NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

ELECTRICAL DEPARTMENT

GENERAL SPECIFICATIONS
FOR
ELECTRICAL MATERIALS AND WORKS

2016

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NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

Technical Specification No. NFR/ELECT/CON/GS/GENERAL

GENERAL SPECIFICATION

1.0 Introduction

All electrification works shall be carried out in accordance with Indian Electricity Rules, Railway Regulations, BIS Specifications and Code of Practices, National Electricity Code, Energy Conservation Building Code (ECBC), National Building Code, Energy Conservation Act 2001with latest amendments. The specifications issued here are meant for guidelines and does not supersede any of the rules/regulations/codes/instructions issued by Railway Board/RDSO/CORE etc from time to time and they shall be followed accordingly. All the equipments and materials to be supplied shall be as per the specified approved/likely sources makes and laid down specifications with latest amendments.

2.1 Scope of work

The scope of general electrical works broadly consists of:

- External electrification works pertaining to cabling/overhead alignment & associated works for extension of power supply, street lighting etc.
- Modification to existing electrical installations as per site requirement.
- Dismantling/relocation of electrical installations as per site requirement.
- Modification to supply Authority's power lines, up to & including 400 kV, to bring them in conformity with the Regulations for Crossing of Railway Track, 1987 (latest).
- Provision of high mast lighting system with luminaries at circulating areas/yards etc.
- Electrification of un-electrified level crossings.
- Provision of 11 kV/415,33kV/415,33kV/11kV Volts electric sub-stations with equipments, panels etc.
- Provision of pumping system for water supply.
- Provision of battery charging and pre-cooling facilities.
- Provision of temporary arrangements for lights & fans during, non-interlocking period.
- Coordination with Power supply authorities.
- Survey and drawings of related electrical works.
- Provision of DG sets, air cooling system, escalators, elevators, travelators and lifts etc.
- Coordination with other agencies working at same site.

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(U. K. Abdiya)
CEE/CON/NFR

3.1 Standards

The following standards as amended from time to time, shall apply:

i) Bureau of Indian Standards (BIS) specifications and Code of Practices.
ii) Indian Electricity Act 2003 and rules framed there under.
iii) Regulations laid down by the Chief Electrical Engineer of the concerned zonal railway/ Chief Electrical Inspector/local authorities.
iv) Indian Electricity rules, 1956.
v) Energy Conservation Act 2001
vi) Energy Conservation Building Code
vii) National Building code
viii) Standards/specifications, Guidelines/directions issued by Railway Board/RDSO from time to time.
ix) International Standards like IEC etc.(as the case may be)
x) GCC-2014 issued by Railways with latest amendments.

NOTE:

a) **In case of any conflict between the above standards, the decision of Railway shall be final.**
b) Henceforth in these Technical Specifications, wherever the BIS specification no. or any other specification, Code of Practice etc. are referred to, **they shall apply to the latest version of the relevant standard**, unless specifically stated otherwise.
c) Only the latest version of rules/standards/drawings/instructions shall be applicable unless specifically stated otherwise. **In case of any conflict between various instructions, decision of the Railway shall be final**. Unless otherwise specified, the specifications/rules/instructions/codes etc applicable on the date of tender opening shall be followed for the work & normally, the bidders shall also follow the cut-in date specified by RDSO/Railway Board.
d) RDSO's specifications (with latest revision) are to be followed. When RDSO's specifications are not available, BIS (Bureau of Indian Standards) specification with latest revisions are to be followed.
(Ref: Rly. Board L/No. 2005/RE/141/1/Pt New Delhi dtd 01.09.2005)
e) **Notwithstanding any approval of drawing or work by Railways, the contractor shall be finally responsible for following correct instructions and drawings as per latest amended details. In case any mistake is found in the work/drawing later on which is not carried out/prepared in accordance with laid down standards, rules and regulations, the Railway shall be free to reject it at any stage of the work. The contractor shall be liable to dismantle/modify/redo the rejected work without any extra cost as per directions of the Railway. The decision of the Railway shall be final in this regard.**

(Mahfuj Sarkar) JE/TECH/CON/HQ	(J.C.Das) AEE/CON/PL/MLG	(K.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CFE/CON/HQ/MLG

(R.K.Maliya)
CEE/CON/HQ/R

3.2 Ratings of Components: All the equipments/components in the electrical system shall be of appropriate rating of voltage/current and frequency as required. All the conductors, switches and accessories shall be of such size as to be capable of carrying maximum current which will normally flow through them without getting them over burdened/overheated.

4.0 Earthing

Earthing shall be provided as per Indian Electricity (IE) Rules, 1956, earthing specification and drawings duly approved by the Railway.

5.0 Safety Instructions

5.1 Indian Electricity Rules 1956, are to be followed.

5.2 The detailed instructions on safety procedures given in BIS Specifications, Indian Electricity Rules, respective Supply Authority's regulations and Railway Rules, shall be applicable, all with their latest amendments.

5.3 The Electrical Contractor/ Sub-Contractor shall hold a valid and relevant Electrical Contractor's License for LT/HT/EHT Voltage issued by any State Government. All the work on electrical installations shall be done under the direct supervision of persons holding valid certificates of competency issued by any State Government.

5.4 No inflammable materials shall be stored in places other than the rooms specially constructed for this purpose in accordance with the provisions of Indian Explosives Act.

5.5 Protective and Safety equipments such as rubber gloves, earthing rods, lineman's safety belt, high visibility jackets, portable artificial respiration apparatus etc., shall be provided to the working staff as and when required for safe working.

5.6 Caution boards such as "Man working on line", " Do not switch on" etc, shall be provided on the HT/LT Panel Boards, for indication that the switch has been put to off position and person has been allowed to work on line.

5.7 "Permit to Work" shall be got issued from the person in-charge of the installation, prior to start of work, on energized electrical installations.

5.8 No work on live bus bar or switch boards shall be handled by a person below the rank of a Licensed Wireman and such work shall be done in the presence of a competent Engineer.

5.9 When working on or near live installations, suitable insulated tools shall be used, and special care shall be taken to ensure that tools do not drop on live terminals causing shock or dead short.

[Manju Tongone] JE/TECH/CON/HQ	[B.C.Das] AEE/CON/PL/MLG	[B.C.Das] EFE/CON/MLG	[Ram Bhiman] DY.CEE/CON/HQ/MLG

[R.K.Moliya] CFE/CON/NFR

5.10 The electrical switch boards/ distribution boards shall be clearly marked to indicate the areas being controlled by them.

5.11 Any other safety instructions required as per Railway working is to be followed.

6.0 Man- Power

6.1 The contractor shall employ competent, licensed, qualified full time electrical engineers to direct the work of electrical installations in accordance with the applicable specifications, IE Rules, Acts, GCC and Railway Regulations. The Contractor's Engineer(s)/ technician(s)/ Workmen shall possess the necessary license/competency certificate issued by competent authority including Railways as required under rules/law etc.

6.2 The Contractor's Engineer shall possess relevant knowledge/ experience in substation work/ wiring of residential/ service buildings, illumination of streets/ railway yards/ circularing areas, designing of distribution system, mains/ sub-mains/ individual distribution boards, modification of overhead power line crossings, stringing of overhead mains and laying of underground cables etc. as applicable to the works included in the scope of the contract.

7.0 Inspection of Equipments/ materials

7.1 The inspection of various Equipments/ materials as specified in relevant IS/Specifications shall be carried out by the agencies as specified below provided the value of material is more than specified limits as per Railway Board Letter No 2000/RS(G)/379/2 dt 10/9/2013 (Rs. 1.5 Lakh as of now). In other cases, inspection shall be arranged by Railways/its Representative as per table below

1	Power Distribution Transformers	RITES
2	H.T./L.T Panels	RITES
3	High Mast Lighting Systems	RITES
4	Diesel Generating Sets	RITES
5	H.T./L.T Cables	RITES
6	Battery Chargers	RITES
7	APFC Panels	RITES
8	ACSR conductor	RITES
9	Tubular Poles	RITES
10	Luminaries and Lamps	Railway/ its Representative
11	Fans and Regulators	Railway/ its Representative
12	Wiring Cables and accessories	Railway/ its Representative
13	Feeder Pillar and Switch Boards	RITES
14	Meter Board, Meters	Railway/ its Representative
15	G.I. Pipes	Railway/ its Representative
16	HT End Terminations	RITES
17	Insulators and Stays	RITES
18	Glow Sign Boards	Railway/ its Representative
19	Battery Charging system and Pre Cooling Points	Railway/ its Representative
20	Pumps	RITES
21	All other materials	Railway/ its Representative

(Neeraj Srivastava) JE/TTC(U)/CON/HQ	ATE/CON/CPL/MLG	(R.T. Das) CEE/CON/MLG	(Ram Bhrosan) Dy.CEE/CON/HQ/MLG

(R.K.Abolhassani) CTE/CON/NCR

7.2 The inspection of the above items will be done at the manufacturer's works or other appropriate location decided by Railway and inspection fees chargeable by Inspecting Authority will be borne by the contractor. In exigency of work or revision in Railway Board's policy, inspection authority may be changed by Railway. If the inspection is carried out by other than RDSO/RITES, the inspection charges shall be recovered as per extent policy of Railway.

7.3 OEM's certificate and other papers, such as material challans etc. shall be furnished by the Contractor, to establish the genuineness of the equipment/ material.

7.4 Nominated Inspector shall have free access to visit the manufacturer's works at all reasonable times to witness and inspect the testing of equipment/ materials. The contractor shall provide all reasonable facilities and equipments/lab at his cost for proper inspection of the material/equipment.

7.5 Item available as catalogued product in market like MCBs, MCCBs, wiring accessories, light fittings, fan etc. will be acceptable on factory routine test report for the batch, certificate from authorized dealer and manufacturer and visual inspection at site. However engineer may decide to get any item under the scope of supply inspected by any agency (RITES/ Rly) at manufacturer's work if so required. And the cost of such test shall be borne by contractor. If Railway wants to get any special test done on any item other than at manufacturer's work, the cost of the same shall be borne by Railway.

7.6 The Contractor shall ensure that all the equipments/materials supplied are tested as per relevant BIS/ BS Specification and comply with instructions on energy star rating issued by BEE wherever applicable. As per present RB instructions, all energy consuming equipments should be procured with min 5 star energy rating.

7.7 The Contractor shall ensure that all the equipments/materials supplied is procured from applicable approved list of sources. In case item is not featuring in approved list or approved itself is not available, prior approval of Railway shall be taken before placing order. Detail guidelines of Railways issued from time to time shall be applicable in this regard.

8.0 Pre- Commissioning tests on Equipment

8.1 The pre commissioning tests on various equipments shall be carried out jointly by the Contractor with the Engineer.

8.2 The Contractor shall get the electrical installations checked and approved from the Concerned Chief Electrical Engineer of Railways, Electrical Inspector/ local Authority/ CEA/ any other regulatory authority as per requirement. The work will not be treated as complete until such clearances are obtained by the Contractor. He shall also obtain any other clearances that may be required from time to time. The installation shall be energized, in the presence of the Engineer, only after the receipt of all such approvals.

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CEE/CON/HQ

9.0 Other Requirements

9.1 Care shall be taken by contractor to avoid damage to the building during execution of his part of work. He shall be responsible for repairing all damages and restoring the same to their original finish at his own cost. He shall also remove at his cost all the unwanted and waste materials arising out of his work from the site. The Contractor shall dress up/repair the site as per the existing surrounding ground/ floor/walls/ road surface etc. after completion of the work and make good any damages that occurred during the execution of works.

9.2 The work shall be carried out with minimum power shut downs. The required shut downs from railway/other agencies will be arranged by the Engineer, with the active assistance of Contractor, in consultation with user departments, and the charges if any & not mentioned otherwise, shall be borne by Railway.

9.3 Coordination with other Agencies:

The contractor shall coordinate with all other agencies working in same site area so that work is not hampered due to delay in his work. Recessed conduit and other works which directly affect the progress of the main work should be done in time and on priority.

Wherever approval is to be taken from other department (s) of state/central government, standards of work and approved list of equipments /materials should be followed as per their requirement and approvals obtained.

9.4 Work in Occupied Buildings:

While working in the occupied buildings, there should be minimum inconvenience to the occupants. Work should be programmed in coordination with the engineer and occupying department. If required, work may have to be planned beyond normal working hours.
The contractor shall be responsible to abide by the regulations/restrictions regarding entry into and movement within the premises.

9.5 The rates are deemed to be inclusive of all lead (except as otherwise specifically provided in the description of the particular item), lifts ascend descend, handling, re-handling, crossing of nullahs/streams/tracks or any other obstructions.

9.6 All enabling works for executing the work e.g. approach road to site, launching arrangements, procuring right of way, arrangement of water and electricity etc. is to be arranged by the contractor at his own cost and is deemed to be included in the quoted rates.

9.7 **Storage of Material:** All the material at site shall be properly stacked & stored so as to facilitate inspection. The material should be properly protected from detrimental effects of nature, fire, theft etc. The contractor shall be responsible for

(Manju Vinayre) JE/TECH/CON/HQ	(S.K.Das) AEE/TECH/PL/NCLG	(D.C.Das) EEE/CON/MLG	(Ravi Bhushan) Dy.CFE/CON/HQ/MLG

(R.S.Arolya) CFE/Con/Hq/MLG

watch & ward and any loss or deterioration on account of above shall lead to rejection of material. In this eventuality, the contractor shall have to replace the same at this own cost

9.8 All minor items viz. hardware items, foundation bolts clamps, termination lugs for electrical connections etc. as required and necessary for proper working of the equipment shall be deemed to have been included in the Bill of Quantities, whether such items are specifically mentioned or not. All hardware & M.S components should be either Galvanized or Electroplated.

9.9 If any activity of work is essential for the satisfactory completion of the work but is not mentioned specifically in the Bill of Quantities or elsewhere in the bidding documents, the same shall be deemed to be included in the scope of work and shall be executed by the contractor within the same accepted cost. The work shall be handed over in a functional manner complete in all respects. However, the major items which have been left out, the cost of the same shall be paid as per existing policy for which approval shall be taken in advance before execution of work.

10.0 Approval of Drawings and completion drawings

10.1 On issue of LOA, the successful bidder shall visit the site and prepare working drawings as per site requirements. Drawings shall conform to the relevant standards and details given in Indian Railway works Manual and prepared in Auto CAD. The drawings which require prior approval shall be first prepared and submitted in three copies with one soft copy as check drawings. The comments and corrections received back shall be incorporated while preparing the final drawing on RTF sheets for signatures and approval.

10.2 The drawings of all equipments including HT/ LT panels, transformer, DG set, distribution boards, pre-cooling/battery charging points battery charger, wiring plan, route of laying of cables, poles , and other items shall be got approved from the tenderer. Manufacturing of the items can be taken in hand only after the approval of the drawings and samples. The Contractor shall supply six copies in addition to one copy on RTF and soft copy of each of these approved drawings before commencement of work.

After completion of the work, as erected completion drawings shall be submitted in four copies in addition to two copies on RTF and soft copy.

11.0 Commissioning of Completed Works:

11.1 After completion of work, the Contractor shall ensure that the installations have been commissioned only after due testing and approval of the Engineer.

(Mohammad Sohel) IF/TECH/CON/HQ	(M.C.Das) AEE/CON/N/MLG	(B.C.Das) TT/CON/MLG	(Ravi Bhushan) JE/C&W/CON/HQ/MLG

(K.K. Mahapatra) CEE/CON/NFR

12.0 Completion Plan and Completion Certificate:

12.1 After completion of works, the Contractor shall submit required sets of 'As Erected' drawings as per para 10.2 above in respect of all the electrical installation works.

12.2 Completion Certificate, in the following format, shall be jointly signed by the Engineer and Contractor.

Completion Certificate

I/ We certify that the installation detailed below has been installed by me/ us and tested and that to the best of my/ our knowledge and belief it complies with Indian Electricity Rules, 1956, Electrical installation at----------
Voltage and system of supply----------

Particulars of work:

(a) Internal Electrical installation :

No.	Total load System of wiring	
i	Light point	
ii	Fan point	
iii	Plug point	
iv	3 pin 5 Amp.	
v	3 pin 15 Amp	
vi	Other points	

(b) Motors

No	Total load	HP/KW	Type of starting
i ii iii			

(c) Other Plants

No		
i		
ii		

(Manju Sengupta) P/T(T/C)/CON/HQ	(S.K.Das) AT/CON/PL/MLG	(T.C.Das) CEE/CON/MLG	(Ram Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Mohanty)
C.T./CON/NJP

(d) Installation of over head line and underground cable

	Overhead line Total length and No. of spans.	
	No. of street lights and its description Underground cable Make and Year	
	Total length of underground cable and its size.	
	Number of joints End point	
	Tee Joint St. through Joint	

(e) Earthing

No.	Details	Qty with unit
a	Description of earthing electrode	
b	No. of earth electrodes	
C	Size of main lead	

(f) Test results- Insulation resistance

I	Insulation resistance of the whole system of conductors to earth in Mega ohms	----- Mega ohms
ii	Insulation between the phase conductor and neutral.	------ Mega Ohms
iii	Between Phase R and neutral	------ Mega Ohms
iv	Between phase Y and neutral	------ Mega Ohms
v	Between phase B and neutral	------ Mega Ohms
vi	Between phase R and phase Y	------ Mega Ohms
vii	Between phase Y and phase B	------ Mega Ohms
viii	Between phase B and phase R	------ Mega Ohms

(g) **Polarity test-** Polarity of non-linked single pole branch switches

(h) **Earth Continuity test** Maximum resistance between any point in the earth continuity conductor including metal conduits and main earthing lead---- Ohms.

(Manoj Agnihotri) JE/TECH/CON/HQ	(S.K.Das) AEE/CON/P.IV.C	(R.C.Das) LDC/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Mishra)
CEE/CON/HQ

(i) **Earth electrode resistance** Resistance of each earth electrode:

No.	
i)	..... Ohms
ii)	..... Ohms
iii)	..... Ohms
iv)	..... Ohms
v)	..... Ohms

Signature of the Engineer **Signature of Contractor**

Note: For obtaining EIG approval for energizing HT installations, the EIG application format of the concerned Railway shall be followed.

13.1 Concrete and Cement

(a) All the foundations [except as per details given in (b)], for masts of street lighting, solar lighting, LT/HT over head conductors, Guy wires, stays, steel/GI Tubular poles, Battery charging poles and pedestals, protective fencing shall be as per the approved drawings of the Railway. In these type of foundations, normally M-10 (1:3:6) cement concrete (except where specified otherwise) conforming to IS-456 with 20 mm coarse aggregates shall be used. The cement to be used shall be OPC 53 or as approved by Railway based on requirement and availability and date of manufacturing shall not be older than three months.

(b) Where foundations of equipments are to be laid as per OEM recommendations/standard drawings of the Railway/SEB, grade of cement, size of aggregate, concrete grade and foundation dimensions etc shall be as per their recommended standard such as High mast lighting system, H pole structures used for power line crossings.

The contractor shall use concrete mixer, proper shuttering and vibrators for compaction for foundations of high mast lighting system, large pumping installations etc as directed by Engineer. For smaller foundations detailed at (a) above, manual concrete mixing and compaction may be adopted.

(Rajeev Tandon) IE/TECH/CON/HQ	(R. Sagar) AFA/CON/S.RAIL	(B.P. Das) EE/CON/MLG	(Ravi Shankar) DY.CEE/CON/HQ/M.G

(R.K. Abolis)
CE/[illegible]/ENFRA

NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

Technical Specification No. NFR/ELECT/CON/GS/01(Power Line Crossings)

MODIFICATION OF POWER LINE CROSSINGS ON RAILWAY TRACKS

1.0 General:

The scope covers:

a) Modification of existing power line crossings of Railway track as per the regulations applicable to electrical overhead crossings and/or underground cables crossing the railway tracks operated by the Indian Railways, Railway companies and port commissioner's railways, including assisted and private sidings on which rolling stock of Indian Railway may work, unless any special section or railway tracks are exempted from these regulations by specific written orders of the Electrical Inspector.

b) Check survey and detailed survey of the sites for proposed modification. Survey should be done by approved surveyor of respective owner of Power line crossings.

c) Detailed drawing of the proposed modification work of crossing shall be prepared and approval be obtained from Railway and concerned owner of Power line crossings. For OH crossing proposed to be modified with underground cable, the size of the cable shall be selected equivalent to the existing OH conductor with the approval of owner of concerned Power line crossing. 6(six) sets of drawings shall be submitted to Railways for approval of competent authorities. After approval of relevant drawings, the work shall be executed under the supervision of concerned owner of Power line crossings/ Railway representative on site. After execution of work, 6(six) sets of hard copies and 6(six) sets of soft copies of as erected drawings shall be submitted by the contractor. All relevant drawings shall be made on autocad.

d) Soil investigation and foundation design:

i) Foundation for tower/ H-Poles etc. shall be made of appropriate design after carrying out soil test and same shall got approved by the owner of respective Power line crossings/ Railways

ii) OPC 53 cement shall be used for construction of foundation of H Poles, towers etc.

1.1 Compliance to Rules and standard specifications.

a) All the crossings shall be modified to comply with the latest Regulations for Electrical crossings of Railway Track 1987 with up to date amendments issued from time to time thereto.

