of indoor type, having the incoming sectionalization and outgoing switch gears as per IS 13118 - 1991 of VCB, IEC 62271 -100 / 200, IS 3427 of switchboard. The degree of enclosure protection shall be IP-4X.
- 3.3.2** All panels assembled to form a panel board shall be suitable for the nominal operating voltage and breaking capacity as specified. They should be rated as specified with a minimum of 630 Amps. and suitable for operation on 11/6 K V. 3 phase 50 Hz system. Type test certificate for the breaking capacity of the panel shall be supplied.
- 3.3.3** The HT panel Board shall be metal clad, indoor, floor mounting, free standing type. It shall be totally enclosed dust, damp and vermin proof.
- 3.3.4 General Construction:** Separately earthed compartments shall be provided for circuit breakers, bus bars, relay & instruments, CT & PT and cable boxes, fully and effectively segregating these from one another so that fault in anyone compartment do not cause damage to equipment(s) in other compartment(s).
The housing shall be of bolted construction to ensure compact and rigid structure.
The sheet steel used should not be less than 2 mm thick.
The panels shall be bolted together to form a continuous flush front switch gear suitable for front operation of board and for extension at both ends.

3.3.5 General Design aspects : The HT panel board shall be designed such that the switchgear, instruments, relays, bus bars, small wiring etc. are arranged and mounted such that:-

- a. Inspection, maintenance and repairs of testing terminals and terminal and terminal boards for ease of external connection is convenient.

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- b. Noise and vibrations are minimized to avoid risk of accidental short circuits.
- c. Connections for power and control circuits are secured and vibration proof.
- d. There is no risk of accidental contact with live parts
- e. All mountings are at approachable height.

3.4 CIRCUIT BREAKERS :

3.4.1 General Arrangements: The circuit breaker panels shall be complete with the following:

- a. Draw in/out arrangement
- b. Mechanical interlocks
- c. Mechanical ON/OFF indication
- d. Minimum 4 NO and 4 NC Contacts directly operated by CB
- e. Anti condensation space heaters suitable for operation on 230V. 1-ph AC for Breaker assembly with thermostat.
- f. Mechanical counter to assess the total number of operations of the breaker

3.4.2 Type :

The circuit breaker shall be of horizontal isolation. horizontal draw out pattern.

3.4.3 The breaker carriage shall be fabricated from steel, providing a sturdy vehicle for the circuit breaker and its operating and tripping mechanism. The carriage shall be mounted on wheel and guide arrangement for easy withdrawal.

Vacuum interrupters shall be hermitically sealed and shall be designed for maintenance free operation.

The drive shall preferably be provided with pad locking arrangement for various position i.e. Service, Test and Isolated.

3.4.5 Operating Mechanism shall be Motor operated spring charged with both electrical and mechanical release for closing. The operating mechanism shall be trip free. It shall be possible to operate it manually in case of motor failure.

Power supply for electrical operation during power supply failure shall be inbuilt in breaker panel with sealed maintenance free batteries.

Provision for connecting external 230V 1-ph supply for heaters and battery charging shall be made.

3.5 BUS BAR SECTION :

- a. The HT panel shall be air insulated encapsulated bus bar housed in separate compartment made up of high conductivity electrolytic grade copper with

minimum rating of 630 A. The bus bar shall be rated for carrying short circuit currents without overheating.

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- b. Alternatively entire bus bar along with breaker shall be housed in sealed stainless steel tank with SF6 insulation. The tank shall be such that it can withstand pressure build up during faults. It shall be provided with gauge to monitor Gas pressure.
- c. Material: The bus bars shall be of high conductivity electrolytic copper rated as specified with a minimum rated current 01' 630 Amps. The bus bars shall be sized for carrying the rated and short circuit current without over-heating .. Maximum bus bar temperature shall not exceed 95 degree C.

3.6.1 Accommodation shall be provided in the circuit breaker panel to mount one set of three numbers dual core dual ratio CTs for metering and protection purposes. Access to the CTs for cleaning, testing or changing shall be from the front, back or top of the panel.

3.6.2 Rating : Dual core & dual ratio CTs of suitable burden (but not less than 15 VA) shall be preferred with 5 Amps secondary. The ratio shall normally be as specified.