(M.P.[illegible]) F/TECH/CON/HQ	(S.K.Das) AFE/CON/Pl/MLG	(S.C.Das) CEE/CON/MLG	(Rao Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Atolaya)
CEE/CON/NFR

b) Except where otherwise provided for in the regulations, the contents of relevant sections of the Indian Electricity Act 2003, Indian Railway Act 1989 and the rules made under these and as amended from time to time thereto and the relevant provisions of Indian Railway's Schedule of Dimensions (IRSOD) for Broad/ Meter / Narrow Gauges together with the latest amendments shall apply to the modified crossings.

1.2 Standard Specifications

All materials used in the construction of the crossing shall comply with the concerned owner of power line crossing / Railways/relevant latest BIS Specifications as the case may be.

1.3 Relevant Standard Specifications and Regulations:

(a) Track Crossing Regulation 1987 and IRSOD as amended/corrected till date.
(b) IS: 800-1984 :- Code of Practice for use of structural steel in general building construction.
(c) IS: 802-1985 :- Loads and permissible stresses.
(d) IS: 2629-1985 :- Recommended Practice For Hot Dip Galvanizing Of Iron And Steel.
(e) IS: 1255 1983 : Code Of Practice For Installation And Maintenance Of Power Cables Up To And Including 33KV.
(f) IS: 398 1961 - Aluminium conductors for overhead transmission purposes.
(g) IS: 7098 (Part-1):- Crosslinked polyethylene insulated PVC sheathed cables: Part 1 : For working voltage upto and including 1100V.
(h) IS: 7098 (Part-2):- Crosslinked polyethylene insulated PVC sheathed cables: Part 1 : For working voltage from 3.3 kV upto and including 33kV.
(i) Report No. BS: 105 of RDSO –Guidelines On Pipeline Crossings Under Railway Track.
(j) Indian Electricity Act 1956 (with latest amendments)
(k) Indian Railway Act 1989
(l) Code of practice for the protection of telecommunication Lines at crossings with Overhead power lines other than Electrical Traction Circuits"

1.4 Method of crossing – Overhead Line Underground Cables:

All low, medium and high voltages up to and including 11 kV crossings shall normally be by means of underground cables. While for voltages higher than 11 kV, crossing may be through overhead lines or underground cables. The use of underground cable to the extent possible would be advantageous particularly up to and including 33 kV systems. The decision for modification of crossing upto 33KV either by OH or underground cable shall be taken by Railways.

1.5 Overhead Power Line Crossing

1.5.1 Angle of Crossing

An overhead line crossing shall normally be at right angles to the railway track. In special cases a deviation of up to 30 degree may be permitted. Deviations larger than 30 degree shall have to be specifically authorized by the Electrical Inspector of the Railway.

(Manoj Sharma) JE/TECH/CON/HQ	(A. Das) AEE/CON/HQ/MLG	(S.C. Das) CEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Mallick)
CEE/CON/NFR

1.5.2 Structures

a) Steel poles/masts, fabricated steel structures poles either of the self-supporting type or guyed type conforming in all respects to the Indian electricity Rules, 1956 (as amended till date) and complying with the latest editions of Codes of Practice, IS: 800-1984 for "Code of Practice for use of Structural steel in General Building Construction, Traction and Telecommunication Lines', shall be used on either side of the track to support the crossing span. These structures shall be of the terminal type. For arriving at the crippling load, the wind loads as detailed in the latest edition of IS: 802 (Part I) – 1995 for "Loads and Permissible Stresses" shall be adopted. The steel structures shall normally be galvanized in accordance with IS:2629-1985 for "Recommended practice for hot dip galvanizing of iron and steel"

b) The minimum distance of the structures (supporting the crossing span) from the centre of the nearest railway track, including new proposed and considering for future, shall be as per para-11(iv) of IRSOD-2004 with latest corrections.

c) The crossing span shall be restricted to 300 m or to 80% of the normal span for which the structures are designed, whichever is less.

d) **Wind pressure**
The maximum wind pressure for design of the structure shall be as prescribed in IS:802/Pt.I/1995 for loads and permissible stresses.

1.5.3 Temperature
The maximum and minimum temperatures for design of the conductors and other wires shall be as prescribed in the latest edition of IS: 802 (pt. 1, Clause 10) with necessary correction for maximum temperature.

1.5.4 Factor of Safety
The factor of safety of all structures, conductors, guards, guys and ground wires used in the crossing shall be as stipulated in the Indian Electricity Rules, 1956 as amended till date and the relevant code of practice. Ground wires used in the crossing shall be as stipulated in the Indian Electricity Rules, 1956 (as amended till date) and the relevant Codes of Practice.

1.6 Clearance between the Overhead Line and Railway Track
An overhead line crossing over electrified railway track shall be located at the middle of overhead equipment span supported by two adjacent traction masts/structures. The distance between any of the crossing conductors and the nearest traction mast or structure under the most adverse conditions shall not be less than 6 m.

Note: If, in unavoidable circumstances, the crossing span cannot be so located, the minimum clearance between any of the crossing conductors of the crossing and the nearest traction mast or structure shall not be less than that specified for buildings in Rule 80 of the Indian Electricity Rules, 1956 (as amended till date). Specific permission in this regard shall be obtained from the Employer, prior to execution of work.

(Manju Vanzara) CTE/C/GDNR/HQ	(B.K.Das) A.CEE/CON/PL/MLG	(B.K.Das) EFR/CON/MLG	(Ravi Bhushan) Dy.CEE/CON/HQ/MLG

(R.K.Aditya)
CEE/CON/NCR

1.6.1 No overhead line crossing shall be located over a booster transformer, traction switching station, traction substation or a track cabin in an electrified area.

1.6.2 Clearance for Power Line Crossings including Telephone Line Crossings of Railway Tracks

Following clearances should be maintained as per ACS-10 of SOD-2004 and Advance correction slip-1A/Jan-2009 to ACTM circulated vide Railway Board's letter no.2000/Elect.(G)/161/1 Part-II dated 19.01.2009.

1.6.3

(a) Clearance for Power Line Crossings in Non-Electrified & Electrified Territory:

Sl. No.	Over Head Crossing Voltage	Minimum Clearance from Rail Level		Minimum Clearance between Highest Traction Conductor and Lowest Transmission line crossing conductor (mm)
		Existing Power line crossing for Non-Electrified Territory (mm)	New Power line crossing or crossing planned for alteration (mm)	
(1)	(2)	(3)	(4)	(5)
1	Upto and including 11 KV	Normally by underground cable		
2	Above 11 KV and upto 33 KV	10860	14660	2440
3	Above 33 KV and upto 66 KV	11160	14960	2440
4	Above 66 KV and upto 132 KV	11760	15560	3050
5	Above 132 KV and upto 220 KV	12660	16560	4580
6	Above 220 KV and upto 400 KV	14400	18260	5490
7	Above 400 KV and upto 500 KV	15360	19160	7940
8	Above 500 KV and upto 800 KV	18060	21860	7940

Note:

i) All heights/clearances are in mm and under maximum sag conditions.

ii) If the crossing is provided with guarding, a minimum clearance of 2000 mm shall be maintained between the bottom of the guard wire and highest traction conductor.

iii) Power line crossings in yard and station area shall be avoided.

iv) For new electrification works, existing crossings can continue, if dimensions are as per Column (5) above.

(Manju Tekam) JE/TECH/CON/HQ	(N.K. Das) AEE/CON/TI/MLG	(S.Gogoi) LLI/CON/MLG	(Ravi Prakash) DY.CEE/CON/HQ/MLG

(R.K. Mishra)
CEE/CON/NFR

(b) **Minimum Horizontal Distance of Structure:**

The minimum horizontal distance measured at right angles from the centre of the nearest track to any part of a structure (all structure shall be rigid and well founded), carrying electrical conductor crossing a railway shall be:

(i) For new structure : (H+6) meters

(ii) For existing structure : (H – 2.135) meters (as per ACS-13)

(where H is height of the post/structure from nearest ground level)

(c) The working of Railway crane under an overhead line crossing shall normally be avoided. If it becomes absolutely essential for a crane to work under such a crossing, the minimum clearance required to be maintained between the highest working point of the jib and the lower crossing conductor shall be as under:

Nominal System Voltage(KV)	Min.Safe Clearance (in mm)
33	1500
66	2000
110	2250
132	2500
220	3500
400	6000
500	7250
800	11500

1.6.4 **Clearance between Power Line & Communication Line:**

The minimum clearance to be maintained between a power line and a communication line shall be as prescribed in the "Code of Practice for the protection of Telecommunication Lines at crossings with Overhead power lines other than Electrical Traction Circuits" (latest edition) issued by Central Electricity Authority (CEA), Telecommunication Directorate, Power and Telecommunication Co-ordination Committee (PTCC Unit), Govt. of India.

Minimum clearance of Power cables to communication cable is 0.30m

1.7 Insulators

A double set of strain insulator strings shall be used in crossing span in conjunction with a yoke plate where necessary. Each string of such strain insulators shall have one insulator more than the number used in a normal span on the overhead line. The factor of safety of each string of insulators under the worst conditions shall be not less than 2.

1.8 **Anti-climbing Devices and Warning Notices:**

Where the voltage exceeds 650V, the supporting structures (of the overhead line crossing) on railway land shall be provided with anti-climbing. Besides, suitable caution/warning notices shall be erected on all such structures, in the regional language and in English, as may be prescribed

[Manoj Patidar] JE/TELE/CON/HQ	[K.B. Das] ASE/CON/PL/MLG	[Sudeep] FEE/CON/MLG	[Ravi Bhushan] DY.CEE/CON/HQ/MLG

[B. C Aloliya] CEE/CON/SER

for the purpose. The anti climbing devices and the caution/warning notices shall be got approved from the Railway by the Engineer.

1.9 Earthing

(a) Each structure on either side of the crossing span supporting the transmission line conductors shall be earthed effectively by two separate and distinct earths and connections. At least one separate earth electrode shall be provided for each earth connection. Earth resistance of the independent electrode shall be less than 5 ohms .

(b) All guard and stay wires shall be properly clamped to the structures connected to earth so as to maintain proper electrical continuity to earth.

(c) Where struts are provided, they shall also be effectively connected to earth separately as well as to the main structure earths.

(d) Where the earth resistance of the independent tower/structure is higher, the owner shall take necessary steps to improve the earth resistance either by providing multiple earth electrodes or by suitably treating the soil surrounding the earth electrode or by resorting to counterpoise earthing. The method of earthing the transmission/distribution line structures etc., for the crossing span shall be got approved from the Railway by the Engineer.

(e) The cross section of the earth conductor/connections for the earthing system shall be adequate for the application. They shall not be liable to be damaged or overheated or melted while carrying the short circuit current.

(f) Earthing shall be carried out as per concerned owner of power line crossing's approved drawings/designs.

(g) Earthing shall be done as per clause no. 9.4 & 9.5 describing typical pipe and plate earthing installation as per IS: 3043-1987 (code of practice for earthing).

1.10 Cable crossing

1.10.1 General

As far as possible, cable crossings shall make use of any existing culverts, sub-way etc. In case of electrified track(s), the crossing shall be provided at locations at least 5 meters away from any traction sub-station or switching station or mast of structure erected or proposed to be erected by the railway for the purpose of supply and distribution of power to the traction overhead equipment. The exact locations of such traction sub station or switching station or mast or structure in any particular area shall be obtained by the Engineer/Employer from the Railway.

1.10.2 Type of cable

Cables shall be armoured where cables are suspended from support and not laid in protective pipe, they shall be of the armoured and sheathed type.

(Man Singone) DY.CFE/CON/NF/G	(B.K.Das) AEN/CON/PL/MLG	(P.K.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CFE/CON/HQ/MLG

(R.K.Arolya)
CFE/CON/NF

1.10.3 Cathodic Protection

Cathodic protection of the cables shall normally not be adopted, unless specifically required by the railway or any other organisation having assets nearby to which interference is likely to be caused by currents following through the crossing.

1.10.4 Method of Laying cable under Railway Track(s)

(a) Cable shall be laid through cast iron (LA type) pipes/HDPE pipe etc. as per 300 item of suitable diameter and strength. Long lengths of pipe shall be laid with a gradient to facilitate drainage of water. The pipe shall be laid upto the point as approved by the Railway/Engineer. The laying of the cable shall be in accordance with the latest edition of IS:1255 1983 "Code of practice for installation and maintenance of Power cables upto and including 33 KV" and Report No. RS 105 of RDSO.

(b) The armouring and sheathing of the underground cable laid across or near any electrified railway track shall be earthed by independent earths at the two sealing ends of the cable.

(c) No further earthing of the armouring and sheathing of the cable shall be done within 500cm of the electrified track. The scheme and method of earthing shall specifically be approved by the Railway.

(c) Cables should be laid not less than 2 meter below the ground level.
(**Note**: Optical cables in block section are laid at 1.65m below GL.)

(c) Underground cable shall be done using any trench less technology like pushing technique or auger boring technique etc. In case it is not practicable to use the trench less technique, the other method can be used with prior approval of Railway.

(f) The diameter of the pipe or duct should be at least 1.5 times the outer diameter of cable. The ducts/pipes should be mechanically strong to withstand forces due to heavy traffic when they are laid across road/railway tracks.
(**Ref**- IS:1255-1983)

(g) In the case of single core cables the cast iron (LA type) or HDPE pipes should be large enough to contain all the three single core cables forming the circuit in the same pipe.
(**Ref** -IS:1255 1983)

(h) Spare cable in separate duct for future extension should be provided.
(**Ref**- IS:1255-1983)

(Manish Gaur) JE/ELE/CON/HQ	(R. Das) AEE/CON/PL/MLG	(R. Verma) EEE/CON/MLG	(Ravi Bhushan) DY.CFE/CON/HQ/MLG 11/5/16

(R. Kavitha)
CFE/CON/HQ

( ) **LT Cable laying:**

- 4 core cable shall be used for crossing for a circuit.
- One spare 4 core cable shall be laid in separate pipe/duct.

1.10.5 Termination of cable with structure

(a) Where the ends of a cable of an underground crossing are terminated on structures for connection to an overhead line, such structures shall comply with the Regulations in so far as they are applicable to overhead line crossings in structures.

(b) The pole on which the cable is terminated shall be provided with strut/stays to take the load of overhead mains. The crossing cable shall be inserted in a HDPE pipe(conforming to IS 4984/1995 and working pressure 6kgf/sq.mm) of suitable diameter. The HDPE pipe shall be supported to the termination pole with proper clamps, bolts and nuts. The clamps shall be provided to support the HDPE pipe at an interval of not more than 2.0 meter. The supporting HDPE pipe shall be provided along the structure upto a height of 2m above the GL. The open ends of the HDPE pipe shall be sealed to prevent extraneous matter causing damage to the cable. The exposed portion of the cable above the HDPE pipe shall be clamped to the pole at an interval of not more than 2m.

(c) The cable end shall be provided with termination kits on either ends of the crossing. Suitable jumper connections shall be provided between the overhead mains and the cable end terminations. Cold shrinkable kit should be utilised in 11KV and 33KV crossings.

1.10.6 Marking of Crossings

Each cable crossing shall be indicated by at least two cable route markers, one at each end of the crossing within the railway boundaries. The cable route marker shall be fixed at both ends of the underground crossings. Route markers for categories crossing are to be provided within railway boundary at railway boundary locations and at toe of the embankment and at an interval of maximum 30m. The following information shall be clearly displayed on the markers.

Electrical Cable	-- KV
Number of cables	-- Nos.
Danger Notice Plate	-- In English, Hindi and the Vernacular language of the District.
Depth of cable	-- mm below track level.
Depth of cable	-- mm below ground level between the toe of bank and railway fencing.

[Manoj Chaudhary] SrTTC(CON/HQ)	[A.K. Das] AFO(CON/PL/MLG	[R.K. Das] EEE/CON/MLG	[Ravi Bhushan] DY CFE/CON/HQ/MLG

[R. Katoli/A]
CFE/CON/NFR

1.11 Guidelines on Pipe Line Crossings under Railway Track as per Report No.BS-105 (October-2009):

1.11.1

(a) The work will be done under the supervision of Railway Engineers under suitable speed restriction and precautions as may be stipulated by the Railways.

(b) **Cushion:**

The minimum cushion below bottom of sleeper will be 600mm (minimum earth cushion should be 350 mm). However, for electrical cables higher cushion may be decided by the Zonal railways on case to case basis after the verification in consultation with the concerned Electricity Board authorities considering the prevalent safety norms and requirements.

(c) The minimum clearance between two pipes in the same location of pipeline crossing should be 600 mm or 2d (where d is the dia of the larger casing pipe) whichever is greater except in case of OFC cables.

(d) The alignment of pipeline should be so decided that it crosses track preferably nearest to right angle. The length of casing pipe should be upto the end of Railway land boundary to accommodate laying of tracks in future. The casing pipe shall extend to 5 m plus depth of pipe below the natural ground level beyond the toe of slope of embankment subject to minimum of 14m from the centre of outside track. However, for higher embankment and where carrier pipe is not required otherwise to be buried in ground, casing pipe will be terminated similar to pipe culvert. Crossing under any yard should be avoided, since it will involve crossing under a number of tracks.

(e) Pipes should be inserted under the track using any trench less technology like pushing technique or auger boring technique etc. In case it is not practicable to use the trench less technique, the Railway can use the cut and cover or service span method.

(f) The recommended safe distance of the edge of the push pit/ catch pit from the outermost railway track centre will be equal to 3m plus twice the formation height plus the depth of catch/push pit. However, this distance will depend upon the local soil conditions and has to be decided by the executive at site after taking into consideration the type of soil and provision or non-provision of any shoring etc.

(g) Route markers for categories crossing are to be provided within railway boundary at railway boundary locations and at toe of the embankment and at an interval of maximum 10m.

(h) Organizations laying pipeline crossing may be allowed to lay pipeline under railway supervision as per extant rules within railway area using their own equipment. Passing of pipelines by pipe pushing / auger boring/ direction drilling would also be done under suitable speed restriction and observation of all safety precautions. The track formation should be kept under careful observation for a few days after laying of pipeline crossing.

(Manju Yadav) IE/TECH/CON/HQ	(S.C.Das) AEE/CON/N.J.M.G	(S.C.Das) CEE/CON/MLG	(Pawan Kumar) Dy.CEE/CON/HQ/MLG

(A.K.Atolia)
CEE/CON/NFR

1.11.2 Pipeline crossings under Railway track or under Railway bridge carrying electrical cables:

(a) The casing pipe size of this type of crossing should be limited to the requirement and preferably not more than 350 mm.

(b) Pipeline should be suitably insulated in case of electrical wire crossings depending upon the voltage and current etc.

(c) Reinforced Concrete pipes conforming to IS: 458 may be used.

(d) Reinforced Cement Concrete (RCC), Pre-stressed Concrete (PSC) of Steel Pipes of adequate size and strength may be used for carrying telephone wires, cables etc.

(e) Both sides of the steel pipes conforming to IS: 458 may be used.

1.12 Co-ordination with concerned owner of power line crossing and standards:

The Railway shall co-ordinate owner of power line crossing for smooth working and shall arrange required approvals if any. Railway shall arrange for shutdown with concerned owner of power line crossing. Contractor shall follow standards and specification, approved list of concerned owner of power line crossing for proper energisation.

1.13 Payment of compensation towards damages (for 66 KV and above) in regard to Right of Way for transmission lines, Railway shall pay compensation as per prevailing rules.

1.14 Likely Sources of Fittings:

1. Tower : Tower should be of POWERGRID approved vendor list M/s. EMC, Kolkata / M/s. RPG Transmission Ltd., Jabalpur/ M/s. Larsen & Turbo Ltd., Pondicherry / M/s. Jyoti Structures Ltd., Nasik.
2. ACSR Conductor: Fort Gloster / Hindustan Bidyut / Lumino / Krishna / Necab / Vinesh /Hement as per BIS standard.
3. HT Disc Insulator : Inyshree / Oblum / Dipro / RRI / Allied / Kappa / Raychem makes.
4. MS Angle, channel, plates: TISCO / IISCO / SAIL.

Note: Apart from above, any other make from approved list for owner of power line crossings shall be accepted with the consent of owner of the power line crossings and approval of the Railway representative as the case may be.

(Manjit Singh) JE/TECH/CON/HQ	(S. Das) APE/CON/PL/MLG	(R. Das) CEE/CON/MLG	(Name illegible) DY.CEE/CON/HQ/MLG

(D K Ahuja)
CEE/CON/NFR

1.15 Terms and Conditions:

1. Work will be executed under supervision of Railway as well as concerned owner of power line crossing.
2. Released materials should be handed over to concerned owner of power line crossing at their Depot including the cost of transportation, loading, unloading, and stacking of the materials etc. after observing all the formalities with the approval of Railway representative at site of the level of Sr. supervisor and above.
3. The entire work shall be executed under the supervision of the representative of concerned owner of power line crossings/ Railways. The erection of towers, stringing of conductors / earth wire / hareware etc. are required to be done after obtaining necessary power block, traffic block and ROW of the surrounding area. The work should be carried out within minimum shut down of such important lines.
4. The necessary inspection of all the materials shall be done by the representative of concerned owner of power line crossing/Railway representative and arrangement of expenditure for inspection of materials from respective approved manufacturer's premises shall be borne by firm himself. Test certificate and Guarantee certificates of Disc insulators of original manufacturer to be submitted at site before execution of work.
5. Arrangement shall be made by the firm for erection of one temporary diversion of line towards ensuring continuity of power flow during execution, if required.,
6. Tower should be supplied by the approved vendors of concerned owner of power line crossing.
7. Routine test of tower super structure materials, galvanisation etc. as per IS should be done at manufacture premises in presence of representative of concerned owner of power line crossing / Railway representative before despatching the materials at site.
8. Routine test for insulator will be conducted at the manufacturer premises or any other registered tested laboratories and the same will be witnessed by the site Engineer of concerned owner of power line crossing / Railways before despatching the same to the site.

[illegible]	(S.K.Das)	(D.C.Das)	(Rowshan Rai)
[illegible]	[illegible]	SEE/CON/MLG	DY.CEE/CON/TG/MLG

(R.K.Acalya)
CEE/CON/NFR

1.16 EQUIVALENT XLPE CABLE TO ACSR CONDUCTOR:

1.16.1 EQUIVALENT XLPE CABLE FOR 19/33 KV SINGLE CORE, AL CONDUCTOR ,XLPE INSULATED ARMOURED CABLES TO ACSR CONDUCTOR

ACSR CONDUCTOR BASED ON IS:398/1961							EQUIVALENT XLPE CABLE (CONSIDERING 40°C AMB. TEMP.) FOR 19/33 KV SINGLE CORE, AL COND. XLPE INSULATED ARMOURED CABLES CONFORMING TO IS: 7098 (PART-2)					
SL. NO.	CONDUCTOR NAME	NOMINAL COPPER AREA EQUIVALENT SQ.MM.		CALCULATED EQUIVALENT AREA OF ALUMINIUM (SQ. MM)	APPROX. CURRENT CARRYING CAPACITY(AMPS)		ALUMINIUM CONDUCTOR					
							GROUND		DUCT		AIR	
		AREA (SQ. MM)	AREA (SQ.INCH)		40°C Amb. Temp.	45°C Amb. Temp.	NOMINAL CROSS SECTIONAL AREA (SQ.MM)	CURRENT CARRYING CAPACITY (AMPS)	NOMINAL CROSS SECTIONAL AREA (SQ.MM)	CURRENT CARRYING CAPACITY (AMPS)	NOMINAL CROSS SECTIONAL AREA (SQ.MM)	CURRENT CARRYING CAPACITY (AMPS)
1	MOLE	6.5	0.01	10.47			-	-	-	-	-	-
2	SQUIRREL	13	0.02	20.71	115	107	35	120	50	120	25	120
3	GOPHER	16	0.03	25.9	130	122	50	140	70	160	35	145
4	WEASEL	20	0.03	31.21	150	139	70	170	70	190	35	145
5	FERRET	25	0.4	41.87	181	168	95	200	120	195	70	220
6	RABBIT	30	0.05	52.21	208	193	120	225	150	215	70	220
7	MINK	40	0.06	68.37	234	217	150	250	185	240	95	265
8	HORSE	42		71.58	-	-	-	-	-	-		
9	BEAVER	45	0.07	74.07	261	242	185	280	240	275	95	265
10	RACOON	48	0.07	77.83	270	250	185	280	240	275	120	300
11	OTTER	50	0.08	82.84	283	260	240	315	300	300	120	300
12	CAT	55	0.09	94.21	305	283	240	315	300	300	150	340
13	DOG	65	0.1	103.6	324	300	300	345	400	330	150	340
14	LEOPARD	80	0.13	129.7	375	348	400	385	630	385	185	385
15	COYOTE	80	0.13	128.5	375	348	400	385	630	385	185	385
16	TIGER	80	0.13	128.1	382	354	400	385	630	385	185	385
17	WOLF	95	0.15	154.3	430	398	630	450	1000	435	240	450
18	LYNX	110	0.18	179	475	440	800	485	-	-	300	500
19	PANTHER	130	0.2	207	520	482	1000	510	-	-	400	570
20	LION	140	0.23	232.5	555	515	-	-	-	-	400	570
21	BEAR	160	0.25	258.1	595	552	-	-	-	-	500	640
22	GOAT	185	0.3	316.5	680	630	-	-	-	-	630	720
23	SHEEP	225	0.34	366.1	745	690	-	-	-	-	800	790

(Manju Yadav) DGM/CON/HQ	(S.K.Das) AGM/CON/PL/MLG	(S.C.Das) PPE/CON/MLG	(Ravi Bhushan) DY.CLL/CON/HQ/MLG

(R.K.Arora)
CPE/CON/NER

ACSR CONDUCTOR BASED ON IS:398/1961							EQUIVALENT XLPE CABLE (CONDUCTOR TEMP. 90°C, AMB. TEMP.) FOR 19/33 KV SINGLE CORE, AL COND. XLPE INSULATED ARMOURED CABLES CONFORMING TO IS 7098 (PART 2) ALUMINIUM CONDUCTOR					
SL. NO.	CONDUCTOR NAME	NOMINAL COPPER AREA EQUIVALENT SQ.MM.		CALCULATED EQUIVALENT AREA OF ALUMINIUM (SQ.MM)	APPROX. CURRENT CARRYING CAPACITY(AMPS)		GROUND		DUCT		AIR	
		AREA (SQ. MM)	AREA (SQ.INCH)		40°C Amb. Temp.	45°C Amb. Temp.	APPROX OVERALL DIAMETER (MM)	CURRENT CARRYING CAPACITY (AMPS)	APPROX OVERALL DIAMETER (MM)	CURRENT CARRYING CAPACITY (AMPS)	APPROX OVERALL DIAMETER (MM)	CURRENT CARRYING CAPACITY (AMPS)
24	KUNDAH	250	0.4	394.4	–	–	–	–	–	–		
25	DEER	260	0.4	419.3	806	747	–	–	–	–	1000	850
26	ZEBRA	260	0.45	428.6	705	736	–	–	–	–	1000	850
27	FIR	300	0.45	465.7	860	796					1000	850
28	CAMEL	300	0.51	464.5			–	–	–	–	–	–
29	MOOSE	325		515.7	920	835	–	–	–	–	–	–
30	MORKUTA	300		540.2			–	–	–	–	–	–
31	SPARROW	29	0.03	33.16	–	–	–	–	–	–	–	
32	FOX	22	0.04	36.21	165	135	70	170	95	175	50	175
33	GUINEA	49	0.08	78.56	–	–	–	–	–	–	–	
34	LARK	124	–	126.1	–	–	–	–	–			

(Manju Tripathi)
EE/CO/CUN/HQ

(S. Das)
AE/CON/P-I/MUC

(G Dutta)
EEE/CON/MUC

(Ravi Bhushan)
20.5.16
SEE/CON/HQ/MUG

(R.K.Mishra)
CEE/CON/HQ

1.16.2 EQUIVALENT XLPE CABLE FOR 6.6/6.6 KV & 6.35/11kV SINGLE CORE, AL CONDUCTOR ,XLPE INSULATED ARMOURED CABLES TO ACSR CONDUCTOR

ACSR CONDUCTOR BASED ON IS:398/1961							EQUIVALENT XLPE CABLE (CONSIDERING 40°C AMB. TEMP.) FOR 6.6/6.6 KV & 6.35/11 KV SINGLE CORE, AL COND. XLPE INSULATED ARMOURED CABLES CONFORMING TO IS: 7098 (PART-2)					
							ALUMINIUM CONDUCTOR					
							GROUND		DUCT		AIR	
SL NO.	CONDUCTOR NAME	NOMINAL COPPER AREA EQUIVALENT SQ.MM.		CALCULATED EQUIVALENT AREA OF ALUMINIUM (SQ.MM)	APPROX. CURRENT CARRYING CAPACITY(AMPS)							
		ACSR (SQ. MM)	AREA (SQ.M M)		85°C Amb. Temp.	42°C Amb. Temp.						
1	MOLE	6.5	0.01	10.17	-	-	-	-				
2	SQUIRREL	13	0.02	20.71	115	107	35	120	50	125	25	120
3	GOPHER	16	0.03	25.9	133	123	50	140	70	155	35	145
4	WEASEL	20	0.03	31.21	150	139	70	175	70	155	50	170
5	FERRET	25	0.4	41.87	181	168	95	205	95	180	70	215
6	RABBIT	30	0.05	52.21	208	193	120	235	150	230	95	260
7	MINK	40	0.06	63.42	234	217	120	235	150	230	95	260
8	HORSE	42	-	71.58	-	-	-	-	-	-	-	-
9	BEAVER	45	0.07	74.07	261	242	185	255	185	280	95	260
10	RACCOON	48	0.07	77.83	270	250	185	255	240	300	120	305
11	OTTER	50	0.08	82.85	281	261	185	255	240	300	120	305
12	CAT	55	0.09	94.21	305	283	240	340	240	400	120	305
13	DOG	65	0.1	103.6	324	300	240	340	300	435	150	345
14	LEOPARD	80	0.13	120.7	375	348	300	385	400	380	185	395
15	COYOTE	80	0.13	128.5	375	348	300	385	400	380	185	395
16	TIGER	80	0.13	128.9	382	354	300	385	500	430	185	395
17	WOLF	95	0.15	154.3	430	398	400	440	500	430	240	470
18	LYNX	110	0.18	179	475	440	500	495	630	480	240	470
19	PANTHER	130	0.2	207	520	482	630	560	800	530	300	540
20	LION	140	0.23	232.5	555	515	630	560	1000	580	400	690
21	BEAR	160	0.26	258.1	595	552	800	620	1000	580	400	690
22	GOAT	185	0.3	316.5	680	630	100	680	-	-	500	730
23	SHEEP	225	0.35	366.1	745	690	-	-			630	840
24	KUNDAH	250	0.4	394.4	-	-	-				-	-
25	DEER	260	0.4	419.3	806	747					630	840
26	ZEBRA	260	0.45	428.6	795	736					640	840

[Manju] IF/TECH/CON/HQ	[R. Das] AGE/CON/PL/M LG	[K.T. Rao] EEE/CON/M LG	[Ravi Krishnan] Dy.CEE/CON/HQ/M LG

[R.K.Atolya] CEE/CON/KAR

SL. NO.	CONDUCTOR NAME	ACSR CONDUCTOR BASED ON IS:398/1961			EQUIVALENT XLPE CABLE (CONSIDERING 40°C AMB. TEMP.) FOR 6.6/6.6 KV & 6.35/11 KV SINGLE CORE, AL COND. XLPE INSULATED ARMOURED CABLES CONFORMING TO IS: 7098 (PART-2)						
		NOMINAL COPPER AREA EQUIVALENT SQ.MM.		CALCULATED EQUIVALENT AREA OF ALUMINIUM (SQ.MM)	APPROX. CURRENT CARRYING CAPACITY(AMPS)		ALUMINIUM CONDUCTOR					
							GROUND		DUCT		AIR	
		[illegible] (SQ. MM)	[illegible] (SQ.IN CM)		[illegible] Amb. temp	[illegible] Amb. Temp	[illegible] AREA (SQ.MM)	CURRENT CARRYING CAPACITY (AMPS)	[illegible] (SQ. MM)	CURRENT CARRYING CAPACITY (AMPS)	[illegible] (SQ. MM)	CURRENT CARRYING CAPACITY (AMPS)
27	ELK	300	0.45	485.7	860	796	–	–	–	–	800	960
28	CAMEL	300	0.51	484.5	–	–	–	–	–	–	–	–
29	MOOSE	375	–	515.7	900	835					800	960
30	MORKULLA	300		549.2			–	–	–	–	–	–
31	SPARROW	29	0.03	33.16	–	–	–	–	–	–	–	–
32	FOX	22	0.04	36.23	165	135	70	170	99	180	90	170
33	GUINEA	49	0.08	78.56	–	–	–	–	–	–		
34	LARK	124		156.1			–	–	–	–	–	–

(Manju Yadav)
JE/CON/CON/HQ

(S.K.Das)
ACE/CON/P&M-C

(S.Das)
DGM/CON/M-C

(Ravi Bhushan)
DY CEE/CON/HQ/MUL

(R.K.Arora)
CE/CON/NER

1.16.3 EQUIVALENT XLPE CABLE FOR 6.6/6.6 KV & 6.35/11kV THREE CORE, AL CONDUCTOR ,XLPE INSULATED ARMOURED CABLES TO ACSR CONDUCTOR

ACSR CONDUCTOR BASED ON IS:398/1961							EQUIVALENT XLPE CABLE (CONSIDERING 40°C AMB. TEMP.) FOR 6.6/6.6 KV & 6.35/11 KV THREE CORE, AL COND. XLPE INSULATED ARMOURED CABLES CONFORMING TO IS: 7098 (PART 2)					
							ALUMINIUM CONDUCTOR					
							GROUND		DUCT		AIR	
SL NO.	CONDUCTOR NAME	NOMINAL COPPER AREA EQUIVALENT SQ.MM.		CALCULATED EQUIVALENT AREA OF ALUMINIUM (SQ.MM)	APPROX. CURRENT CARRYING CAPACITY (AMPS)							
		ACSR (SQ. MM)	ACSR (SQ.MM.)		65°C Amb. Temp.	75°C Amb. Temp.	NO. (AND NOMINAL SECTIONAL AREA) SQ.MM	CURRENT CARRYING CAPACITY (AMPS)	NO. (AND NOMINAL SECTIONAL AREA) SQ. MM	CURRENT CARRYING CAPACITY (AMPS)	NO. (AND NOMINAL SECTIONAL AREA) SQ.MM	CURRENT CARRYING CAPACITY (AMPS)
1	MOLE	6.5	0.01	10.47			-	-	-	-	-	-
2	SQUIRREL	13	0.02	20.71	115	107	35	115	50	115	35	125
3	GOPHER	16	0.03	25.9	133	123	70	160	70	140	50	150
4	WEASEL	20	0.03	31.21	150	139	70	160	95	165	50	150
5	FERRET	25	0.4	41.87	181	168	95	190	120	190	70	190
6	RABBIT	30	0.05	52.31	208	193	120	220	150	210	95	230
7	MINK	40	0.06	68.32	254	237	150	245	185	240	120	260
8	HORSE	42		71.58			-	-	-	-	-	-
9	BEAVER	45	0.07	74.07	263	242	185	275	240	275	120	260
10	RACCOON	48	0.07	77.88	270	250	185	275	240	275	150	295
11	OTTER	50	0.09	82.85	281	260	240	315	300	310	150	295
12	CAT	55	0.09	94.29	305	283	240	315	300	310	185	335
13	DOG	65	0.1	103.6	324	300	300	355	400	350	185	335
14	LEOPARD	80	0.13	129.7	375	348	400	400	400	350	240	395
15	COYOTE	80	0.13	128.5	375	348	400	400	400	350	240	395
16	TIGER	80	0.13	128.1	382	354	400	400	-	-	240	395
17	WOLF	95	0.15	154.3	430	398	-	-	-	-	300	460
18	LYNX	110	0.18	179	475	440	-	-	-	-	400	520
19	PANTHER	130	0.2	207	520	482	-	-	-	-	400	520
20	LION	140	0.23	232.5	555	515	-	-	-	-	-	-
21	BEAR	160	0.25	258.1	595	552	-	-	-	-	-	-
22	COAT	185	0.3	316.5	680	630	-	-	-	-	-	-
23	SHEEP	225	0.35	366.1	745	690	-	-	-	-	-	-
24	KUNDAH	240	0.4	394.4								
25	DEER	260	0.4	419.3	806	747						
26	ZEBRA	260	0.45	428.6	795	736						

(Manju Nath) JE/TECH/CON/HQ	(Libes) AEE/CON/PLNG	(B.C.Das) EE/CON/MLG	(Ravi Bhushan) Dy.C.L/CON/TQ/MLG

(B.K.Ahuja)
CE/CON/NER

SL NO.	CONDUCTOR NAME	NOMINAL COPPER AREA EQUIVALENT SQ.MM.		CALCULATED EQUIVALENT AREA OF ALUMINIUM (SQ.MM)	APPROX. CURRENT CARRYING CAPACITY(AMPS)		EQUIVALENT XLPE CABLE (CONSIDERING 40°C AMB. TEMP.) FOR 6.6/6.6 KV & 6.35/11 KV THREE CORE, AL/COPPER COND. XLPE INSULATED ARMOURED CABLES CONFORMING TO IS 7098 (PART 2) ALUMINIUM CONDUCTOR					
							GROUND		DUCT		AIR	
		AREA (SQ. MM)	AREA (SQ.MM)		65°C Amb. Temp.	40°C Amb. Temp.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
27	TUK	300	0.45	465.7	860	796	–	–	–	–	–	–
28	CAMEL	300	0.51	464.5	–	–	–	–	–	–	–	–
29	MOOSE	325	–	535.7	900	835						
30	MORKUTA	300	–	549.2	–	–						
31	SPARROW	29	0.03	33.16	–	–						
32	FOX	22	0.04	36.21	165	155	95	110	95	165	70	190
33	GUINDA	19	0.08	78.56	–	–	–	–	–	–	–	–
34	LARK	224	–	196.1	–	–	–	–				

[Manju Yadav] JL/TLC I/CON/HQ	[R.Das] AEE/CON/PL/MLG	[B.C.Das] EFE/I/ON/MLG	[Ravi Bhushan] DY.CE/CON/HQ/MLG

[R.K.Acelya]
CFE/CON/AHQ

1.16.4 EQUIVALENT XLPE CABLE FOR 1.1kV FOUR CORE, AL CONDUCTOR ,XLPE INSULATED GALVANIZED STEEL WIRE/STRIP ARMOURED CABLES TO ACSR CONDUCTOR

ACSR CONDUCTOR BASED ON IS:398/1961							EQUIVALENT XLPE CABLE (CONSIDERING 40°C AMB. TEMP.)					
							FOR 1.1KV FOUR CORES, AL COND. XLPE INSULATED, GALVANIZED STEEL WIRE/STRIP ARMOURED CABLES CONFORMING TO IS 7098 (PART-1)					
							ALUMINIUM CONDUCTOR					
							GROUND		DUCT		AIR	
SL NO.	CONDUCTOR NAME	NOMINAL COPPER AREA EQUIVALENT SQ.MM.		CALCULATED EQUIVALENT AREA OF ALUMINIUM (SQ.MM)	APPROX. CURRENT CARRYING CAPACITY(AMPS)							
		AREA (SQ. MM)	AREA (SQ.INCH.)		50°C Amb. Temp.	40°C Amb. Temp.						
1	MOLE	6.5	0.01	10.47			-	-	-	-	-	-
2	SQUIRREL	13	0.02	20.71	115	107	35	110	70	140	35	117
3	GOPHER	16	0.03	25.9	133	123	50	140	70	140	50	140
4	WEASEL	20	0.03	31.21	150	139	70	170	95	165	70	176
5	FERRET	25	0.4	41.87	181	168	95	200	120	185	95	221
6	RABBIT	30	0.05	52.21	208	193	120	225	150	210	95	221
7	MINK	40	0.06	63.32	234	217	150	255	185	235	120	258
8	HORSE	42	-	71.58	-	-	-					-
9	BEAVER	45	0.07	74.07	261	242	185	285	240	270	150	294
10	RACCOON	48	0.07	77.82	270	250	185	295	240	270	150	294
11	OTTER	50	0.08	82.85	281	260	185	285	300	305	150	294
12	CAT	55	0.09	94.21	305	283	240	325	300	305	185	339
13	DOG	65	0.1	106.6	324	300	240	335	400	350	185	339
14	LEOPARD	80	0.13	129.7	375	348	400	435	500	405	240	402
15	COYOTE	80	0.13	128.5	375	348	400	435	500	405	240	402
16	TIGER	80	0.13	128.1	382	354	400	435	500	405	240	402
17	WOLF	95	0.15	154.3	430	398	400	435	680	470	300	461
18	LYNX	110	0.18	179	475	440	500	481	640	470	400	542
19	PANTHER	130	0.2	207	520	482	630	587	-	-	400	542
20	LION	140	0.23	232.5	555	515					500	624
21	BEAR	160	0.25	258.1	595	552	-	-	-	-	500	624
22	GOAT	185	0.3	326.5	680	630	-	-			630	723
23	SHEEP	225	0.35	366.1	745	690	-	-	-	-	-	-
24	KUNDAH	250	0.4	304.4		-	-	-	-	-	-	-
25	DEER	260	0.4	419.3	806	747	-	-	-	-	-	-
26	ZEBRA	260	0.45	428.6	795	736	-	-	-	-	-	-

(Manju Yadava) JE/TECH/CON/HQ	(R.K.Das) AEE/CON/P_/MLG	(U.C.Das) EE/CON/MLG	(Ravi Bhushan) JWALL/CON/ IC/MLG