3.6.3 The CTs shall conform to relevant Indian Standards. The design and construction shall be robust to withstand thermal and dynamic stresses during short circuits. Secondary terminals or CTs shall be brought out suitably to a terminal block which will be easily accessible for testing and terminal connections. The protection CTs shall be or accuracy class 5 P 10 or IS 2705 Part III-1992. The metering CTs shall conform to the metering ratio and accuracy class 05 of IS 2705-1992 for incomer and class 1 for outgoing Panels.

3.7 POTENTIAL TRANSFORMERS :

3.7.1 General Requirements: Potential transformer of burden not less than 100 VA and of proper ratio as specified shall be provided at the incoming panel. The accuracy class for the PT shall be class 0.5 as per IS 3156 parts I to III for incomer and class 1 to 3 for outgoing Panels.

The transformer shall be of cast epoxy resin construction. It shall be fixed/withdrawal type. HRC fuses/MCBs shall be provided on both HV and LV sides.

3.8 PROTECTION AND TRIPPING ARRANGEMENT :

3.8.1 Protection : The Relays shall be microprocessor based numerical relays with Overload, Earth fault and instantaneous short circuit protection. Tripping relay shall be used to energize tripping coil of CB.

Power Pack converters fed through PT/230V shall be provided with SMF batteries for tripping and indication purpose. Power supply shall be independent for each CB. In cases where tripping is fed through PT. VA burden of PT shall be suitably.

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3.8.2 Relays : Over current Relays shall have adjustable setting for current from 50% to 200% and earth fault from 10% to 40% or 20% to 80%. These should be of manual reset type. All relays shall have a LED indicator which will indicate operation for each function. It shall be possible to reset it only by manual operation. The number and types of relays shall be as specified.

3.9 Other Wiring : The small wiring shall be carried out with minimum 1.5 Sq. mm FRLS/HFFR insulated copper conductor cables. CT wiring shall be done with minimum 2.5 sq mm wires with colour code: RYB, Gray for auxiliary DC circuits and Black for auxiliary AC circuits The wiring shall be securely fixed and neatly arranged to enable easy tracing of wires. Identification tags/Ferrules shall be fitted to all wire terminals to render identification easy and to facilitate checking in accordance with IS 375. Necessary terminal blocks and cable entries shall be provided for relay wiring, power supply etc.

3.10 INSTRUMENTATION & METERING :

3.10.1 Metering : Energy metering shall be provided on the incomers & Outgoing feeders.

3.10.2 Voltage Selection Scheme : Where a bus coupler is incorporated and only one incomer feeder (out of two available) is intended to be operated at a time. a VT Transfer Relay shall be incorporated to provide necessary potential for metering. Alternatively PTs shall be provided on both the bus sections (incomers) with individual metering for each incomer.

3.10.3 Instrument Panels : The instrument panel shall form part of the housing. Relays, meters and instruments shall be mounted as per general arrangement drawings to be submitted by the tenderer. They shall be preferably of flush mounting type at a maximum height of 1800 mm.

3.10.4 Instrumentation :

- a. A voltmeter of class 1.5 accuracy as per IS-1248 shall be provided at each incomer panel, with selector switch. The instrument shall be calibrated for the ranges specified.
- b. Energy meters of class 1.0 Conforming to IS. 722 (Part IX) and power factor meter of class of accuracy of 2 shall be provided, if specified.
- c. Ammeter of specified range of class 1.5 accuracy as per IS-1248 shall be provided at both incomer and outgoing panels along with necessary selector switches.

- d. Alternatively a multifunction meter as specified shall be provided to include all the parameters of the feeder.
- e. The indication panel shall provide :
 - i. LED indication shall be provided to indicate ON/OFF (red/green) of switch gear.

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- ii. Panel illuminating lamp
- iii. Mechanical indication for spring charge status
- iv. LED indicating lamp for tripping at fault status.
- v. Healthy trip supply shall be indicated by clear lamp.
- vi. Separate fuses/MCBs shall be provided for lamps, heaters. voltmeters and other instrumentation etc. on each panel.
- vii. Anti-condensation space heaters shall be provided, and shall be suitable for operation on 240 V, I phase, 50 Hz A.C. for each panel if specified.
- viii. Where there is more than one incomer and bus sections, there shall be castle key interlocking as per interlocking scheme specified.

3.11 CABLE BOXES :

Cable boxes shall be situated in a compartment at the rear/front side of the housing.

3.12 CABLE ENTRY :

Provision for top / bottom or such other side entry shall be made as per requirement with sufficient head room for cable termination. 3 mm thick removable gland plate shall be provided for cable termination.

3.13 EARTHING :

The earthing of the breaker body and moving portion shall be so arranged. that the earthing of the non-current carrying structure to the frame earth bar is completed well before the main circuit breaker plugs enter the fixed house sockets.

The entire panel board shall have a common tinned copper earth bar of suitable section with 2 earth terminals for effectively earthing metallic portion of the panels. The frame earthing of panel shall be in accordance with chapter 4 of. this specifications.

3.14 INSTALLATION :

The installation work shall cover assembly of panels lining up. grouting the units etc. In the case of multi panels switch boards after connecting up the bus bar all joint shall be insulated with HV insulation tape or with approved insulation compound. A common earth bar shall be run preferably at the back of the switch board connecting all the sections for connecting the earth system. All protection, indications & metering connections and wirings shall be completed. Where. trip supply battery is installed the unit shall be commissioned, completing initial charging of the batteries . All relay instruments and meters shall be mounted and connected with appropriate wiring. Calibration checks of units as necessary and required by the licensee like

CTs , VTs Energy Meters etc. shall be completed before pre-commission checks are undertaken.

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3.15 TESTING & COMMISSIONING :

Commissioning checks and tests shall include in addition to checking of all small wiring connections, relays calibration and setting tests by secondary injection method and primary injection method. Primary injection test will be preferred for operation of relay through CTs. Before panel board is commissioned, provision of the safety namely fire extinguishers, rubber mats and danger board shall be ensured. In addition; all routine megger tests shall be performed. Checks and test shall include following :

- a. Operation checks
- b. Interlock function test
- c. Continuity checks of wiring fuses etc.
- d. Insulation tests
- e. Trip test and protection gear tests
- f. The complete panel shall be tested with 500 V megger for insulation between phases and phases to earth. Insulation test of secondary of CTs and PT to earth shall be conducted using 500 V megger.

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Part - II Chapter - IV

EARTHING

4.0 SCOPE :

This chapter covers the essential requirements of earthing system components and their installation. For details not covered in these specifications IS code of Practice on Earthing (IS: 3043-1987) shall be referred to.

4.1 APPLICATION :

- 4.1.1** The electrical distribution system is with earthed neutral (i.e. neutral earthed at the transformer / generator end). In addition to the neutral earthing, provision is made for earthing the metallic body of equipments and non-current carrying metallic components in the substation, as well as in the internal/external electrical installations.
- 4.1.2** Earthing system is also required for lightning protection, computer installations and hospital operation theaters, etc. for functional reasons.
- 4.1.3** Earthing requirements are laid down in Indian Electricity Rules, 1956, as amended from time to time, and in the Regulations of the Electricity Supply Authority concerned. These shall be complied with.
- 4.1.4** Application for Internal Earthing Installation
- a) Every sub-main will have earth continuity conductor to run along with sub-main wiring. In case of 3-phase sub-main wiring two earth continuity conductors shall be provided.
 - b) Every circuit will have its earth continuity conductor to run along -with circuit wiring. In case of 3-phase circuit two earth continuity conductors shall be provided.
 - c) Looping of earth is allowed only in case of point wiring.
 - d) When 2/3 power outlets are looped to one circuit, earth looping of these outlets is permissible.

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4.2 TYPES OF ELECTRODES & MATERIAL :

4.2.1 Earth Electrodes

4.2.1.1 Types :

The type of earth electrode shall be any of the following, as specified.

- a. Pipe earth electrode.
- b. Plate earth electrode.
- c. Strip or conductor earth electrode.