(U.K.Abolyo)
CE/CON/NER

ACSR CONDUCTOR BASED ON IS:398/1961							EQUIVALENT XLPE CABLE (CONSIDERING 40°C AMB. TEMP.)					
							FOR 1.1 KV FOUR CORES, AL COND. XLPE INSULATED, GALVANIZED STEEL WIRE/STRIP ARMOURED CABLES CONFORMING TO IS: 7098 (PART-1)					
							ALUMINIUM CONDUCTOR					
							GROUND		DUCT		AIR	
SL NO.	CONDUCTOR NAME	NOMINAL COPPER AREA EQUIVALENT SQ.MM.		CALCULATED EQUIVALENT AREA OF ALUMINIUM (SQ. MM)	APPROX. CURRENT CARRYING CAPACITY(AMPS)							
		AREA (SQ. MM)	AREA (SQ.INCH.)		40°C Amb. Temp.	50°C Amb. Temp.	XLPE (COPPER CONDUCTOR) AREA (SQ.MM)	CURRENT CARRYING CAPACITY (AMPS)	XLPE (COPPER CONDUCTOR) AREA (SQ.MM)	CURRENT CARRYING CAPACITY (AMPS)	XLPE (COPPER CONDUCTOR) AREA (SQ.MM)	CURRENT CARRYING CAPACITY (AMPS)
27	FIK	300	0.45	465.7	860	705	–	–	–	–	–	–
28	CAMEL	300	0.51	464.5								–
29	MUSK	325	–	505.7	900	855						–
30	MORKULLA	300	–	549.2			–	–	–	–	–	–
31	SPARROW	29	0.03	33.16	–	–	–					
32	FOX	22	0.01	36.21	165	135	70	170	95	165	70	176
33	GUINEA	40	0.08	78.56			–	–	–	–	–	–
34	LARK	134	–	196.1			–	–	–	–	–	–

(Manju Bhatnagar) JE/TECH/CON/HQ	(S.K.Das) AM/CON/PL/M.G.	(R.C.Das) CEQ/CON/M.G	(Devi Jhajharia) DY.CEE/CON/HQ/M.G

(R.K.Arolia)
CEE/CON/NFR

1.16.5 EQUIVALENT XLPE CABLE FOR 1.1kV SINGLE CORE, AL CONDUCTOR ,XLPE INSULATED GALVANIZED STEEL WIRE/STRIP ARMOURED CABLES TO ACSR CONDUCTOR

ACSR CONDUCTOR BASED ON IS:398/1961							EQUIVALENT XLPE CABLE (CONSIDERING 40°C AMB. TEMP.)					
SL NO.	CONDUCTOR NAME	NOMINAL COPPER AREA EQUIVALENT SQ.MM.		CALCULATED EQUIVALENT AREA OF ALUMINIUM (SQ.MM)	APPROX. CURRENT CARRYING CAPACITY(AMPS)		FOR 1.1 KV SINGLE CORE, AL COND. XLPE INSULATED, AL WIRE/STRIP ARMOURED CABLES CONFORMING TO IS: 7098 (PART-1)					
							ALUMINIUM CONDUCTOR					
							GROUND		DUCT		AIR	
		AREA (SQ. MM)	AREA (SQ.INCH.)		65°C Amb. Temp.	45°C Amb. Temp.	SEC. CROSS SECTIONAL AREA (SQ.MM)	CURRENT CARRYING CAPACITY (AMPS)	SEC. CROSS SECTIONAL AREA (SQ.MM)	CURRENT CARRYING CAPACITY (AMPS)	SEC. CROSS SECTIONAL AREA (SQ.MM)	CURRENT CARRYING CAPACITY (AMPS)
1	MOLE	6.5	0.01	10.47	-	-	-	-	-	-	-	
2	SQUIRREL	13	0.02	20.71	115	107	35	117	50	125	25	115
3	GOPHER	16	0.03	25.9	135	129	50	138	70	155	35	140
4	WEASEL	20	0.03	31.21	150	139	70	168	70	155	50	170
5	FERRET	25	0.4	41.87	181	168	95	201	95	185	70	210
6	RABBIT	30	0.05	52.21	208	193	120	230	120	210	70	210
7	MINK	40	0.06	63.32	234	217	150	265	185	260	95	255
8	HORSE	42	-	71.58	-	-	-				-	-
9	BEAVER	45	0.07	74.07	261	242	300	265	185	260	120	300
10	RACCOON	48	0.07	77.83	270	260	185	265	240	300	120	300
11	OTTER	50	0.08	82.85	281	260	185	295	240	300	120	300
12	CAT	55	0.09	94.21	305	300	240	295	300	335	150	342
13	DOG	65	0.1	108.6	324	300	240	340	300	335	150	342
14	LEOPARD	80	0.13	129.7	375	348	300	390	400	380	185	385
15	COYOTE	80	0.13	128.5	375	348	300	390	400	380	185	385
16	TIGER	80	0.13	128.1	382	354	300	390	500	430	185	385
17	WOLF	95	0.15	154.3	430	398	400	450	500	430	240	450
18	LYNX	110	0.18	179	475	440	500	500	640	485	300	520
19	PANTHER	130	0.2	207	520	482	630	555	800	530	300	520
20	LION	140	0.23	232.5	555	515	630	555	1000	570	400	605
21	BEAR	160	0.25	258.1	595	552	800	625	1000	570	400	605
22	GOAT	185	0.3	316.5	680	630	1000	690			500	700
23	SHEEP	225	0.35	366.1	745	690	-	-	-	-	630	809
24	KUNDAH	250	0.4	394.4			-	-	-	-	-	-
25	DEER	260	0.4	419.3	806	747	-	-	-	-	630	809
26	ZEBRA	260	0.45	428.6	795	736	-	-	-	-	630	809

(Manik Yadapet) IF/TECH/CON/HQ	(S.R.Das) DGM/CON/PL/M-G	(R.C.Das) EEE/CON/M-G	(Ravi Bhushan) DY.CFE/CON/HQ/M-G

(R.K.Malya)
CFE/CON/HQ

SL. NO.	CONDUCTOR NAME	NOMINAL COPPER AREA EQUIVALENT SQ.MM.		CALCULATED EQUIVALENT AREA OF ALUMINIUM (SQ.MM)	APPROX. CURRENT CARRYING CAPACITY(AMPS)		EQUIVALENT XLPE CABLE (CONSIDERING 40 C AMB. TEMP.) FOR 3.3 KV SINGLE CORE, AL COND. XLPE INSULATED, AL WIRE/STRIP ARMOURED CABLES CONFORMING TO IS:7098 (PART 1) ALUMINIUM CONDUCTOR					
							GROUND		DUCT		AIR	
		AREA (in sq. mm)	AREA (in sq. mm.)		40°C Amb. Temp.	15°C Amb. Temp.	SEC (NOM. CROSS SECTIONAL AREA) (in sq. mm)	CURRENT CARRYING CAPACITY (AMPS)	SEC (NOM. CROSS SECTIONAL AREA) (in sq. mm)	CURRENT CARRYING CAPACITY (AMPS)	SEC (NOM. CROSS SECTIONAL AREA) (in sq. mm)	CURRENT CARRYING CAPACITY (AMPS)
27	TLK	300	0.45	465.7	860	796	–	–	–	–	800	935
28	CAMEL	300	0.51	464.5			–	–	–	–	–	–
29	MOOSE	324		515.7	900	885	–	–	–	–	800	935
30	MORKULL A	300		549.2		–	–	–	–	–	–	–
31	SPARROW	29	0.03	33.15	–	–	–	–	–	–	–	–
32	FOX	22	0.04	35.21	165	135	70	168	95	184	50	170
33	GUINEA	40	0.08	78.55			–	–	–	–	–	–
34	LARK	124	-	196.1	–	–	–	–	–	–	–	–

(Manju Tandon)
AL/ELU(CON/HQ

(B.K. Das)
AL/CON/P&C/MLG

(S.C.Das)
EE/CON/MLG

(Ravi Prasad)
SY.EE(LU/CON/ HQ/MLG

(S. K. Abdiya)
CE/(LU)CON/NER

NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

Technical Specification No. NFR/ELECT/CON/GS/02/Internal Electrification(wiring)

INTERNAL ELECTRIFICATION WORKS(WIRING)

2.0 Scope

This specification pertains to internal electrification of residential and service buildings on 3 phase, 415 volts or single phase, 230 Volts, 50 Hz Ac supply system, including provision of conduits with accessories, metal boxes and Boards, wiring, emergency and non-emergency circuits, power, sub lighting circuits, fan circuits etc.

2.1 Relevant Standard Specifications and Regulations (Latest Amendments):

(a) I.E.Rules 1956(latest amended)
(b) National Electric Code (NEC)
(c) Energy Conservation Building Code(ECBC)
(d) National Building Code
(e) IS:732-1989 :- Indian Standard Code of Practice for Electrical Wiring.
(f) IS:694/2010 :- PVC insulated unsheathed and sheathed cables/cords with rigid and flexible conductor for rated voltages up to and including 450/750V (Estd 9 Power Cables)
(g) IS:2509-1973 :- Rigid non-metallic conduits for electrical installations.
(h) IS:3419-1989 :- Fittings for rigid non-metallic conduits.
(i) IS:9537(Part 5):2000 :- Conduits for Electrical installations Part 5: Pliable Conduits of Insulating Material (Superseding IS 6946).
(j) IS:2667-1988 :- Fittings for rigid steel conduits for electrical wiring.
(k) IS:9537 Part 1,II,III :- Conduits for electrical installations.
(l) IS:14927-2(2001) :- Cable Trunking and Ducting Systems intended for mounting on walls or ceiling.
(m) IS:371/1999(ISI Marked) :- Ceiling Roses (Ltd 14 : Electrical wiring Accessories)
(n) IS:2036-1995 :- Phenolic Laminated Sheets
(o) IS:3043-1987 :- Indian Standard Code of Practice for Earthing.
(p) IS:374:1979 :- Electric ceiling type fans and regulators.
(q) Railway Board's Directives (latest)

2.2 The definitions of terms shall be in accordance with IS.732-1989 (Indian Standard Code of Practice for Electrical Wiring), except for the definitions of point wiring, circuit, sub-main and main wiring.

The conventional signs & symbols for technical work shall be indicated in the working and as erected drawings.

(Nirmal Kumar Gupta) CE/CON/COORD/MG	(S. Das) ALO/CON/PL/MLG	(S.C.Das) FA&CAO/CON/MLG	(Ravi Vishwakarma) DY.CE/CON/HQ/MLG

(R.K.Arolya)
CE/CON/NFR

2.3 SYSTEMS OF DISTRIBUTION AND WIRING AND GENERAL CONDITIONS:

a. Before starting wiring work approval of site drawings shall be obtained regarding layout, no. of points to be wired and location of switchboards etc.

b. All switchboards shall be of GI box type/ PVC box compatible with modular switches/plug points. No wooden switchboards shall be used.

c. 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.

d. Each main distribution board and branch distribution board shall be controlled by an incoming circuit breaker. Each outgoing circuit shall be controlled by a circuit breaker/switch with fuse. All Main/sub distribution boards shall be single/double door recess type/ surface type and shall be earthed.

e. For non-residential buildings, as far as possible, DBs shall be separate for light and power. Only MCCB/MCB type DBs shall be used. Kitkat fuse, glass fuse, Re-wirable type fuses shall not be used.

f. Three phase DBs shall not be used for final circuit distribution as far as possible.

g. '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.

h. Essential/non-essential/UPS/inverter distribution each will have a completely independent and separate distribution system starting from the main, switchboard up-to final wiring for each system.

i. Generally, no switchboard will have more than one source of incoming supply. More than one incoming supply will be allowed only at main board with proper safety and interlocking so that only one source can be switched on at a time.

j. Each MDB/DB/Switch Board will have spare outgoing ways for future expansion.

k. All M.S clamps/structures/hardware should be hot dip galvanized. If not possible special structures cold galvanization paint shall be applied and shall be earthed.

l. Balancing of 3-phase circuit shall be done.

m. Recessed conduit work is generally suitable for all applications. Surface conduit work may be adopted in places like workshops etc. and where recessed work may not be possible to be done. The type of work shall be as specified in individual works and can be carried out with the approval of HQ.

n. Adequate measures shall be taken to ensure proper clearing of cables running along the walls of station building/FOB and provide cover either made of FRP/Nylon or mild steel as per site conditions. Cable running on FOB should be preferably be laid in conduits.

2.4 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 meter board or main board/ sub main board to Distribution board/ Sub distribution board as the case may be. Looping of distribution boards/ sub distribution boards shall also be provided along the length of conduit for Sub Main wiring.

(M. Ali Sarfaraz) IF/TTC/CORE/HQ	(P.C. Das) AL/CON/P_/MLG	(B.C. Das) [illegible]/CON/MLG	11/5/16 (Arun Bhushan) DY.CEE/CON/HQ/MLS

(R.K. Arora) CEE/CON/NTR

(c) **Circuit wiring:** Circuit Wiring shall mean the wiring from the distribution board to the first tapping point inside the switch Board, from where point wiring starts.

(d) Circuit Wiring/ Sub main wiring cable/s along with earth wire cable/s shall be of the capacity specified in Bid document/ Railways standard. Wiring of each circuit wiring/ sub/ main wiring cable/ s along with earth wire cable/s shall be drawn into an independent conduit. Drawn boxes of suitable size shall be provided at convenient locations to facilitate easy drawing of the circuit wiring/ sub main wiring cable/s. Cost of junction Board/ draw Boxes are deemed to be included in the rates of circuit wiring/ sub main wiring cables along with earth wire cable/s. Single phase circuits shall have single earth wire whereas three-phase circuits shall be provided with two earth wires.

(e) Where sub- main, circuit wiring and point wiring cables are connected to the switch/ switchgear etc. sufficient extra length of cable/s (not less than 150 mm) shall be provided to facilitate easy connection and maintenance.

2.5 Measurement of Submain and Circuit Wiring

(i) Circuit and submain 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. The increase on account of diversion or slackness shall not be included in the measurement.

(ii) 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.

Note: Conduit carrying submain will not carry circuit/point wiring. Similarly conduit carrying circuit wiring will not carry submain/point wiring. Conduit carrying point wiring will not carry submain/circuit wiring.

2.6 Measurement of Other Wiring Work

Except as specified above for point wiring, circuit wiring and submain wiring, other types of wiring shall be measured separately on linear basis along the run of wiring depending on the actual number and sizes of wires run.

2.7 Cables

PVC insulated, multi stranded, Heat resistant fire retardant (HRFR) flexible copper conductor cables of 1.1 kV grade, conforming to IS: 694/1990, ISI marked as per likely sources shall be used. The sizes/s shall be as specified in the Bill of Quantities (BOQ).

(i) Copper conductor cable only will be used for submain/ circuit/ point wiring.

(Manoj Gautam) JE/TECH/CON/HQ	(R.C.Jain) AEN/PL/MLG	(R.C.Jain) ENGINEERING	(Ravi Bhushan) DY.CFE/CON/HQ/MLG

(R. K Aloliya) CC/CON/NFR

(ii) Minimum size of wiring cables for light and power points shall be as below:

Light /Fan Wiring	:	1.5 sq.mm.
Light plug point	:	2.5 sq.mm.
Circuit wiring for Light /Fan Point/6A. Plug point	:	2.5 sq.mm.
Circuit wiring for 16 A Plug Point	:	4.0 sq.mm.
Group Point wiring	:	2.5 sq.mm.
Power Wiring	:	4.0 sq.mm.

Power wiring with more than 1 KW load the size shall be assessed by the contractor based on load calculations and approved by the Engineer.

(iii) Flexible cable: Copper conductor, 3 core flexible cables shall be used for connecting single phase appliances etc

(Manish Agrawal) DGM(Elect/Con/CS)	(R. K. Das) AGM/CON/PL/M LG	(S.C.Das) PE/CON/M LG	(Rajendra Jha) WCE/CON/HQ/MLG

(R. K.Atolia)
CE/CON/NCR

2.8 **Sizes of single core (copper conductor) cable for point, circuit and sub main wiring, circuits, distribution board/s, etc. for Qrs.**

TABLE I

	Nos. of points and size of wiring cables									Nos. Of circuits and size of wiring cables					Size of Sub-main wiring cable	
	Size of point wiring cable (copper conductor)									Size of circuit wiring cable (copper conductor)					For L&F Load	For Power load
	LP	TLP	FP	CRP	CHP	PPSA 20A	PP 15A /16A	GP	PP 32A /ACP	For L&P	For 5A /6A plug	For 15A /16A plug	For 32A AC	For geyser		
Phases & Neutral	1.5sq.mm					2.5sq. mm	4sq. mm	6sq. mm	6sq. mm	2.5sq mm	4sq. mm	4sq mm	6sq.mm	6sq.mm	4sq.mm	10sq mm
Continuous earth	1.5sq.mm					2.5sq. mm	4sq. m	6sq.m m	6sq. mm	2.5sq mm	4sq mm	4sq mm	6sq.mm	8sq.mm	4sq.mm	10sq mm.

(Mrs.B.Varalakshmi) EE/CO/CON/HQ	(B.R.Das) AE/CO/APL/MLG	(S.C.Das) SEE/CON/MLG	(Ashis Kumar) 23/5/16 Dy.CSE/CON/HQ/MLG

(R.C.Atolia)
CE/CON/HQ

2.9 **Point wiring:**

2.9.1 **Point wiring for light points, fan points, exhaust fan points, call bell points etc. (except plug points)**

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 5/6 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.
i. Earth wire run as per requirements.
j. Interconnecting wiring between switches within the switch box on the same circuit.

2.9.2 **Point wiring for plug points**

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

2.9.3 **Twin Control Light Point Wiring**

(i) A light point controlled by two numbers of two way switches shall be measured as two points from the fitting to the switches on either side e.g. staircase lighting.

(ii) No recovery shall be made for non-provision of more than one ceiling rose or connector in such cases.

2.9.4 **Group Control Point Wiring**

(i) In the case of points with more than one point controlled by the same switch, such points shall be measured in parts i.e. (a) from the switch to the first point outlet as one point, and (b) for the subsequent points, the distance from that outlet to the next one and so on, shall be treated as separate point(s).

(ii) No recovery shall be made for non-provision of more than one switch in such cases.

		(S.K.Das) SEE/CON/MLG	(Ravi Bhushan) DY.CE/TRD/CON/MLG

(R.K.Arolia)
CE/CON/NCR

2.9.5 **Multiple Controlled Call Bell Point Wiring**

(i) In the case of call bell points with a single call bell outlet, controlled from more than one place, the points shall be measured in parts i.e.

(a) from the call bell outlet to one of the nearest ceiling roses meant for connection to bell push, treated as one point

(b) from that ceiling rose to the next one and so on, shall be treated as separate point(s)

(ii) No recovery shall be made for non-provision of more than one ceiling rose or connector for connection to call bell in such cases.

2.10 **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.

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. Light, fans and call bells shall be wired in the "lighting" circuits. 15A/16A socket outlets and other power outlets shall be wired in the "power" circuits. 5A/6A socket outlets shall also be wired in the "power" circuit both in residential as well as non-residential buildings.

e. **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.

f. **Termination of Circuit into Switchboard**

Circuit will consist of phase/neutral/earth wire. Circuit will terminate in a switch board (first tapping point, where from point wiring starts) in following manner:

Phase wire terminated in phase connector.
Neutral wire terminated in neutral connector.
Earth wire terminated in earth connector.

The switchboard will have phase, neutral and earth terminal connector blocks to receive phase/ neutral/ earth wire.

(Ma[illegible])	(T[illegible])	(Sec.Das)	(Rasi Bhushan)
/[illegible]	AEE/CON/PL/M.G	PEE/CON/Pall G	[illegible]

(B.K.Andley)
[illegible]/CON/NCR

2.11 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/PVC 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. Where number of electrical services like electrical wiring, telephone wiring, computer cabling, pass through corridors, it may be proper to plan such service with properly designed aluminium/PVC channels duly covered by a false ceiling, so that subsequently such service can be maintained and additional cables can be provided.

f. Generally conduits for wiring will not be taken in floor slabs. When it is unavoidable special precaution to be taken to provide floor channels with provision for safety and maintenance. Alternatively false flooring can be provided.

2.12 Passing through walls or floors :

When wiring cables are to pass through a wall, these shall be taken through a protection (PVC) pipe 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 PVC or other approved material.

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

2.13 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

d. All joints in the wiring shall be made at main switch boxes and distribution boards only. No joint shall be made in conduits and junction Boxes or in the length of wiring cable.

(Manjit Singh) DY.CEE/CON/HQ	(U. Das) AEE/CON/FL/MLG	(R.T. Das) EE/CON/MLG	(Smt. Bhushan) DY.CEE/CON/HQ/MLG

(U.K Mishra)
CEE/CON/NFR

e. Wiring cable shall be continuous from outlet to inlet.

f. All joints shall be made by use of connectors and lugs. All wire ends to be provided with lug and connected with requisite fasteners. Lugs should be crimped properly with crimping tools.

2.14 Capacity of Circuits (Sub-main) :

a. Lighting circuit from each sub main shall feed light/fan/call bell/6A outlet points. Each circuit shall not have more than 800 Watt connected load or more than 10 points whichever is less. However in case of LED points where load per point may be less, number of points may be increased.

b. Power sub main circuit will have only one 16A outlet per circuit. Not more than 4 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.

d. Power Wiring with Bus Trunking: It is permitted to meet large-scale power requirement in a hall, or floor, with use of single phase or 3 phase bus bars running inside a metal enclosure. This will be provided with careful design and use of factory fabricated bus-trunking of reputed make, conforming to relevant BIS standards and with standard accessories like End feed unit, tap off with necessary safety features like over current, short-circuit and earth fault protection. Such trunking will be of specified breaking KA rating.

2.15 Socket Outlets (Plug points)

(i) Socket outlets modular type shall be 6A 3 pin,6A 5pin, 16 Amp 3 pin or 16/6 Amp 6 pin.

The third pin shall be connected to earth through protective (loop earthing) conductor.

(ii) 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.

(iii) Sockets for the power outlets of rating above 1KW shall be of industrial type with associated plug top and controlling MCB.

(iv) Where specified, shutter type (interlocking type) of sockets shall be used.

(v) 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.

(Manoj Kumar) JE/TECH/CON/HQ	(R.C.Das) AT/TECH/CON/PL/MLG	(B.C.Das) EE/CON/MLG	(Hari Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Arjiya)
EE/CON/NTR

(vi) 5A/6A and 15A/16A socket outlets shall be installed at the following positions, unless otherwise specified.

(a) *Non-residential buildings* – 23 cm above floor level.

(b) *Kitchen* – 23 cm above working platform and away from the likely positions of stove and sink.

(c) *Bathroom* – No socket outlet is permitted for connecting a portable appliance thereto. MCB/IC switch may be provided above 2 m for fixed appliances, and at least 1 m away from shower.

(d) *Rooms in residences* – 23 cm above floor level, or any other level in special cases as desired by the Engineer-in-charge.

(vii) Unless and otherwise specified, the control switches for the 6A and 16A socket outlets shall be kept along with the socket outlets.

2.16 Measurements

Measurement of point wiring for light points, fan points, exhaust fan points, group points, light plug points, power plug points & call bell points shall be done on unit basis by counting only.

Measurement of twin control point wiring shall be done on unit basis by counting.

2.17 Wiring Accessories

(a) Control Switches for lights/ fans etc.

(i) All 5/6 and 15/16 Amp switches/ sockets (5 pin/6 pin) including bell push shall be modular/non modular type suitable for use on 230 Volts A.C. supply system. Switch plate shall be matching with modular/non modular switches/sockets. All switches, sockets, etc., shall normally be of white finish or as approved considering matching with the colour of walls/surface.(Generally all service buildings will have modular switches/sockets).

(ii) All the switches controlling the lights/fans etc. shall be connected to the phase wire of the circuit. Switches for lights and 5/6 Amp & 15/16 amp outlets shall be located at 1250 mm above finished floor level and the sub distribution boards (SDB), distribution boards (DB) shall be at 1500 mm above finished floor level unless otherwise instructed by the Engineer.

(iii) It is recommended to provide double pole MCB ('C' series) in proper enclosure as power outlet for window type AC units, geysers, water coolers etc.

(Manish Agarwal) E/TTC) /CCG/ HQ	(S.K.Das) ACE/C.Rly/P.Mtg	(S.C.Das) SEE/CON/MLG	(Ravi Bhushan) Dy.CFT/TTC/HQ/MLG

(R.K.Andliya)
CEE/C.Rly/NGP

(b) Switch Box

(i) 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 then modular switches/ sockets)

(ii) 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 approved shade shall be used for switch box covers. These shall be of 3 mm thick synthetic phenolic resin bonded laminated sheet as base material and conforming to grade P-1 of IS 2036 : 1974.

Note: Specification for switch boxes is covered in the chapters on the various types of wiring.

(d) Ceiling Rose

The ceiling rose shall be of PVC, 5 amps, 250 volts, conforming to latest version of IS:371/1999(ISI marked). The colour shall normally be of white finish or as approved considering matching with the colour of wall.

(e) Lamp Holders

The lamp holder shall be Polycarbonate of model as approved (ISI Marked). The colour shall normally be of white finish or as approved.

(f) Call Bell

Call bell shall be fixed on metal box of approved size with 3mm Phenolic laminated sheet on top (conforming to IS: 2036:1995) fixed with brass screws and brass cup washers and shall be suitable to work on 230 V AC, single phase 50 cycle. Piano type bell push shall be fixed at the entrance door.

2.18 Outdoor Fittings:

Outdoor fittings shall have suitable IP protection. It is preferable that street light fittings are of cast aluminium body of IP 65, for reducing recurring maintenance cost and improved performance. Where required IP 66 fittings also can be provided for reducing maintenance frequency and cost.

Other fittings, which are not available with tested IP 65/54 protection, can be properly fabricated with weatherproof features, proper gasketing etc. As far as possible corrosion free material like cast aluminium, stainless steel, engineering plastics may be used for fabrication of such fittings, to prolong life of such fittings. There should not be any exposed wiring in such outdoor fittings.

(Manju Panzade) JE/TECH/CON/66	(S.R.Das) AE/TECH/CON/66	(S.C.Das) EE/CON/M.G	(Ravi Bhushan) SUPDT/CON/TCT/66

(R.C.Mishra)
CSE/CON/NFR

2.19 Attachment of fittings and accessories :

(a) **Conduit wiring system:**

(i) All accessories like switches, socket outlets, call bell pushes and regulators shall be fixed in modular/non modular sheets in boxes. Accessories like ceiling roses, brackets, batten holders etc. shall be fixed on outlet boxes.

(ii) Aluminium Alloy or cadmium plated iron screws shall be used to fix the accessories to their bases.

(iii) The switch box/regulator box shall normally be mounted with their bottom 1.25m from floor level, unless otherwise directed by the Engineer-in-Charge.

(b) **Fixing to walls and ceiling:**

(i) 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.

(ii) Drilling of holes shall be done by drilling machines only. No manual drilling of hole will be allowed.

(iii) PVC spacers shall be provided during fixing of fittings and other items on wall.

2.20 For termination of cables, crimping type cable socket/lugs shall be provided and soldered if necessary/instructed.

2.21 Load Balancing:

Balancing of circuits in three-phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.

2.22 Earthing of Non- current Carrying Part

All the non-current carrying metal parts of electrical installations shall be earthed properly. All metal enclosures, cable armour, switchgear, distribution boards, light fittings and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system

2.23 Earth Conductor

Every earthing conductor shall be of copper single core pvc wire / G. I of suitable size.

2.24 Testing of Wiring:

Wiring system shall be tested as per IS:732 for:

i) Continuity of all circuits.

ii) Earthing after the wiring is completed and before energizing.

iii) Polarity test of switches etc.

(Manju Nath) Jt/11Cy/CON/HQ	(S. Das) AEE/CON/"I"/MLG	(A. Das) EEI/CON/MLG	(RSM Shukhla) DY.CPE/CON/HQ/MLG

(B.K.Mishra) CEE/CON/NFR

2.25 Testing

The entire installation shall be tested and shall comply with the requirements of specifications, IS code and IE norms.

2.25.1 Testing of Earth Continuity Path:

The earth continuity test of metallic envelopes shall be done for electrical continuity. Electrical resistance of the same, along with the earthing lead, excluding any added resistance of earth leakage circuit breaker, measured from the connection with the earth electrode to any point in the earth conductor in the completed installation, shall not exceed one Ohm.

2.25.2 Polarity Test of switch

In a two-wire installation, a test shall be made to verify that all switches in every circuit have been fitted in the same conductor throughout, and such conductor shall be labeled or marked for connections to the phase conductor or to the non-earthed conductor of the supply.

In a three or four wire installation, a test shall be made to verify that every non-linked single pole switch is fitted in a conductor which is labeled or marked for connection to one of the phase conductors of the supply.

2.25.3 Earth Resistance Test

Earth Resistance Test shall be carried out in accordance with Indian Standard Code of Practice for earthing IS 3043 - 1987. All tests shall be carried out in the presence of the Engineer- In-Charge at site.

2.25.4 After testing of installation, test results shall be recorded and jointly signed by the Contractor and the Engineer.

2.26 Marking of Switch Boards

(i) *Schematic Diagram*

First a comprehensive schematic diagram for each building is to be prepared, starting from Main LT Panel, rising main, submain boards, DBs, etc. and the manner in which they are connected. This will include essential, non-essential and UPS systems. Sizes of interconnecting main/submain cables shall be indicated.

(ii) *Marking of each Main Board*

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.

(Manjunath Gowda) JE/TECH/CON/HQ	(B.C.Das) AEE/CON/[illegible]	(B.C.Das) EEE/CON/MLG	(Sunil Bhushan) Dy.CEE/CON/[illegible]

(R.K.Atolia)
CEE/CON/NTR

(iii) *Marking of Distribution Board*

Each Distribution Board shall be marked indicating detail of incoming switch (Size of cable and from where it is fed) and marking of each outgoing MCB indicating the area it feeds. Suitable marking sticker will be suitably fixed to indicate such details.

(iv) *Marking of Power/Light DBs*

Power/light DBs shall be marked 'P' and 'L' respectively.

(v) *Marking for Non-essential/Essential/UPS/Switch Boards*

Each switchboard shall be marked essential/non-essential/UPS to indicate the nature of such switchboards.

(vi) *Marking of Main Earthing Terminal*

Main arthing terminals in main/submain switchboard shall be permanently marked. as "Safety Earth Don't Remove".

2.27 **LT Distribution Switchgear**

Only following type switchboards will be used:

(a) Main/Submain switchboard of cubicle type.

(b) DBs Conventional DBs of reputed makes can also be used with the approval of technical sanctioning authority in addition to prewired DB.

(c) Specially designed switchboards.

Alsn specially designed switchboards can be used with detailed specification and fabrication drawings approved by the technical sanctioning authority.

2.28 **Location of Switchboards**

(i) Switchboards are to be located in common areas like corridors, lobby etc. and not to be located in locked room.

(ii) Switchboard shall be located only in dry situation and in well-ventilated space. They shall not be placed in the vicinity of storage battery or exposed to chemical fume.

(iii) Switchboards shall not be erected above gas stove, or sinks or within 2.5 meter of any washing unit in washing rooms of launderings or in the bath rooms, toilets, or kitchen.

(iv) As far as possible main boards shall not be located in basement. Such main boards can be located in ground floor.

(v) It is preferable to locate floor main boards in rising main shafts of adequate size, with steel doors (having ventilation) or in suitable room.

(Manjit Gogoi) JE/TECH/CON/HQ	(B.S.Das) AEE/CON/HQ/MLG	(B.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CFE/CON/HQ/MLG

(B.K.Bhaiya)
CEE/CON/NFR

(vi) Similarly DBs can be in suitable niches in corridor walls having doors.

(vii) Locating main boards under staircase or standing open in corridor is not a desirable practice, besides being highly unaesthetic.

(viii) The main switchboard, which receives power to the building, should be invariably located in a switch room, having round the clock access, for emergency attendance to the switchboard.

2.29 Guidelines for Planning Residential Areas

(i) U.G. System of Power Distribution, Street Lighting, Telephone Cabling and TV Cabling

For long-term economical maintenance, better reliability of service, safety, protection against heavy rains, storm, wind etc. and aesthetics, under ground cable system will be generally followed. Also considering the high cost of land, under ground system results in better economic utilization of land area, otherwise substantial land route has to be earmarked for overhead lines.

(ii) Efficient working of street lights and staircase lighting is required for security of the colony and safety and convenience of the residents. Therefore adequate street lighting, staircase lighting is to be provided. Generally back lanes of residential blocks remain dark. Such areas are also to be covered by basic street lighting for security.

(iii) Kitchen

(i) Exhaust fans opening with one point outlet to be provided irrespective of yardstick of provision of exhaust fans.

(ii) In addition to one 16 A 6-pin power outlet for kitchen, one 3 pin 6 Amp. outlet to be provided for water filter.

(iv) Washing Machine

Location to be finalized in consultation with the Architect. A power outlet plus water supply/drainage to be coordinated with Architect/Civil Engineer.

(v) Meter Board

(For a Block of Quarters)

Generally for a block of quarters of 2/3/4 storied, electric supply for each block is received in a meter board, where a cubicle meter panel is provided with system of power distribution to each quarter.

At present such meter boards are invariably located under staircase. This is not a desirable practice from technical/aesthetic viewpoint.

(Manoj Kumar Jha) JE/TECH/CON/HQ	(B.K.Das) AEE/CON/PL/MLG	(G.C.Das) CEE/CON/MLG	(Ravi Bhushan) DY.CFE/CON/HQ/MLG

(R.Chaliha)
CEE/CON/N.FR

It is technically desirable to coordinate with Architect to provide separate meter room for each block of quarters or a number of blocks.

(vi) Stair Case Lighting

Stair case lighting is to be treated as an extension of street lighting, for security and convenience of the residents. LED type stair case lighting may be provided to reduce load. Incandescent stair case lighting and bulk head fittings should not be provided, in view of excessive energy consumption and low burning hours.

(vii) Emergency Electric Supply

For ensuring essential water supply and security lighting, a D.G. set to be provided for each colony to take care of water supply pump set, street lighting and essential load requirement of buildings.

(viii) Main Board of Each Quarter

It shall be MCB type with provision of ELCB with the incoming MCB. It shall be located in a nitch with ventilated door cover, in the room connecting to the entry of the quarter. MCB DB shall be pre-wired type, for trouble free service.

(ix) Corrosion Free Fittings

Coastal areas and humid areas like kitchen, toilet are subject to corrosion, which substantially reduces the useful life of such fittings, besides giving an ugly look on account of rusting.

Therefore for coastal areas, and other humid areas corrosion free type of fittings (like aluminium, stainless steel, engineering plastic) should be used, for ensuring long life of such fittings and to achieve life cycle economy, after taking into account recurring expenditure on account of painting of fittings.

(x) Telephone Wiring

Telephone wiring is to be provided for each quarter. One outlet up to type III quarters, two outlets up to type IV quarters and three outlets above type IV quarters. Such telephone wiring to be brought to a tag-block at a suitable point in ground floor. Provisions shall be kept for suitable entry-pipe for laying incoming telephone cable.

(xi) TV Cabling

Internal TV cabling shall be provided, with two outlets up to type III quarters and three outlets for type IV quarters and above. Similarly, from suitable point at ground floor, TV cabling shall be provided. With use of suitable splitters, such TV cabling to be connected to each quarter.

(Manjunath) CE/ETD/CHN/HQ	(T. Das) AEE/ETD/FL/MLG	(B.C.Das) EE/ETD/M.G.	(Ravi Prashar) SE(E)/ETD/HQ/MLG

(R.K.Hadiga)
CE/ETD/BNR

(xii) Lighting for Parks

Colonies are provided with parks. Such parks should be provided with adequate lights to include area lights, pathway lights etc. so that the parks can be effectively used by the residents and they remain secure during night time.

(xiii) External Pipe Network for Laying Telephone and TV Cabling for the Colony

Starting from a suitable room, pipe network may be provided to lay telephones/TV cables for the colony. Suitable road cross pipe and manholes to be provided for drawing such cables and their maintenance.

2.30 Guidelines for Planning Office Buildings

(i) The main objective is to avoid possible fire hazards, which calls for sound detailed designing and use of quality equipments and materials executed with sound workmanship and supervision.

(ii) All control LT Panels, controlling power supply to the entire building will be located in a centralized room, from where centralized control and monitoring of the entire power supply system can be made.

(iii) Earth fault protection shall be provided for each individual building at the LT receiving point i.e. Main LT Panel. ELCB shall not be provided as a matter of routine in distribution boards. These can be provided, if required, by the Chief Engineer (F), in charge.

(iv) Office buildings are prone to fire hazard during night hours. Therefore, after office hours, all the LT Panels should be switched off. Based on need of the building, only the specified LT panel to be kept 'ON' which feed the loads during night hours. Such panel, called common service panel, may feed following loads, which are normally used after office hours:-

a) Some specified lifts.

b) Staircase/ Corridor/ Compound light.

c) Fire protection loads.

d) Pump Sets.

e) Other loads which are kept 'ON' after office hours.

(Ashok Kumar Jha) SE(Tech)/CON/HQ	(S.K.Das) AEE/CON/PL/MLG	(S.C. Das) EE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Malviya)
CEE/CON/NPR

2.31 Conduit System

2.31.1 Type and Size of Conduit

a) The Conduit wiring shall be carried out as under:
All the non-metallic conduit pipes and accessories shall be of suitable materials complying with IS-2509 1973 and IS-3419 1989 for rigid conduits and IS-9573 (Part 5):2000 for flexible conduits. Internal wiring in the buildings shall be done with ISI marked PVC rigid conduit of size not less than 25 mm diameter and thickness 2.0 mm (Nominal size). PVC conduit shall be used with all its associated accessories such as bends, couplers, saddles, metal deep boxes (100 mm deep for ceilings), PVC bends etc.

b) Normally, concealed wiring shall be provided in all the buildings. Surface conduit wiring shall be provided if specifically given in BOQ or where it is not practicable to provide concealed wiring with approval of the Railway.

c) **Limitations**
The maximum number of PVC insulated 650/1100 V grade copper conductor cables that can be drawn in conduit pipes shall be limited to 45 % of the capacity of the conduit. Table indicating the capacity is as under:-

S. No.	Size of Conduit	100 % capacity in Sq mm	45% capacity in Sq mm
1.	25 mm	490	220
2.	32 mm	804	362

d) **Conduit joints :**
Conduits shall be joined by means of screwed or plain couplers depending on whether the conduits are screwed or plain. For conduit fittings and accessories reference may be made to the good practice (IS : 2667, IS:3419, IS 9537 Part-I II III).

e) **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 center of such fittings except that the spacing between saddles or supports is recommended to be 600 mm for rigid non metallic conduits.

f) **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.
Conduit fittings shall be avoided, as far as possible, on outdoor systems.

g) **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.

h) Heat may be used to soften the conduit for bending and forming joints in case of plain conduits. As the material softens when heated, siting of conduit in close proximity to hot surfaces should be avoided

[M.K. Gupta] JE/ITC/CON/HQ	[P. Das] ALL/CON/P-I/MLG	[B.C.Das] FEE/CON/MLG	[Gopi Bhushan] DY.CLE/CON/HQ/MLG

[R.K. Arora] CE/CON/NFR

i) Fixing of conduit in chase (concealing in plaster of wall):

The conduit pipe shall be fixed by means of staples 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/staples shall be fixed at a distance of 15 cm from the center of bends.

j) 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 II

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

Size of wires		Size of conduit (dia in mm)						
mm²	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

Table III

Maximum Number of Single-Core Cables that can be drawn into Casing and Capping

Size of wires		Size of Casing					
Mm²	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	7/1.06	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

(Man Mohan) JE/TECH/CON/HQ	(T.K.Das) AEE/CON/PL/MLG	(B.C.Das) EE/CON/MLG	(Ravi Shankar) DY.CEE/CON/HQ/MLG

(B.K.Medhi)
CEE/CON/NFR

2.31.2 Surface Conduits

a) Surface or open conduit pipes shall be fixed by heavy gauge saddles, secured to suitable approved plugs embedded in walls/ firmly screwed with trusses etc. with screws in an approved manner at an interval of not more than 60 cm on either side of the coupler or bends or similar fittings. The saddles shall be fixed at a distance of 30 cm from the center of such fittings. Open conduit wiring shall be laid parallel/ perpendicular to the walls and suitable clamps shall be fixed properly. For 25 mm diameter conduit, width of clamp shall be 19 mm and of 20 SWG wall thickness. For conduits of 32 mm and above, width of clamp shall be 25 mm and of 18 SWG wall thickness.

b) Where conduit pipes are to be laid along trusses, steel joints etc., the same shall be secured by means of special clamps made of mild steel. Where it is not possible to drill holes in the truss members, suitable clamps with bolts and nuts shall be used.

c) Where conduit pipes are to be laid above false ceiling, conduit pipes shall not be clamped to false ceiling frame work and shall be suspended with suitable supports from the suffix of slab. For conduit pipes to run along with wall , the conduit pipe shall be clamped to wall above false ceiling in uniform pattern with special clamps approved by the Engineer at site.

2.31.3 Installation of Conduit system :

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) **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

d) 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.

e) Care shall be taken while bending the pipes to ensure that the conduit pipe is not damaged, and that the internal diameter is not effectively reduced.

f) **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 Engineer.

g) **Painting:** After installation, all accessible surfaces of metallic accessories shall be painted.

2.32 Casing and Capping:

PVC casing and capping shall conform to BIS Specification No.14927 Part 2 and for wiring application with the required accessories viz. bends and tees etc., as per site conditions. They should be properly fitted along with the required accessories viz. couplers, junction box, bends, tees, PVC round blocks, sockets, clamps, bolts, nuts, screws etc., as per the site conditions. They shall be used in suitable size to accommodate the wiring and shall be laid straight horizontally/vertically on the wall/roof etc.

(Manju Kalyani) JE/TC/CON/HQ	(T. Das) AEE/CON/PL/MLG	(B.C.Das) EE/CON/MLG	(Ravi Shankar) DY.CEE/CON/HQ/MLG

(R.K.Arolya)
CTE/CON/NFR

NON-METALLIC CONDUIT WIRING SYSTEM

2.33 Scope

This chapter covers the detailed requirements for wiring work in non-metallic conduits. This chapter covers both surface and recessed types of wiring work.

2.34 Application

2.34.1 Recessed conduit work is generally suitable for all applications. Surface conduit work may be adopted in places like workshops etc and where recessed work may not be possible to be done. The type of work shall be as specified in individual works.

2.34.2 Flexible non-metallic conduits shall be used only at terminations, wherever specified.

2.34.3 Special Precautions

i) If the pipes are liable to mechanical damages, they should be adequately protected.

ii) Non-metallic conduit shall not be used for the following applications:-

a) In concealed/inaccessible places of combustible construction where ambient temperature exceeds 60 degrees C.

b) In places where ambient temperature is less than 5 degrees C.

c) For suspension of fluorescent fittings and other fixtures.

d) In areas exposed to sunlight.