4.2.1.2 Electrode materials and dimensions.

- i. The materials and minimum sizes of earth electrodes shall be as per Table 4.2.
- ii. GI pipe electrodes shall be cut tapered at the bottom, and provided with holes of 12mm dia, drilled not less than 7.5 cm from each other up to 2 m of length from the bottom.
- iii. The length of the buried strip or conductor earth electrode shall be not less than 15 m. This length shall suitably be increased if necessary, on the basis of the information available about soil resistance, so that the required earth resistance is obtained. Prior approval of the Engineer-in-Charge shall be taken for any such increase in length.
- iv. All hardware items used for connecting the earthing conductor with the electrode shall be of OI in the case of OI pipe and OI plate earth electrodes, and forged tinned brass in case of copper plate electrodes.

4.2.2. Earthing Conductor & sizes

- i. The earthing conductor (protective conductor from earth electrode up to the main earthing terminal earth bus, as the case may be shall be of the same material as the electrode, viz. GI or copper, and in the form of wire or strip as specified.
- ii. The size of earthing conductor shall be specified, but this shall not be less than the following
 - a. 4mm dia. (8 SWG) copper wire.
 - b. 25mm x 4mm in the case of GI strip, or,
 - c. 20mm x 3mm in the case of copper strip.
- (iii) Earthing conductor larger than the following sectional areas need not be used, unless otherwise specified.
 - (a) 150 sq.mm. in case of GI, or,
 - (b) 100 sq.mm. in case of copper.

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4.2.3 Earth continuity / loop earthing conductor & sizes :- The material and size of protective conductors shall be as specified below:

Table 4.1

Size of Phase conductor	Size of protective conductor (of same material as phase conductor)
Up to 4 sq mm	4 sq mm
4-16 sq mm	Same size as of phase conductor
16-35 sq mm	16 sq mm
Above 35 sq mm	Half of phase conductor

4.3 LOCATION FOR EARTH ELECTRODES :

- i. Normally an earth electrode shall not be located closer than 1.5 m from any building. Care shall be taken to see that the excavation for earth electrode does not affect the foundation of the building; in such cases, electrodes may be located further away from the building, with the prior approval of the site-in-Charge.
- ii. The location of the earth electrode will be such that the soil has a reasonable chance of remaining moist as far as possible. Entrances, pavements and roadways, should be avoided for locating earth electrodes.

4.4 INSTALLATION :

4.4.1 Electrodes

4.4.1.1. Various types of electrodes

- i. a. Pipe electrode shall be buried in the ground vertically with its top at not less than 20 cm below the ground level. The installation shall be carried out as shown in approved drg.
- b. In locations where the full length of pipe electrode is not possible to be installed due to meeting a water table, hard soil or rock, the electrode may be to reduced length, provided the required earth resistance result is achieved with or without additional electrodes, or any alternative method of earthing may be adopted, with the prior approval of the Engineer-in-charge. Pipe electrodes may also be installed in horizontal formation in such exceptional cases.
- ii. Plate electrode shall be buried in ground with its faces vertical, and its top not less than 1.5 m below the ground level.

- iii. When more than one electrode (plate/pipe) is to be installed, a separation of more than 2 m shall be maintained between two adjacent electrodes.
- iv. a. The strip or conductor electrode shall be buried in trench not less than 0.5 m deep.

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- b. If conditions necessitate the use of more than one strip or conductor electrode, they shall be laid as widely distributed as possible, in a single straight trench where feasible, or preferably in a number of trenches radiating from one point.
- c. If the electrode cannot be laid in a straight length, it may be laid in a zigzag manner with a deviation up to 45 degrees from the axis of the strip. It can also be laid in the form of an arc with curvature more than 1 m or a polygon.

4.4.1.2. Artificial treatment of soil

When artificial treatment of soil is to be resorted to, the same shall be specified in the schedule of work. The electrode shall be surrounded by charcoal/coke and salt as indicated in Fig. 11 and 12. In such cases, excavation for earth electrode shall be increased as per the dimensions indicated in these figures.

4.4.1.3 Watering arrangement

- i. In the case of plate earth electrodes, a watering pipe 20 mm dia. Medium class pipe shall be provided and attached to the electrodes as shown in Fig. 9 and 10. A funnel with mesh shall be provided on the top of this pipe for watering the earth.
- ii. In the case of pipe electrodes, a 40 mm x 20 mm reducer shall be used for fixing the funnel with mesh.
- iii. The watering funnel attachment shall be housed in a masonry enclosure of size not less than 30 cm x 30 cm x 30 cm.
- iv. A cast iron / MS frame with MS cover, 6mm thick, and having locking arrangement shall be suitably embedded in the masonry enclosure.