2.35 Materials

2.35.1 Conduits

i) All non-metallic conduit pipes and accessories shall be of suitable material complying with IS 2509 : 1973 and IS 3419 : 1989 for rigid conduits and IS 9537 (Part 5) 2000 for flexible conduits. The interior of the conduits shall be free from obstructions. The rigid conduit pipes shall be ISI marked.

ii) 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 V.

iii) No non-metallic conduit less than 20 mm in diameter shall be used.

iv) Wiring Capacity

The maximum number of PVC insulated aluminium/copper conductor cables of 650/1100 V grade conforming to IS 694 : 1990 that can be drawn in one conduit of various sizes is given in Table II & III. Conduit sizes shall be selected accordingly.

(Manju Agarwal) JE/TEC-I/CON/HQ	(S.K.Das) AEE/CON/CF/MLG	(S.C.Das) CEE/CON/MLG	(Devi Bhushan) Dy.CFE/CON/HQ/MLG

(R.K.Gupta)
CFE/CON/NFR

2.35.2 Conduit Accessories

i) The conduit wiring system shall be complete in all respect including accessories

ii) Rigid conduit accessories shall be normally of grip type.

iii) Flexible conduit accessories shall be of threaded type.

iv) Bends, couplers etc. shall be solid type in recessed type of works, and may be solid or inspection type as required, in surface type of works.

v) Saddles for fixing conduits shall be heavy gauge non-metallic type with base.

vi) The minimum width and the thickness of the ordinary clips or girder clips shall be as per Table IV.

vii) For all sizes of conduit, the size of clamping rod shall be 4.5 mm (7 SWG) diameter

2.35.3 Outlets

i) The switch box shall be made of either rigid PVC 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.

ii) 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 m.

iii) The specifications for metallic boxes shall be as follows:

a) The switch box or regulator box shall be made of metal on all sides, except on the front. In the case of cast boxes, the wall thickness shall be at least 3 mm and in case of welded mild steel sheet boxes, the wall thickness shall not be less than 1.2 mm (18 gauge) for boxes upto a size of 20 cm x 30 cm, and above this size 1.6 mm (16 gauge) thick MS boxes shall be used. The metallic boxes shall be duly painted with anticorrosive paint before erection as per Annexure A of these Specifications.

b) (i) Outlet boxes shall be of one of the size, covered in the Schedule of Rates (Elect.), 2012

(ii) Where a large number of control switches and/or fan regulators are required to be installed at one place, these shall be installed in more than one outlet box adjacent to each other for ease of maintenance.

c) An earth terminal with stud and 2 metal washers and terminal block shall be provided in each MS box for termination of protective conductors and for connection to socket outlet/metallic body of fan regulator etc.

(Manju Bhargava) JE/TLC-I/CON/HQ	(T.S. Das) AEE/CON/P-I/MLG	(B.C.Das) EFE/CON/Bld.6	11/5/15 (Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Acharya) CEE/CON/NER

d) A metal strip shall be welded/screwed, to the metal box as support if tumbler type of control switches, sockets and/or fan regulators in flush pattern.

e) Clear depth of the box shall not be less than 60 mm and this shall be increased suitably to accommodate mounting of fan regulators in flush pattern.

f) The fan regulators can also be mounted on the switch box covers, if so stipulated in the tender specifications, or if so directed by the Engineer-in-charge at site.

g) Except where otherwise stated, 3 mm thick phenolic laminated sheets as per clause 1.17 (c) shall be fixed on the front with brass screws, or aluminium alloy/ cadmium plated iron screws as approved by the Engineer-in-charge at site.

iv) 3 mm thick phenolic laminated sheet covers for all types of boxes shall be as per requirements of clause 1.17 (c).

2.36 Installation

2.36.1 Common Aspects for Both Recessed and Surface Conduit Works

i) The erection of conduits of each circuit shall be completed before the cables are drawn in.

ii) Conduit Joints

a) 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.

b) The Engineer-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.

iii) Bends in Conduit

a) 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.

b) 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.

c) 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.

iv) 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 Engineer-in-charge.

[Manoj Kumar Gupta] JE/TECH/CON/HQ	[S. Das] AEE/CON/T. /MLG	[B.L.Das] EEE/CON/MLG	[Ravi Bhushan] DY.CFE/CON/HQ/MLG

[U.K.Abolya] CFE/CON/NFR

v) Painting

After installation, all accessible surfaces of metallic accessories shall be painted in compliance with clauses under Annexure A

2.36.2 Additional Requirements for Surface Conduit Work

i) Conduit pipes shall be fixed by heavy gauge non-metallic saddles with base secured to suitable approved plugs with screws in an approved manner, at an interval of not more than 60 cm but on either side of couplers or bends or similar fittings, saddles shall be fixed at a closer distance from the centre of such fittings. Slotted PVC saddles may also be used where the PVC pipe can be pushed in through the slots.

ii) Where the conduit pipes are to be laid along the trusses, steel joists etc. the same shall be secured by means of saddles or girder clips as required by the Engineer- in-charge. Where it is not possible to use these for fixing, suitable clamps with bolts and nuts shall be used.

iii) If the conduit pipes are liable to mechanical damage, they shall be adequately protected.

2.36.3 Additional Requirements for Recessed Conduit Work

i) Making Chase

a) The chase in the wall shall be neatly made and of ample dimensions to permit the conduit to be fixed in the manner desired.

b) In the case of buildings under construction, the conduits shall be buried in the wall before plastering, and shall be finished neatly after erection of conduit.

c) In case of exposed brick / rubble masonry work, special care shall be taken to fix the conduit and accessories in position along with the building work.

ii) Fixing Conduits in Chase

a) 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.

b) At either side of the bends, saddles/staples shall be fixed at a distance of 15 cm from the centre of the bends.

iii) Erection in RCC Work

a) The conduit pipes shall be laid in position and fixed to the steel reinforcement bars by steel binding wires before the concreting is done. The conduit pipes shall be fixed firmly to the steel reinforcement bars to avoid their dislocation during pouring of cement concrete and subsequent tamping of the same.

[Manju Vaidya]	[R.R. Das]	[D.C.Das]	[Ravi Bhushan]
JT/TECH/CON/NFR	ALL/CON/PL/MLG	EE/CON/M-5	DY.CL./CON/HQ/MLG

[K.Chaliha]
GM/CON/NFR

b) Fixing of standard bends or elbows shall be avoided as far as practicable, and all curves shall be maintained by bending the conduit pipe itself with a long radius, which will permit easy drawing in of conductors.

c) Location of inspection / junction boxes in RCC work should be identified by suitable means to avoid unnecessary chipping of the RCC slab subsequently to locate these boxes.

iv) Fixing Inspection Boxes

a) Suitable inspection boxes to the minimum requirement shall be provided to permit inspection and to facilitate replacement of wires, if necessary.

b) These shall be mounted flush with the wall or ceiling concrete. Minimum 65 mm depth junction boxes shall be used in roof slabs and the depth of the boxes in other places shall be as per IS 2667 : 1988.

c) Suitable ventilating holes shall be provided in the inspection box covers.

v) Fixing Switch Boxes and Accessories

Switch boxes shall be mounted flush with the wall. All outlets such as switches, socket outlets etc. shall be flush mounting type, unless otherwise specified in the Additional Specifications.

vi) Fish Wire

To facilitate subsequent drawing of wires in the conduit, GI fish wire of 1.6 mm/1.2 mm (15/18 SWG) shall be provided along with the laying of the recessed conduit.

vii) Bunching of Cables

For ease of maintenance, cables carrying direct current or alternating current shall always be bunched so that the outgoing and return cables are drawn in the same conduits.

2.36.4 Earthing Requirements

i) 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 DBs.

ii) Gas or water pipe shall not be used as protective conductors (earth medium).

(Manju Pathak)		(B.C.Das)	(Rao Nitish Raj)
IE/TECH/CON/HQ	AE/CON/HQ/MLG	EE/CON/HQ/MLG	DY.CLL/CON/HQ/MLG

(K.K.Arora)
CLL/CON/NTR

TABLE IV

2.37 Dimensional Details of Rigid Non-metallic Conduits

(All dimensions in mm)

S. No.	*Nominal Outside Diameter (in mm)*	*Maximum Outside Diameter (in mm)*	*Minimum Inside Diameter (in mm)*	*Maximum Permissible Eccentricity (in mm)*	*Minimum Permissible Ovality (in mm)*
1.	20	20 + 0.3	17.2	0.2	0.5
2.	25	25 + 0.3	21.6	0.2	0.5
3.	32	32 + 0.3	28.2	0.2	0.5
4.	40	40 + 0.3	35.8	0.2	0.5
5.	50	50 + 0.3	45.0	0.4	0.6

TABLE V

2.38 Ordinary Clips or Girder Clips

Size of Conduit	*Width*	*Thickness*
(1) 20 mm & 25 mm	19 mm	20 SWG (0.9144 mm)
(2) 32 mm & above	25 mm	18 SWG (1.219 mm)

(Manju Yadav) JE/CLD/CON/HQ | (A.K.Das) AEE/CON/PL/MLG | (B.C.Das) EE/CON/MLG | (Ravi Shankar) DY.CLE/CON/HQ/MLG

(R.K.Mridha) CLE/CON/NFR

2.39 Standard list of Electrical fittings in Railway Quarters (Ref: Enclosure to Board's letter no. 99/Elec(G)/136/1 dt 3.03.05)

	TYPE VI		TYP E V spl		TYP E V		TYP E IV spl		TYP E IV		TYPE III		TYPE II		TYPE I (2 rooms)		TYPE I	
	Pro p.	Exis t.	Pro p.	Exis t.	Pro p.	Exis t.	Pro p.	Exis t.	Pro p	Exis t	Pro p.	Exis t.	Pro p.	Exis t.	Pro p.	Exis t.	Pro p.	Exis t.
LIGHT POINT	24	24	18	18	16	10	13	11	11	8	7	6	5	5	6	5	4	3
TUBE	7	5	7	5	6	5	5	4	5	4	3	2	2	2	2	1	1	1
FAN	6	5	6	5	5	5	5	3	3	3	3	3	3	3	2	2	1	1
5 AMP (5 P.N)	7	6	6	5	6	4	5	4	4	3	3	3	3	3	2	2	3	3
15 AMP (5 P.N)	6	4	5	3	3	3	3	3	4	-	3	-	2	-	2	-	1	
32 AMP MCB (MCI	3	-	3	-	2		1		1	-	-	-					-	-
BELL	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
EXHAUST FAN	1	-	1	-	1		1		1	-	-				-	-	-	-
GEYSER	2		2		2		1	-	1					-	-	-	-	
ELCB	1		1		1		1	-	1		1		1	-	1	-	1	
TOTAL	58	46	50	38	45	34	38	28	32	20	21	14	17	13	15	10	10	7

NOTE: Provision of AC points in type III Staff Quarters vide *Railway Board's L/No. 2009/Elect (G)/156/1/Pt.II dated 25.09.2012*

2.40 Special Provisions required at Railway Station and Station building

2.40.1A. Comprehensive instruction for provision of Passenger Amenities at Stations vide Railway Board's L/No. 2012/LM(PA)/3/5 New Delhi dt.11.09.2012.

1) Provision of water coolers as per norms on platforms at 'A1' to 'D' category stations as Minimum Essential Amenity (MEA). Provision of emergency supply to water cooler where DG set is installed.

[Manju Yadav] IE/TECH/CON/HQ	[S.K.Das] AFE/CON/KLM.C	[B.C.Das] EFE/CON/MTG	[Ravi Bhushan] JA/ELL/CON/HQ/MTG

(R.K.Adolia) SE/CON/MTG

ii) Induction of solar energy technology for improved lighting and segregation of lighting levels during "no train" and "train" periods.

iii) Escalators/elevators to be introduced at 'A1' category and escalators at 'A' category, 'C' category and stations of tourist importance under desirable amenities.

iv) Provision of standard signage has been extended to 'A' and 'B' category stations under Minimum Essential Amenity (MEA).

B. Illumination & Energy saving:

The illumination at the stations should be improved. The enquiry and Booking Offices should be specially brightened up at all the stations. LED based station name boards on the station building shall be provided at A-1, A & B category stations as per RDSO specifications. Platform name-boards should suitably illuminated so that the station name is visible at night to the passengers travelling by trains.

For ensuring energy conservation:

(a) Platform lighting circuit shall be segregated such that during "No train" period about 30% lights are 'ON' and before train arrival all the lights are switched 'ON'. In this regard, necessary changes in electrical circuits at stations may be planned in a phased manner as per the RDSO's specification.

(b) All the electrical fittings and power supply equipments with at least BEE's 5 star rating shall be used.

(c) Provision of façade lighting at State Capitals and States of historical and tourist importance..

C. Mobile & Laptop Chargers:

5 pin, 5 amp, 230V (Railway approved) sockets for mobile and laptop charging shall be provided in adequate numbers at refreshment rooms and waiting rooms.

D. Air Cooling System:

At A-1,A & B category stations where natural ventilation is not adequate, air cooling system should be installed subject to feasibility.

E. NORMS OF MINIMUM ESSENTIAL AMENITIES AT VARIOUS CATEGORIES OF STATIONS

S.N	Amenity	STATION CATEGORY						
		A1	A	B	C	D	E	F
1	Booking Facility (No. of counters)	15	10	6	4	4	2	1
2	UTS as per norms	Yes	Yes	Yes	Yes	Yes	Yes	-
3	Drinking water (No. of taps/ PF)	20	20	20	6	8	2	Appropriate drinking water facility
4	Waiting hall	250	125	75	0	30	15	10 sqm booking office cum W/p hall

(Manju [illegible]) AE/ELECT/CON/HQ	[illegible] AEE/CON/PL/MLG	(B.C.Das) FPE/CON/MLG	(Ravi Bhushan) DY.CLE/CON/HQ/MLG

(R.K.Arora)
CE/CON/NFR

5	Seating arrangement (No of seats/PF)	150	125	100	10	30	10	-
6	Platform shelter (on each PF)	500 sqm	400sqm	300sqm	200sqm	50 sqm +	50 sqm	Shady trees
7	Urinals	12	10	6	4	4	1	-
8	Latrines	12	10	6	2	4	1	
9	Foot over bridge	1 with cover	1 with cover	1	1			
10	Water cooler	2 on each PF	2 on each PF	2 on each PF	2 on main PF	1 on main PF		
11	Signage (Standardized)	Yes	Yes	Yes	-	-	-	
12	Platforms	High Level	High Level	Medium Level	High Level	Medium Level	Rail Level	
13	Lighting (Lux level)	As per Annexure II of Board's letter No. 2004/Elect(G)/109/1 dated 18.5.2007						
14	Fans &	As given below						
15	Parking cum circulatory area, with lights	As per extant instructions						

14 Solar energy based lighting needs to be introduced to provide emergency lighting at "D" and "E" Category stations, wherever feasible, in non- electric traction areas.

& For covered platforms having width of 6-9mts, one row of fans should be provided @ one fan in the center supporting columns. For covered platforms with more than 9mts width, fans should be provided in 2 rows.

F. Illumination level Approved for Model Stations:

S.N.	Location	Approved Lux levels for different category of stations		
	Category of Stations	A1/A	B/C	D/E
1	Concourse	150	100	50
2	Circulating areas	50	30	20
3	Waiting Hall	150	100	100
4	Retiring room	100	100	100
5	Platform			
	a) Open	50	30	30
	b) Covered	150	100	100
6	Enquiry cum reservation office			
	a) General	150	100	100
	b) Counter	150	150	100
7	Covered Passage way			
	a) Corridors	50	50	50

(Manju Yadav)		(A.C.Das)	(Ravi Bhushan)
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(R.K.Mallya)
CEE/CO/CN/NFR

	b) FOB	50	50	50
	c) Stairs	50	50	50
8	Parcel/luggage office			
	a) General	100	100	50
	b) Counter	150	150	150
9	Time table#	200	200	200
10	Outdoor car parking	50	30	20
11	Restaurant area			
	a) Kitchen	200	150	150
	b) Stores	150	100	100
	c) Dining Hall	200	150	150
12	Other Service buildings at station	200	200	200
13	Cloak Room			
	c) General	100	100	100
	d) Counter4	150	150	150
14	Public Utility Services (Toilet/Bathroom)	100	75	50

Using Task Lighting

G. Illumination level Approved for other than Model Stations:

S.N.	Location	Approved Lux levels for different category of stations		
	Category of Stations	A1/A	B/C	D/E
1	Concourse	100	50	50
2	Circulating areas	30	20	20
3	Waiting Hall	100	100	100
4	Retiring room	100	100	100
5	Platform			
	c) Open	20	30	30
	d) Covered	100	100	100
6	Enquiry cum reservation office			
	c) General	100	100	100
	d) Counter	150	100	100
7	Covered Passage way			
	d) Corridors	50	50	50
	e) FOB	50	50	50
	f) Stairs	50	50	50
8	Parcel/luggage office			
	e) General	100	50	50
	f) Counter	150	150	150
9	Time table#	200	200	200
10	Outdoor car parking	30	20	20
11	Restaurant area			
	d) Kitchen	150	150	150

(Manju Yadav) IF/TECH/CON/HQ	(S.K.Das) AEE/CON/P_/N_L	(D.C.Das) EFE/CON/MLG	(Ravi Bhushan) DY.CE/ELDS/HQ/RLY

(R.K.Addl/CE) CE/CON/NFR

	c) Stores	100	100	100
	f) Dining Hall	150	150	150
12	Other Service buildings at station	200	200	200
13	Cloak Room			
	g) General	100	100	100
	h) Counter#	150	150	150
14	Public Utility Services (Toilet/Bathroom)	75	50	50

Using Task Lighting

2.40.2 Provision of switch button to self-start DG set on ASM panel

All the new DG sets purchased in future must have the facility for automatic starting through AMF panel and a switch button to self-start these DG sets should be provided on ASM panel on station or near the Commercial/Operating staff available on the station

2.40.3 Air conditioning of S & T installations

RRI relay rooms will be air conditioned with back up DG sets at stations and hence suitable wiring to be done accordingly.

2.40.4 Emergency Power Point:

Emergency light load consists as a minimum of one light point in ASM's room, two points on the platform outside the station building, one at the ticket windows/waiting hall, on the FOBs and one on each cabin and in apparatus room, relay room, battery and equipment room, cabin basement where signaling equipments are provided and in telecom. repeaters/cable huts as applicable.

2.40.5 Advance metering system:

Provision of advance metering system shall be done for vendors and major railway colonies.

2.40.6 Additional Requirement of Officers Rest House/Retiring room:

i) Provision of key type master switch for energy saving .
ii) Modular switches to be provided.
iii) Provision of energy meter for each room.

2.40.7 Additional Requirement of Offices/ Administrative buildings:

i) Occupancy sensors to be provided .
ii) Modular switches to be provided

2.40.8 Additional Requirement of Offices/ Administrative buildings:

i) Occupancy sensors to be provided for office, toilet, washroom and store room etc.

(Manju Sadhu) JE/TELE/CON/ITD	(D. Das) AFE/CON/N /MLG	(B.C.Das) LEE/LUN/MLG	(Ravi Bhushan) DY.CFE/CON/ITD/MLG

(R K Arolwar)
CEE/CON/NFR

NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

Technical Specification No.NFR/ELECT/CON/GS/03/LUMINARIES & EQUIPMENTS

LUMINARIES & EQUIPMENTS FOR INDOOR/OUTDOOR ELECTRIFICATON WORKS

3.0 Scope

This specification covers supply and fixing of various electrical luminaries and other equipments for installing inside/outside the service buildings, staff quarters, platforms, passenger shelters, sheds, foot-over bridges (FOB) etc. LED type luminaries to be provided. Electrical equipment includes fans, geysers, water coolers, Meter boards etc.

3.1 Relevant Standard Specifications & Regulations (Latest Amendments):

a) IS: 374/1979 :- Electric ceiling type fans and regulators.
b) IS 2312-1967 :- Propeller type ac ventilating fans [ETD 5: Electric Fans]
c) IS:10322:- Luminaries.
d) IS.15111:- Self Ballasted Lamps for General Lighting Service.
e) IS:694/2010:- PVC insulated unsheated and sheated cables/cords with rigid and flexible conductor for rated voltage upto and including 450/750V [ETD 9: Power/Cables]
f) IS:2082:- Stationary storage type electric water heater.
g) IS:1475(Part-1)/2001:- Self Contained Drinking Water Coolers.
h) IS:10617/Part-1/2013 :- Hermatic Compressors.
i) IS:113338/1985:- Thermostat
j) IS:11951-1987 (Reaffirmed 2007) with Admt 1 to 4
k) IS:1391 pt I/1992(Amdt 1,2):-Room Air Conditioners, Part 1: Unitary Air Conditioners
l) IS:1391 pt-II/1992 (Amdt 1):- Room Air Conditioners, Part 2: Split Air Conditioners.
m) RDSO Specification No. RDSO/2009/EM/SPEC/0001,(Rev.'0') Amdt-1.
n) RDSO Specification No. RDSO/PE/SPEC/PS/0123(REV'0'-2009
o) RDSO Specification No.RDSO/PE/SPEC/PS/0100 (REV-1)-2011
p) Railway Board's letter no. 2004/Elect(G)/180/11 pt.II (N1) dated 22.07.08

3.2 LED based lighting in following general service applications on Indian Railway

a. All indication light
b. Station name
c. Signage
d. Façade lighting
e. Tunnel lighting
f. Emergency light in buildings, subway, station for egress of public.
g. Manned Level crossing
h. Street lights at remote places
i. Task lighting at stations

(Manoj Kumar) JE/TECH/CON/NC	(R.K.Das) AEE/CON/PL/MIG	(P.K.Das) TI/CON/MIG	(Ravi Bhushan) Dy.CEE/CON/HQ/MIG

(R.K.Ambiya)
CEE/CON/N-E

j. Pit lighting in maintenance sheds/depots
k. Under water application
l. Medical lighting where infra red radiation and light temperature are unwanted
m. Lantern
n. Stage/studio lighting
o. Touch sensing for control of light.
p. Wall washers.