4.4.2 Earthing conductor (Main earthing lead) :

- i. In the case of plate earth electrode, the earthing conductor shall be securely terminated on to the plate with two bolts, nuts, check nuts and washers.
- ii. In the case of pipe earth electrode, wire type earthing conductor shall be secured as indicated in fig. 11 using a through bolt, nuts and washers and terminating socket.
- iii. A double C-clamp arrangement shall be provided for terminating tape type earthing conductor with GI watering pipe coupled to the pipe earth electrode. Galvanized "C" shaped strips, bolts, washers, nuts and check nuts of adequate size shall be used for the purpose.
- iv. The earthing conductor from the electrode up to the building shall be protected from mechanical injury by a medium class, 15mm dia. GI pipe in the case of wire, and by 40mm dia, medium class GI pipe in the case of strip. The

protection pipe in ground shall be buried at least 30 cm deep (to be increased to 60 cm in case of road crossing and pavements). The portion within the building shall be recessed in walls and floors to adequate depth in due co-ordination with the building work.

- v. The earthing conductor shall be securely connected at the other end to the earth stud/earth bar provided on the switch board by:

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- a. Soldered or preferably crimped lug, bolt, nut and washer in the case of wire, and
- b. Bolt, nut and washer in case of strip conductor.

In the case of substations or alternators, the termination shall be made on the earthing terminal of the neutral point on the equipment and/or the earth bus, as the case maybe.

4.4.3 Loop Earthing/Earth continuity Conductor :

- i. Earth terminal of every switchboard in the distribution system shall be bonded to the earth bar/terminal of the upstream switch board by protective conductor(s).
- ii. Two protective conductors shall be provided for a switchboard carrying a 3-phase switchgear thereon.
- iii. Loop earthing of individual units will not be however necessary in the case of cubicle type switchboards.
- iv. The earth connector in every distribution board (DB) shall be securely connected to the earth stud/earth bar of the corresponding switch board by a protective conductor.
- v. The earth pin of socket outlets as well as metallic body of fan regulators shall be connected to the earth stud in switch boxes by protective conductor. Where the switch boxes are of non-metallic type, these shall be looped at the socket earth terminals, or at an independent screwed connector inside the switch box. Twisted earth connections shall not be accepted in any case.

4.5 EARTH RESISTANCE :

- i. The earth resistance at each electrode shall be measured. No earth electrode shall have a greater ohmic resistance than 5 ohms as measured by an approved earth testing apparatus. In rocky soil the resistance may be up to 8 ohms.
- ii. Where the above stated earth resistance is not achieved, necessary improvement shall be made by additional provisions, such as additional electrode (s), different type of electrode, or artificial chemical treatment of soil etc., as may be directed by the site-in-Charge.

4.6 MARKING :

- i. Earth bars/terminals at all switch boards shall be marked permanently as "E"
- ii. Main earthing terminal shall be marked "**SAFETY EARTH - DO NOT DIS-**

CONNECT".

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4.7 USE OF RESIDUAL CURRENT DEVICES (RCDs) :

An extract on selection and application of RCDs (also known as RCCBs) from IS: 12640-1988 is given at Appendix G. Provision of RCD shall be specified in individual cases keeping in view the type, use, importance, system of earthing and nature of electrical installations to be protected by the RCCBs, requirements of the local electric supply company, etc. The sensitivity shall be 30mA, 100mA, 300mA, or 500mA, as specified.

TABLE 4.2

Type of Electrode	Material	Size
Pipe	GI medium class	40 mm x 3.45 m without joint
Plate	Copper	60 cm x 60 cm x 3 mm thick
Strip	Copper	40 sq mm section
Conductor	Copper	4 mm dia

Part - II
Chapter - V

COMPACT SUB-STATION

5.1 SCOPE :

Compact Sub-station shall consist of 11/6 KV SF6 Insulated compact switchgear with VCBs as Protection to Transformer, Transformer and L.T. Switchgear with all connection accessories, fitting & auxiliary equipment in a pre-fabricated enclosure . The complete unit shall be installed on a substation plinth (base) as Outdoor substation. 11/6 KV Load Break Cable Switches control incoming-outgoing feeder cables of the 11/6 KV ring/radial distribution system. The Vacuum Circuit Breaker snail be used to control and isolate the Distribution transformer. The transformer's LT side shall be connected to L.T. switchgear.

The pre-fabricated compact substation shall be designed for size, ease of installation and maintenance and safety of staff and public using the area.

5.2 OUTDOOR ENCLOSURE :

5.2.1 The enclosure shall be made of Galvanized Sheet Steel or such other tropicalised material to meet Indian weather conditions.

5.2.2 The base of the enclosure shall ensure rigidity for easy transport & installation.

5.2.3 The structure of the substation shall be capable of supporting the gross weight of the equipment & the roof of the substation compartment shall be designed for adequate loads. There shall be no bolting arrangement on the doors and sides (periphery) so that there is no access of water, dust inside. This also ensures that the unit is well protected from outside from public nuisance owing to its being located in a crowded and compact places. Hinges and locks on the door shall be so designed that they are either not accessible to public from outside or can not be tampered with.

5.2.4 There shall be proper / adequate ventilation inside the enclosure so that hot air inside enclosure is directed out by help of duct. Louvers apertures shall be provided so that there is circulation of natural air inside the enclosure.

5.2.5 The complete design shall be modular in design i.e. small sheets shall be joined together to make a big sheet. The doors shall be provided with proper interlocking arrangement for safety of operator.

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5.2.6 The enclosure shall be provided with adequate lifting points such that entire CSS can be shifted with the help of crane without any need for dismantling from inside any of the components.

5.2.7 Covers & Door : Covers & doors are part of the enclosure. When they are closed, they shall provide the degree of protection specified for the enclosure. Additional wire mesh may be used with proper Danger board for safety of the operator. All covers, doors or roof shall be provided with locking facility or it shall not be possible to open or remove them before doors used for normal operation have been opened. The doors shall open outward at an angle of at least 90° & be equipped with a device able to maintain them in an open position. The top cover shall be slightly inclined so that there is no accumulation of water during rainy season or otherwise. Proper padlocking facility shall be provided for doors of each compartment.

5.2.8 Earthing: All metallic components shall be earthed to a common earthing point. It shall be terminated by an adequate terminal intended for connection to the earth system of the installation by way of flexible jumpers/strips & Lug arrangement. The continuity of the earth system shall be ensured taking into account the thermal & mechanical stresses caused by the current it may have to carry. The components to be connected to the earth system shall include:

- (a) The enclosure of substation,
- (b) The enclosure of High voltage switchgear & control gear from the terminal provided for the purpose.
- (c) The metal screen & the high voltage cable earth conductor,
- (d) The transformer tank or metal frame of transformer,
- (e) The frame &/or enclosure of low voltage switchgear.

5.2.9 Painting and Fabrication process

The paints shall be carefully selected to withstand tropical heat & rain. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling. For this purpose poly-urethane (or such other suitable) paint shall be used.

Special care shall be taken by the manufacturer to ensure against rusting nuts, bolts and fittings during operation. All bushings and current carrying parts shall be cleaned properly after final painting. The fabrication process shall ensure that there are no sharp edges on the sheets used. For modular structure the two smaller units shall be joined together by Clinching Technology so that there is no piercing of the material being joined. This type of joint shall ensure robust mechanical strength to the complete structure so made.

5.3 INTERNAL DESIGN :

5.3.1 Interconnection : The connection of HT switchgear to Transformer shall be with the help of suitable size of cables from Transformer to L T switchgear with the help of suitable size of Copper/Aluminum bus bars. The interconnections inside the unit shall be the responsibility of the supplier.

5.3.2 Internal Fault : Failure within the unitized substation due either to a defect, an exceptional service condition or mal-operation may initiate an internal arc. The unit shall be tested for Internal Arc fault test as per latest IEC 61330.

5.3.3 Internal Illumination : There shall be arrangement for internal lighting activated by associated switch a doors for HV, Transformer & LV compartments separately.