3.2.1 LED Tube light fittings for new office buildings/Railway stations/Staff quarters/ and other installations etc. shall be used

3.3 LIGHTING on PLATFORMS:

3.3.1 LED type fittings shall be provided as per recommended lux level

3.3.2 Octagonal poles of 7m height shall be used.

3.3.3 4 core X 10sq.mm AL armoured XLPE cable shall be used for Platform lighting.

3.3.4 Approx. distance between poles and luminaire wattage for use at Platform in various type of stations.

A. For platform width between 6 to 9m.

Type of station	Lux level required	Distance between two poles	Approx. wattage of luminaire
A1/A2	50	15	2x45
B/C	30	15	1x45
D/E	20	20	1x45

B. For platform width between 3 to 6m.

Type of station	Lux level required	Distance between two poles	Approx. wattage of luminaire
A1/A2	50	20	2x45
B/C	30	20	1x45
D/E	20	25	1x45

3.4 Scale of amenities for Goods shed.

3.4.1 Illumination level for freight terminals (Goods shed) for facilitating night loading/unloading.

SN	Location	Proposed Lux level	Suggested Luminaries*
1	Circulating area	20	High Mast with LED
2	Loading unloading area		
	i) Covered platform+	50	LED
	ii) Open platform	30	High Mast with LED
3	Merchant room	150	LED
4	Booking office	150	LED

*Colour – Day light white

Note: Lighting circuit must be provided with programmable timer control.

[Manoj Gautam] JE/TECH/CON/HQ	[Sanjay Tak] AEE/CON/PL/MLG	[B.C.Das] TT/CON/MLG	[Ravi Bhushan] DY.CEE/CON/HQ/MLG

[B.K.Awlaye] CEE/CON/NFR

3.4.2 Cold water dispensers.

3.4.3 Fanmage- One fan of 1500mm sweep for every 10sq. m in merchant room and booking office.

3.5 LED type luminaires:

Refer detail specifications in relevant specifications no Tech Spec.No. NFR/ELECT/CON/GS/03/LED TYPE LUMINARIES

3.6 Solar Photovoltaic LED based Street light system:

Refer detail specifications in relevant specifications no.Tech.Spec.No. NFR/ELECT/CON/GS/04/SOLAR LIGHTING SYSTEM

3.7 High Mast Lighting System:

3.7.1 High mast shall generally be used in circulating area and yard. Illumination Level are as follows:

SN	LOCATION	Approved lux level for different category of stations		
	Category of Stations	A1/A	B/C	D/E
1	Circulating area(Model Stations)	50	30	20
2	Circulating area(Non-Model Stations)	30	20	20
3	Circulating area(Goods shed loading/unloading area)		20	
4	Open platform (Goods shed loading/unloading area)		30	

3.7.2 Generally 12m, 16m, 20m, 25m and 30m height High Mast Tower shall be used.

3.7.3 Types of mast and luminaire wattage and distance between High Mast Tower shall be approximately as given below.

i) **For illumination level of 50 lux.**

Height of tower (m)	Distance between two tower (m)	Approx. coverage area of each high mast tower (sq. m)	Recommended Luminaire Wattage
12	30	800	6 X 100 W
16	40	1200	8 X 150 W
20	50	2000	9 X 180 W
25	60	3000	12 X 210 W
30	80	5000	16 X 240 W

[Manoj Sonkusre]	[S.R.Das]	[]	[Ravi Bhushan]
JE/TECH/CON/HQ	ALE/CON/PL/MLG	FEE/CON/MLG	JTALL/CON/HQ/MLG

[R.K.Atoliya]
CEE/CON/NFR

ii) **For illumination level of 30 lux.**

Height of tower (m)	Distance between two tower (m)	Approx. coverage area of each high mast tower (sq. m)	Recommended Luminaire Wattage
12	40	1200	6 X 100 W
16	50	2000	8 X 150 W
20	60	3000	9 X 180 W
25	75	4500	12 X 210 W
30	90	6500	16 X 240 W

iii) **For illumination level of 20 lux.**

Height of tower (m)	Distance between two tower (m)	Approx. coverage area of each high mast tower (sq. m)	Recommended Luminaire Wattage
12	45	1500	6 X 100 W
16	60	3000	8 X 150 W
20	75	4500	9 X 180 W
25	90	6500	12 X 210 W
30	110	10000	16 X 240 W

3.7.4 Refer detail specifications of High Mast Towers , relevant specifications no.Tech.Spec.No. NERSL/EL/CON/GS/06/HIGH MAST LIGHTING SYSTEM

3.8 Ceiling Fan

(i) Ceiling fans shall be provided with suspension hook arrangement in the concrete slab/roof members at appropriate stage before casting of roof at locations indicated on the working drawings prepared by the contractor. Co-ordination has to be maintained with civil engineering contractor authorities for the dates of casting of roof in order to provide fan box with MS hook as approved.

(ii) Ceiling fans shall be continuous duty type with double ball bearings, copper wound motor, complete with canopies, down rod, 3 blades, capacitor etc (as per BOQ item) conforming to IS 374/1979, suitable for operation on 230 Volt +/- 10 %, 50 Hz. A. C. supply and star rated Fans shall be generally off white.

(iii) Normally 1400 mm ceiling fans shall be provided in service building/ passenger shelters/ waiting halls or rooms and 1200mm sweep ceiling fans in residential buildings.

(iv) Stepped type electronic regulator (as per BOQ item) shall be provided for control of speed of fan at locations other than passenger shelters/ sheds as per Engineer's decision.

(v) For covered platforms having width of 6-9mts: one row of fans should be provided (one fan in the center of supporting columns. For covered platform with more than 9mts width, fans should be provided in 2 rows.

[Manju Tripathi]	[S.R.Das]	[V.C.Jain]	[Ram Bhushan]
EE/TECH/CON/HQ	AEE/CON/PL/MLG	EE/CON/MLG	Dy.CFE/CON/HQ/M.C

[R.K.Aditya]
CFE/CON/NER

(vi) Ceiling fans including their suspension shall conform to relevant Indian Standards.

(vii) The height of fan blades above the floor should be (3H + W)/4, where H is the height of the room, and W is the height of the work plane.

(viii) The minimum distance between fan blades and the ceiling should be about 0.3 meters.

(ix) When actual ventilated zone does not cover the entire room area, then optimum size of ceiling fan should be chosen based on the actual usable area of the room, rather than the total floor area of the room.

(x) The number of fans and the optimum sizes for rooms of different dimensions are given in the following table:

Optimum Size/Number of Fans for Rooms of Different Sizes

Room Width	*Room Length*										
m	4m	5m	6m	7m	8m	9m	10m	11m	12m	14m	16m
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
3	1200/1	1400/1	1500/1	1050/2	1200/2	1400/2	1400/3	1400/2	1200/3	1400/3	1400/3
4	1200/1	1400/1	1200/2	1200/2	1400/3	1400/2	1400/2	1500/2	1200/3	1400/3	1500/3
5	1400/1	1400/1	1400/2	1400/2	1400/3	1400/2	1400/2	1500/3	1400/3	1400/3	1500/3
6	1200/2	1400/2	900/4	1050/4	1200/4	1400/4	1400/4	1500/4	1200/6	1400/6	1500/6
7	1200/2	1400/2	1050/4	1050/4	1200/4	1400/4	1400/4	1500/4	1200/6	1400/6	1500/6
8	1200/2	1400/2	1200/4	1200/4	1200/4	1400/4	1400/4	1500/4	1200/6	1400/6	1500/6
9	1400/2	1400/2	1400/4	1400/4	1400/4	1400/4	1400/4	1200/4	1400/6	1400/6	1500/6
10	1400/3	1400/2	1400/4	1400/4	1400/4	1400/4	1400/4	1200/4	1400/6	1400/6	1500/6
11	1500/2	1500/2	1500/4	1500/4	1500/4	1500/4	1500/4	1500/4	1500/6	1500/6	1500/6
12	1200/3	1400/3	1200/6	1200/6	1200/6	1400/6	1400/6	1500/6	1200/7	1400/9	1400/9
13	1400/3	1400/3	1200/6	1200/6	1200/6	1400/6	1400/6	1500/6	1400/9	1400/9	1500/9
14	1400/3	1400/3	1400/6	1400/6	1400/6	1400/6	1400/6	1500/6	1400/9	1400/9	1500/9

Note : This table is indicative only. Case specific design should be done by field officers based on site conditions & constraints.

(xi) Energy Efficient fans with BEE 5 star rating or complying with IS 374: 1979, shall be used.

[Name & Designation] JE/TECH/CON/HQ	[R.C.Das] AEE/CON/HQ/MLG	[B.C.Das] EEE/CON/MLG	[Pave Bhushan] DY.CEE/CON/HQ/MLG

[R.K.Atolia]
CEE/CON/KTR

(xii) For other fan size (mm) the following table may be considered.

Standard Power with Air Delivery of Fan as per the IS 374 Code

Fan Size	*Type*		*Minimum Air Delivery*	*Minimum Service Value*	*Maximum Power Input*
(mm)			m^3/min	$m^3/min/W$	*W*
900	Capacitor	AC	130	3.1	42
		DC	130	3.4	38
1050	Capacitor	AC	150	3.1	48
		DC	150	3.4	44
1200	Capacitor	AC	200	4	50
		DC	200	4.6	44
1400	Capacitor	AC	245	4.1	60
		DC	245	4.8	51
1500	Capacitor	AC	270	4.3	63
		DC	270	5.1	53

Note: Air delivery values are on the basis of air velocity measurements up to 15m/ min.

(xiii) Step Type Electronic regulators should be used instead of resistance type regulators for controlling speed of fans.

(xiv) 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.

(xv) 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.

(xvi) 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.

(xvii) For concrete roofs, a 12mm 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

[Manoj Kapasia] JE/TC/NTR/MIG	[B.C.Das] AEE/CON/PL/MIG	[B.C.Das] EEE/CON/MIG	[Jitu Bhushan] DY.CEE/CON/HQ/MIG

[R. Chaliya] CEE/CON/SER

the roof shall be used. Where suspension arrangement for fan has not been provided by civil dept., suspension arrangement shall be done with threaded nut arrangement by drilling in concrete and applying suitable chemical.

(xviii) In buildings with concrete roofs having a low ceiling height, where the fan clamp mentioned under sub-clause (v) above cannot be used, or wherever specified, recessed type fan clamp inside metallic box.

(xix) Canopies on top of suspension rod shall effectively hide the suspension.

(xx) The leading in wire shall be of normal cross sectional area not less than 1.5 sq. mm, and shall be protected from abrasion.

(xxi) Unless otherwise specified, all ceiling fans shall be hung 2.75 m above the floor.

(xxii) 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.

(xxiii) The wiring of extra down rod shall be paid as supplying and drawing cable in existing conduit.

3.9 Exhaust fans

(i) Exhaust fans shall conform to relevant Indian Standards.

(ii) Exhaust fans shall be erected at the places indicated by the Engineer-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, care being taken to see that the blades rotate in the proper direction.

(iii) Exhaust fans for installation in corrosive atmosphere, shall be painted with special PVC paint or chlorinated rubber paint.

(iv) Installation of exhaust fans in kitchens, dark rooms and such other special locations need careful consideration, any special provisions needed shall be specified.

(v) Exhaust fans shall be heavy-duty type, suitable sweep (as specified in BOQ.) , 900 rpm (as per BOQ item), noise free with fiber/steel body, star rated (if available in India), double ball bearing and conforming to IS 2312-1967. Exhaust fan shall be complete with copper wound motor, capacitor and louver/shutter, frame and mounting bracket and shall be suitable for operation on 230 volt +/- 10 %, 50 Hz, single phase AC supply system. The color of the exhaust fan shall be preferably matching with the wall or as decided by engineer at site.

(vi) A suitable hole 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 size of the rack bolt and spacing shall match with the holes on the frame of exhaust fans. The hole shall be neatly finished to the original shape of the wall.

(Mrinal Sengupta) JE/ELECT(CON)/HQ	AEE/CON/PL/MLG	(B.Das) TTT/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Arora) CE/CON/NFR

3.10 Regulators

The metallic body of regulators of ceiling fans/exhaust fans shall be connected to earth by protective conductor. Regulator shall be electronic type.

3.11 Geyser:

(a) Geyser (storage type water heater) shall be suitable to operate on 230 V AC, single phase, 50 Hz supply. Geyser shall have copper/SS inner shell and fiber body outer shell. Geyser orientation shall be of vertical / Horizontal type as per site requirement and shall be of specified capacity (as per BOQ item) conforming to IS:2082, ISI marked of approved make and 5 Star rated. It should be provided with inlet and outlet PVC (with steel mesh) water connections. The geysers shall be provided with a suitable thermostat control on which the range of temperature is indicated. The thermostat control shall have an adjusting knob for setting the temperature of water to the desired level. The water temperature indicator shall be available on geyser body. At the set temperature, the thermostat shall cut off the power supply automatically. The geyser shall be provided with an LED/ LCD lamp to indicate that the power supply is ON/ OFF. The body of the geyser shall be provided with an earth connection to protect leakage of current.

(b) The geyser shall be mounted vertically /horizontally on the wall by providing rack bolts embedded in the wall. The water connection shall be provided to the inlet port from the nearest water pipe line in order to maintain water supply to the geyser continuously. The outlet of the geyser shall be connected to water pipe line for drawing hot water.

(c) The geyser shall be provided with suitable length of 3 core flexible cord and power plug of 16 A. The power supply shall be through MCB provided in the SDB to protect the geyser from overloads and short circuits and controlling switch shall be located outside the bathroom.

3.12 Water Cooler:

a) Water cooler conforming to IS-1475 (Part-1)/2001 shall be complete with hermetically sealed type, suction cooled compressor (conforming to IS 10617/Part-1/2013), with overload protection and 5 Star rated and all connected standard fittings, accessories, etc. It shall be suitable to operate on 230 volt AC, single phase, 50 Hz supply.

b) Cooling capacity of water shall be 150 liter per hour or as specified in the relevant BOQ item. The tank shall be manufactured from stainless steel of minimum 0.8 mm thickness. The cabinet of the water cooler shall be made of stainless steel sheet not less than 1.0 mm thick. The front panel below the water outlet & drain pan shall be made of stainless steel of 0.8 mm thickness. The bottom pedestal shall be made of thickness not less than2.65 mm. Power factor of water cooler shall not be less than 0.85 at the rated capacity of the cooler. The thermostat shall conform to IS 11333/1985 and the setting shall be adjustable through rotary switch from 10 to 25 degree C which shall be marked suitably. The

(Manoj Srivastava) IF/TECH/CON/HQ	(Amit Das) AEE/CON/PL/MIG	(S.C.Das) EE/CON/MIG	(Ravi Bhushan) WCFF/CON/HQ/MIG

(R.K.Aadliya)
CCE/CON/NER

thermostat control shall have an adjusting knob for setting the temperature of water to the desired level. At the set temperature, the thermostat shall cut off power supply automatically. The body of the water cooler shall be distinctly provided with an earth connection to protect from leakage of current.

c) The water cooler shall be provided with a suitable length of 3 core flexible cord and a power plug of 16 A and earthing. The power supply shall be through MCB provided in the SDB to protect the water cooler from overloads and short circuits.

d) The water cooler shall be placed on brick masonry platform. The water connection to be given shall be provided to the inlet port from the nearest water pipe line in order to maintain water supply to the water cooler continuously.

e) Water cooler shall be provided with 5 KVA electronic auto voltage stabilizers, suitable for operation on single phase 160 to 260 volts input supply, with provision for time delay start, voltmeter, instant start etc.

f) Provision of Water cooler In Different Categories of Stations as per Railway Board's Letter No. 2012/LM (PA) /3/5 Dated 11.09.2012.

SN	AMENITY	STATION CATEGORY						
		A1	A	B	C	D	E	F
1	WATER COOLER	2 ON EACH PF	2 ON EACH PF	2 ON EACH PF	2 ON EACH PF	1 ON MAIN PF	-	-

3.13 Meter Board

a) The meter Board shall be suitable to operate on 230/415 volts Ac, single / three phase, 50 Hz supply system (as per BOQ item) and complete with all equipments including meter/s, MCB's etc. (as per BOQ item).

b) The meter Board shall be out door type, weather proof, fabricated with 1.6 mm CRCA sheet & compartmentalized for accommodating each unit. It shall be flush mounting type with degree of protection not less than IP-54. Each compartment shall have its own door with insulated thumb screw. MCB compartment shall be suitable to accommodate each MCB directly mounted on DIN channel in its own chamber. Meter compartment shall be suitable to accommodate each energy meter in its own chamber and have provision of concealed lock for sealing the individual compartment. Suitable provision shall be made on the front of the door to record the meter reading by providing a glass window 6 mm thick. The provision to be made for padlock/ seal. Meter and meter box should be provided with anti-temper single use seal with sr no. Provision of suitable glass/fiber window shall be made for meter reading without opening the meter board and invariably located outside under shed.

c) The meter compartments shall be with vertical formation and cable alley shall be in the center of the meter Board. Bus bar compartment shall be on the lower side of accommodate incoming cable for termination on incoming MCB. Outgoing MCB compartment/s for each quarter shall be on upper side (on top).

(Manoj Agrawal)	(S.K.Das)	(D.C.Das)	(Ravi Bhushan)
F/TECH/CON/HQ	ALF/CON/P.../MLG	FEE/CON/MLG	DY.CLE/CON/HQ/MLG

(R.K.Adaliya)
CFE/CON/MLG

d) Connections from bus bars to meters and from meter to MCB shall be housed in flexible MS/ PVC conduit through cable alley.

e) The meter Board shall be provided with detachable gland plates on top & bottom with knock outs and earthing terminal etc. as required. Bottom plate shall be provided with cable gland for incoming cable. Suitable knock outs shall also be provided on upper portion and on back side of MCB compartment to connect outgoing wiring/conduit.

f) The bus bar chamber, incoming and each outgoing MCB chamber shall have double doors. It shall be possible to operate the MCBs only after opening of the outer door.

g) Neutral supply to be provided with link in the all distribution boards. No MCB or fuse should be provided in the neutral circuit.

Meter board shall be manufactured to meet the requirement/s as per site conditions i.e. for one/two/three/four unit blocks etc.

NOTE:
Prior to bulk manufacturing, one sample of each type of meter Board shall be got approved from the Engineer.

3.14 Air Circulators:

Air circulators shall be Heavy duty wall mounting, oscillating type fan 600 mm sweeps (24") complete with guard without regulator. Air-circulators should be supported on wall, pillars/poles with suitable mounting arrangements like brackets, clamps and hardware as approved by engineer at site with all connected accessories viz. pipes, brackets, hook/clamps, bolts, nuts, washers, split pins, rubber pads etc. The fan shall be electrically connected to 3 terminal ceiling rose and from the ceiling rose to the Air Circulator by 3 core flexible copper cable run in suitable size PVC flexible hose.

3.15 Window and Split Air Conditioners:

Window and split type AC shall conform to IS-1391 pt I/1992 (amdt 1,2) and IS-1391 pt- II/1992 (Amdt-1) respectively and 5 Star rated, remote control suitable to operate on 230V 1Ph, 50Hz AC supply and includes all connected accessories viz. clamps, bolts, nuts, washers, angulars, iron stand/frame, rubber packing, brackets, copper pipe etc. The AC shall be fitted with adequate length of copper pipe which should be covered with insulation of suitable thickness. Suitable draw pipes should be provided for draining out condensate water in PVC pipes or G.I / Plastic / Fibre trays as per site conditions and as per instructions of Engineer-in charge at site.
The AC shall be installed with suitable rated voltage stabilizer. The windows shall be properly sealed with insulating material after installation of AC.

(Manoj Agarwal) E/TECH/CON/HQ	(S.Sarkar) AFE/CON/PLNG	(R.C.Das) EEE/CON/MHS	(Ravi Bhushan) DFE/CFE/CON/HQ/MLG

(R.K.Abaliya) CFE/CON/NFR

Inverter type AC with 5 star rating or equivalent with remote control suitable to operate in 230 V, 1 ph , 50Hz can also be used.

3.16 Cassette type Air Conditioner:

These ACs are designed to be installed on ceiling. They should operate on 230V 1Ph. or 440V, 3Ph., 50Hz AC supply depending on its rating. AC should be 5 Star rated, remote controlled with suitable mounting arrangements on ceiling. The AC shall be fitted with adequate length of copper pipe which should be covered with insulation of suitable thickness. Suitable draw pipes should be provided for draining out condensate water in PVC pipes or G.I / Plastic / Fibre trays as per site conditions and as per instructions of Engineer-in charge at site.

The AC shall be installed with suitable rated voltage stabilizer to protect it from voltage fluctuations.

3.17 Package type Air Conditioner:

These ACs are designed to be installed inside room on the floor. The AC should be suitable to work on 440V, 3Ph., 50Hz AC supply and shall be suitably rated. AC should be 5 Star rated, remote controlled. The AC shall be fitted with adequate length of copper pipe which should be covered with insulation of suitable thickness. Suitable draw pipes should be provided for draining out condensate water in PVC pipes or G.I / Plastic / Fibre trays as per site conditions and as per instructions of Engineer-in charge at site.The package units may be air/water cooled type as specified in BOQ.