5.3.4 Labels : Labels for warning, manufacturer's operating instructions etc. & those according! local standards & regulations shall be pasted / provided inside and shall be durable & clearly legible.

5.4 11 KV SWITCHGEAR (Gas insulated Compact Switchgear) :

Extensible SF6 Insulated Compact Switchgear as required shall consist of following items:

5.4.1 Load Break Cable Switch : Load Break Cable Switch with integral earth switch both having full making capacity shall be used for Incoming and Outgoing cables if used in a ring. Suitable arc proof tested cable covers shall be provided for each cable switch. The cable covers accessible from front shall be mechanically interlocked to its corresponding earth switch and the earth switch shall be mechanically interlocked to its corresponding cable switch for safety of the operator.

5.4.2 Vacuum Circuit Breaker :

Vacuum Circuit Breaker shall be used for distribution network of HT switchgear. Vacuum Circuit Breaker complete with operating mechanism, self powered microprocessor based protection relay with associated Current Transformers shall be used for control and protection of Transformer. The VCB being fixed type shall be provided with an Isolator in series for isolation purpose for maintenance. An integral cable earthing switch with full making capacity shall be provided. The arc proof cable covers accessible from front shall be mechanically interlocked to the earthing switch, which in turn shall be interlocked to the isolator for safety of the operator.

5.4.3 The above Load Break Cable Switches, vacuum circuit breakers, Bus bars should be mounted inside a robotically welded sealed for life, stainless steel tank of 3 mm thick sheet metal. The operating mechanism of the switches and breakers shall be outside the SF6 tank and accessible from front. The tank should be filled with SF6 gas at adequate pressure. The degree of protection for gas tank should be IP67. There

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shall be provision for filling the SF6 gas at site. Moreover the Stainless Steel Gas Tank shall confirm to the sealed pressure system as per IEE and ensure the gas leakage up to 0.1 % per year as per IEE.

The VCB is required to control distribution Transformer and relay settings and Current Transformers shall be selected accordingly.

5.4.4 Ratings : The bus bars shall have continuous rating of 630 Amps. The isolator shall have a continuous rating of 630 Amps. VCB breaker shall have a continuous rating of 200 Amps in accordance with relevant IS / IEC standard

The Load Break Cable Switches shall be capable for breaking rated full load current. The same along with its earthing switch shall also be suitable for full making capacity of the system as specified. The complete switchgear shall be suitable for breaking capacity of 21 KA.

Switchgear shall be complete with all connection, bus-bars etc. Copper bus bars continuous rating shall be 630 Amps. The bus bars should be fully encapsulated by SF6 gas inside the steel tank.

5.4.5 Protection : The Circuit Breaker shall be fitted with microprocessor based self powered relay inside the front cover to avoid any tampering. The same shall be used in conjunction with suitable Current Transformer and Tripping Coil for fault tripping of the Circuit Breakers.

5.4.6 Cable Termination : Each Cable compartment shall be provided with three bushings of adequate sizes to terminate the incoming and outgoing 11/6 KV 3 Core cables. There shall be enough height (Minimum 450mm) from the base of the mounted switchgear so that the cables can be bent and taken vertically up to the bushings. The Cable termination shall be done by Heat shrinkable Termination method so that adequate clearances shall be maintained between phases for Termination. Access to all the cables should be possible from the front of panel. Cable Termination boots shall be supplied by the switchgear manufacturer.

5.4.7 Locking Arrangement : Suitable padlocking arrangements shall be provided as stated below:

- a. CB manual operating handle in the "OFF" position.
- b. Each feeder Panel operating handles in 'Closed' 'Open" or 'Earth' position.
- c. Each isolator operating handle in 'Closed', , Open', or 'Earth' position.

5.4.8 Testing : Each type of HT Switchgear shall be completely assembled, wired, adjusted and tested at the factory as per the relevant standards i.e. IS:9920, IS:3427. IS: 13118, IEC:265, IEC:298 during manufacturing and on completion.

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5.4.9 Routine Test: The tests shall include all tests as per relevant IS for the components following:

- a. Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme and proper functioning of the equipment.
- b. All wiring and current carrying part shall be given appropriate High Voltage test.