3.18 AIR COOLING SYSTEMS

(a) The air-cooling system is provided in the waiting halls, station buildings, service buildings, running rooms and rest houses etc.

(b) The air cooling system in Waiting Room and Lounge at stations shall conform to RDSO Specification No. RDSO/2009/EM/SPEC/0001,(Rev.'0')Amdt-1.

(c) The air cooling system in other places like service buildings, running room and rest house shall also generally conform to above RDSO Specification. Prior approval of Railway should be taken for any changes in the RDSO specification suiting to local requirement and specific to the building.

3.19 ROOM HEATER:

Provision of Room Heater 5 Star rated in AC retiring rooms may be decided based on the local climatic conditions

3.20 ENERGY SAVERS:

The ENERGY SAVERS consists of Street light /High Mast controller complete with infrared sensors, contactors and MCB, terminal board etc. for 25 KW load. Energy Pack, should be a lighting control device for outdoor luminaries. It should

(Manju Verma) JE/ELO/CON/HQ	(S.K.Das) AEE/CON/PL/MLG	(S.C. Das) EFE/CON/MLG	(Ravi Bhushan) DY.CFE/CON/HQ/MLG

(R.K.Aaliya)
CCT/CON/NER

optimize the switching ON/OFF cycle, automatically, using Nature Switch having space grade infra-red sensor, as per seasonal variation of daylight. It should be suitable for automatic, group control of outdoor luminaries, eliminating the need for any manual operation. Auto switch 'ON' of light at dusk Auto switch 'OFF' at dawn or after selected duration. No clock setting or clock tuning should be required. It should have operating voltage range from 185 to 275 V. the enclosure shall be IP 54 protected.

3.20.1 Constructional Features

Metallic/plastic molded housing to accommodate power contactor, overload protection devices, terminal blocks, MCB for three phases etc. Front opening door shall be with clear transparent window for sensing variation of daylight by the nature switch.

MS plates should be fixed to the housing for pole mounting. Front door shall be provided with unique lock and key arrangement for safety

3.20.2 Technical Specifications

Sr No	Parameter	Details
1	Operating Voltage Range	185 - 275V AC, 50-60 Hz
2	Maximum Load	15KW (3 Phase)
3	Endurance at rated load	Minimum 5000 cycles
4	Operating Illuminance Levels	
	a) For Switching ON	<60 lux for >30 sec (per Std. Test Procedure)
	b) For Switching OFF	>10 lux for >30 sec (per Std Test procedure)**
5	Max. Device Power Consumption	1 Watt at 230V AC
6	Insulation Resistance	Minimum 5 Mega Ohms
7	Operating Temperature Range	-10 C to +60 C
8	Operating Humidity Range	Up to 95% RH at 40 C
9	Over Voltage trip levels	
	a) Auto High Voltage Sense and Trip	Above 270V
	b) Auto High Voltage Sense and Reset	Below 255V AC AC

(Mahesh Yenagare) EE/TEC-1/CON/HQ	(B.A.Das) AEE/CON/PL/MUG	(D.P.Tyagi) EEE/CON/MUG	(Ravi Bhushan) DY.EE/CON/HQ/MUG

(R.K.Atoliya)
CE/CON/NRE

10	Under Voltage trip levels (a)Auto Low Voltage Sense and Trip /(b)Auto Low Voltage Sense	 Below 150V AC Above
11	Selectable res. for switching off from dusk	4 Hrs to 8 Hrs with a resolution of half an hour
12	Override facility for continuous 'ON' and continuous 'OFF' for maintenance	Yes

3.21 **Intelligent Street Light Management System Using RF/GPRS/GSM**

3.21.1 Intelligent street light management system should be used to control and operate the outdoor lights in circulating area and street lights etc

3.21.2 This intelligent system shall be web based technology to remotely control and monitor the electrical parameters of street lights and its status. The system shall include, Control Unit, Light Control Unit, Auxiliary Power Supply, Smart Light Manager Web application etc. The system utilizes wireless technology (RF & GRPS) to control light ON/OFF, individual dimming, group dimming, and some environmental condition by sending a command from the PC/ Laptop/Tablet/Smart phone.

3.21.3 **Intelligent system should have following features.**

a) **Wireless Technology:** The complete system configuration and control shall be achieved remotely through wireless technology.

b) **Dimming/Intensity Control:** The Intensity level of Group and Individual Lights shall be controlled dynamically (instantly)/ automatically by adjusting/ pre-programming the intensity levels. On/OFF/Dimming shall be made automatically based on Real Time Clock (RTC). Dimming shall be possible between 30-100% intensity levels.

c) **Group Dimming:** A group of street lights under same cluster shall be made ON/OFF/Dimming in single click.

d) **Configuration & Control:** Options shall be available to configure and control individual street lights or a group of lights under same Cluster. Configuration includes Setting Date and Time, Intensity Level, Operating Mode, TOD setting (Pre-program intensity level).

e) **Remote Monitoring:** The Light Status such as AC input voltage, AC input current, System Power, Active Energy (kWh), ON hours, operating Mode (Auto/Manual), Intensity Level shall be monitored remotely through web application.

f) **Operating Mode:** Lights shall be configured with 2 modes- Auto and Manual modes. Fault Monitoring- This system shall incorporates automatic fault detection algorithm to identify various faults and fault details can be viewed in Web application. Faults shall be alerted through SMS/ email. Faults monitored shall include Auxiliary Power Supply failure, RF failure, Driver failure, RTC failure, GPRS failure etc.

[Manish Gupta] JE/ELTCT/CON/HQ	[T. Das] AEE/CON/P.MIS	[S.C.Das] EE/CON/MLG	[Ravi Bhushan] DY.CEE/CON/HQ/MIG

[R.K.Aeolya]
CEE/CON/HQ

g) **Graphical Analysis Dashboard:** System shall do graphical analysis like Allocation of lights per cluster, Month wise total energy consumption, Month wise energy consumption per cluster, Energy savings per cluster and all clusters due to dimming, Cumulative light faults, cumulative CCU faults etc

h) **Reports:** The system shall generate various detailed real time reports which include month Wise light power consumption reports, Cluster failure reports, light failure reports etc.

[Manju Sarkar] JL/TECH/CC&C/HQ	(S.K.Das) AGL/CON/P_&_M_C	[S. Das] LLL/CON/M LG	16/5/16 [Ravi Bhushan] DY.CLL/CON/HC/M LG

(R K Mishra)
CLL/CON/NER

NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

Technical Specification No.- NFR/ELECT/CON/CS/04/SOLAR LIGHTING SYSTEM

SOLAR LIGHTING SYSTEM

4.0 Scope:

This specification covers supply, fixing, installation and testing of staud-alone solar home lighting and street lighting system at wayside stations including halt stations, L.C. gates where state power supply is not available within 1km and not likely to be available in foreseeable future and for back up provision for service buildings

4.1 Relevant Standard Specifications and Regulations:

i) IS:2713 (pt. I,II,III) 1980 amended upto date.
ii) Railway Board's letter no. 2002/Elect(G)/150/9 dated 08.03.2007
iii) Railway Board's letter no. 2002/Elect(G)/150/9 dated 18.01.2006

4.2 Solar Home Lighting:

4.2.1 General: Solar Home Lighting System shall comprise of lead acid battery , PV module, module mounting hard-ware, battery box, compact fluorescent lamp complete with luminaries, Fan, control electronics, interconnecting cables/wires etc.

4.2.2 Load: Solar home lighting system shall provide solar electricity for operating 2 lights and 1 fan for 24 hours continuously.

4.2.3 Component Details:

i)	PV MODULE	2 X 37Wp or 1 X 74Wp
ii)	Lamp	2 X LED (11W)
iii)	Fan	1 X DC Fan (with wattage less than 20 W)
iv)	Battery	1X 12 V, 75 AH minimum
v)	Other components	Control electronics, module mounting hardware, and battery box of thickness not less than 0.71 mm (made up of MS Sheet), inter-connecting wires/cables, switches etc.

NOTE:

a) All the item shall be as per latest MNES specifications (latest) and shall possess satisfactory test certificate issued by Solar Energy Centre or any other approved testing center by MNES.
b) PV Modules manufacturer should be MNES approved.

(Manju Yaduvanshi) JE/TECH/CON/HQ	(B.K.Das) AEE/CON/PL/MLG	(B.C.Das) SSE/CON/MLG	(Atul Bhushan) DY.CEE/CON/HQ/MLG

(B.K.Mahanta) CEE/CON/MLG

c) The lamps should be housed in an assembly suitable for indoor use, with a reflector on its back. While fixing the assembly, the lamp should be held in a base up configuration.

4.2.4 SPECIFICATIONS OF COMPONENTS:

4.2.4.1 BATTERY:

a) The battery will be of flooded electrolyte type, positive tubular plate, low, maintenance lead acid battery.
b) The battery will have a minimum rating of 12V, 75 Ah at C/10 discharge rate.
c) 75% of the rated capacity of the battery should be between fully charged & Load cut off conditions.
d) The Battery shall be of standard makes of Panasonic, Exide, Amaraja, Hitachi, CSB, and Tata BP.

4.2.4.2 ELECTRONICS & ELECTRONICS PROTECTIONS:

a) The inverter should be of quasi sine or full sine wave type with frequency in the range of 20-35 KHz. Half wave operation is not acceptable.
b) The total electronic efficiency should be at least 80%.
c) No backening or reduction in the lumen output by more than 10% should be observed after 1000 ON/OFF cycles (two minutes ON followed by four minutes OFF is one cycle.
d) The idle current consumption should not be more than 10 mA.
e) Electronics should operate at 12 V and should have temperature compensation for proper charging of the battery though out the year.
f) Necessary lengths of wires/cables, switches suitable for DC use and fuses should be provided.
g) Adequate protection is to be incorporated under no load conditions e.g. when the lamps are removed and the system is switched ON.
h) The system should have protection against battery overcharge and deep discharge conditions.
i) Fuses should be provided to protect against short circuit conditions.

4.2.4.3 PV MODULE(S):

a) The PV module(s) shall contain crystalline silicon solar cells.
b) The power output of the module(s) under STC should be a minimum of 37W or 74W i.e. two modules of 37 W each or one module of 74W should be used.
c) The operating voltage corresponding to the power output mentioned above
d) Should be 16.4 V.
e) The open circuit voltage of the PV modules under STC should be at least 21.0 Volts.

4.2.4.4 MECHANICAL COMPONENTS:

Metallic frame structure (with corrosion resistance paint) shall be fixed on the roof of the house to hold the SPV module(s). The frame structure should have provision to

adjust its angle of inclination to the horizontal between 0 and 45, so that it can be installed at the specified tilt angle.

4.2.4.5 **INDICATIONS:**

The system should be provided with 2 LED indicators, a green light to indicate charging in progress and a red LED to indicate deep discharge condition of the battery. The green LED should glow only when the battery is actually being charged.

NOTE:

Components and parts used in solar home systems should conform to the latest BIS specifications, wherever such specifications are available and applicable.

4.3 SOLAR LED STREET LIGHT SYSTEM:

4.3.1 Solar Photo voltaic (SPV) based LED street lighting system should design in such a way that it should provide uninterrupted illumination of the streets, pathways & surroundings of the buildings from dusk-to-dawn for security & safety. This solar based photovoltaic system should capability to integrate with local power supply so that when solar power is not available due to cloudy/rainy day then battery are being charged with local power supply.

4.3.2 Solar Photo voltaic (SPV) based LED street lighting system shall consists of the following elements-

(a) SPV Module to convert solar radiation directly into electricity.
(b) 7 m height GI octagonal pole with necessary accessories.
(c) Battery bank to store the electrical energy generated by SPV panel during day time.
(d) Charge controller to maintain the battery to the highest possible State of Charge (SOC) while protecting the battery from deep discharge (by the loads) or extended overcharge (by the PV array).
(e) Blocking diode, preferably a Schottky diode, connected in series with solar cells and storage battery to keep the battery from discharging through the cell when there is no output or low output from the solar cell, if such diode is not provided with the module itself.
(f) 15 W LED based luminaire as a light source.
(g) Interconnecting wires/cables & hardwares

4.3.3 **The salient features of the system are listed below:**

4.3.3.1 GENERAL REQUIREMENTS

The system shall be designed to have 4 days autonomy (i.e. system will run for 4 consecutive days without charging from the panel).

4.3.3.2 BATTERY BANK:

(a) The storage battery Bank shall have enough capacity to keep the system going on without break down when the weather is not favourable for generation of electricity due to cloudy days and rains.
(b) Battery shall be Tubular Gel Valve Regulated Lead acid battery.
(c) The container material shall be PP
(d) Battery shall have a design life expectancy of >5 years at 50% DOD at 27°C.
(e) The permissible self-discharge rate shall be less than 2% of the rated capacity per month at 27°C.
(f) The charging instructions shall be provided along with the batteries.
(g) The batteries shall be discharged up to 80% DOD and battery shall be accordingly sized.
(h) Suitable Battery Box made of Plastic OR M.S fabricated shall be provided to house the battery.
(i) The minimum capacity of the battery bank shall be 12V/75 Ah @ C10
(j) Alternatively VRLA type battery of proven design for such application may also be considered provided such battery have been in such application for more than 3 years satisfactory service.
(k) The Battery shall be of standard makes of Panasonic, Exide, Amaraja, Hitachi, CSB, and Tata BP

4.3.3.3 CABLES AND HARDWARE

i) Cable shall meet IS Part 1: 1988 & shall be of 650V/1.1 KV.
ii) A metallic frame structure (with corrosion resistance paint) to be fixed on the pole to hold the SPV module(s). The frame structure should have provision to adjust its angle of inclination to the horizontal between 0 and 45 so that the module(s) can be oriented at the specified tilt angle.

4.3.3.4 POLE

GI octagonal pole of 7m height shall be used. Each pole shall be provided with 16 mm dia. GI earth terminals of suitable length for earth connection. Pole shall be suitable to wind pressure of not less than 150 KMPH. Drawing of pole shall be got approved from the Engineer at site of Railways.

4.3.3.5 FOUNDATION:

(i) Foundation for erection of pole shall be constructed at the approved location.
(ii) After excavation of pit of suitable size, cement concrete bed of approx.50mm thickness, using cement concrete of M-10 grade (1:3:6), shall be first provided at the bottom of the pit.
(iii) Square foundation shall be made with cement concrete of M-10 grade (1:3:6) of size. The edge of foundation shall not be less than 150mm from edge of pole. The depth of the foundation shall be 1/6th of the length of pole. Circular muffing of 150mm thickness around the mast shall be made for 300mm height above ground and sloped at the top.
(iv) It shall be ensured that the GI/HDPE pipe/s for the cable/s entry is/are placed in position. Muffing shall be plastered, finished and also cured.

(v) After foundation work, the pit shall be filled with excavated earth. During back filling of earth, ramming and watering shall be done.

4.3.3.6 ERECTION OF POLE:

The pole shall be erected in plumb on constructed foundation at the specified location and bolted on a pre-casted foundation with asset of four bolts. Top of all the poles shall be at the same level to maintain uniformity.

NOTE:

1. Components and part used in the solar street lighting systems should conform to the latest BIS specification. Wherever such specifications are available and applicable.
2. All the item shall be as per latest MNES specification and manufacturer shall possess satisfactory test certificate issued by Solar Energy Centre or any other approved testing center by MNES and same shall also be furnished at the time of inspection and copies of the same shall be supplied with supply of material/equipment.

4.4 HYBRID TYPE SOLAR STREET LIGHT SYSTEM (SOLAR + GRID SUPPLY)

4.4.1 Hybrid Type Solar Street Light System should be same as that of 4.3 above with additional controller i.e. grid supplied charger that can accept 140-260 Volts, single phase, 50Hz AC supply and deliver DC power supply to charge the battery.

4.4.2 INTEGRATED FUNCTIONING OF CHARGE CONTROLLERS AND CHARGER

It will be necessary that the charge controller and the grid fed charger shall maintain the battery to the highest possible State of Charge (SOC) while protecting the battery from deep discharge or extended overcharge. As far as possible, renewable energy will be utilized for battery charging. But if the battery's state of charge drops below a point, then the battery would be charged through the grid power supply; it should be possible to set the battery voltage at which the grid fed charger will cut in. The charge controllers and grid fed charger (if any) should function in an integrated manner and without necessitating manual operation. Wherever necessary, a master controller (or functionality thereof) shall be provided towards this end. The controller shall have dusk to dawn switching for outdoor lighting.

4.4.3 INDICATIONS AND METERS

Relevant meters should be provided for voltage, current and indication for low Battery, Battery on charge and Battery fully charged. Detailed scheme shall be submitted at design/ drawing approval stage.

(Manju Yonzone) JE/TECH/CON/HQ	(B.K.Das) AEE/CON/PL/MLG	(S.Dilas) EE/CON/M.S	[Ravi Bhushan] DY.CFE/CON/HQ/MLG

(B.K.Mallick) CLE/CON/NER

NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

Tech. Spec. No. NFR/ELECT/CON GS/05/LED TYPE LUMINARIES

SPECIFICATION FOR LED TYPE LUMINARIES

5.0 Scope:

This specification covers for the LED fitted luminaries used for outdoor and indoor applications for working at 220V+10% , 50 Hz +/- 3% . Single phase input system. The luminaries are used at Railway Stations , Circularing Areas buildings and offices etc. It consist of:

a) Fixture
b) LED
c) Driver and Electronics

5.1 Relevant Standard Specifications & Regulations:

(i) IS 14700: Part 3: Sec 4/Sec11-Electromagnetic Compatibility.
(ii) IS: 1534 : Part 1 Ballast for fluorescent lamps: Part 1 for switch start circuit.
(iii) IS 15885- Safety of Lamp Controlgear.
(iv) IS: 6573- Dimensions for pneumatic coal pick shanks and chuck bushings.
(v) IS 16101 to 16108-General Lighting.
(vi) IS 10322-Specifications for luminaries.
(vii) IEC 60598-1,2,3
(viii) IEC 62031
(ix) IEC 62612
(x) IEC 62471
(xi) IEC 61547
(xii) IEC 61000-4-2
(xiii) IEC 61000-4-3
(xiv) IEC 61000-4-4
(xv) IEC 61000-4-5 3KV/4KV
(xvi) IEC 61000-4-6
(xvii) IEC 61000-4-11
(xviii) IEC 61000-3-2 (Class C)
(xix) IEC 61000-3-3
(xx) IEC: 61347-2-13
(xxi) IEC: 62384
(xxii) EN:61347-2-13
(xxiii) EN: 62471
(xxiv) EN 61000-3
(xxv) CISPR 15
(xxvi) LM 79/80/6/24
(xxvii) ADC 12
(xxviii) ANSI standard C 78.377A
(xxix) RDSO Specifications.
(xxx) Railway Board's Policy.

[Manu Vandna] JE/TECH/CON/MLG	[P.K.Das] ADE/CON/PL/MLG	[S.C.Jha] FA&CAO/CON/MLG	[Ravi Bhushan] DY.CEE/CON/HQ/MLG

[R.Kashyap] CE/CON/N.F.R

5.2 General

5.2.1 LED base lighting system to be used in the following Railway application .

a. All indication light
b. Station name
c. Signage
d. Façade lighting
e. Tunnel lighting
f. Emergency light in buildings, subway, station for egress of public.
g. Manned Level crossing
h. Street lights at remote places
i. Task lighting at stations
j. Pit lighting in maintenance sheds/depots
k. Under water application
l. Medical lighting where infra red radiation and light temperature are unwanted
m. Lantern
n. Stage/studio lighting
o. Touch sensing for control of light.
p. Wall washers.

5.2.2 Use of LED based tube light fittings over IR

LED Tube light fittings for new office buildings/Railway stations/Staff quarters/ and other installations etc shall be used.

5.2.3 Warranty:

The supply shall be covered by a warranty of 60 months from the date of commissioning or 72 months from the date of supply, whichever is earlier.

5.2.4 Minimum IP, IK ratings for indoor/outdoor luminaire:

(i)	Indoor fittings:	IP-20.
(ii)	Outdoor fittings	IP-65, IK-05
(iii)	Pit line.	IP-67, IK-08
(iv)	Tunnel lighting:	IP-67, IK-10

5.2.5 The normal system wattage of luminaire supplied by a firm is permitted to vary by upto +10% to 20% from the value available in the schedule for achieving same lumen output mentioned in schedule

5.2.6 Earthing:

Before installing the LED luminaires on site, it is recommended to ensure that the earthing arrangements in the distribution system are functional and no loose contacts, etc. are set right.

5.2.7 Indoor Applications:

i) The product should be latest state of art and compliant to relevant IEC 60598-1,2,3, IEC 62031 and IEC 62612 or their latest edition depending on the type of luminaries. In addition to the above luminaries shall adhere to relevant BIS standards TS 15885, 16101, 16102, 16103, 16104, 16105 16106, 16107(Part 1 & II) as per the application. The product shall be of proven design should possess type test certificate /performance certificate from the accredited laboratory. The product and its major components shall be

(Manish Kulshrestha) JE/TCC(I)/CON/HD	(P. Das) AEE/CON/MLG	(P. Das) EEE/CON/MLG	(Ravi Bhushan) DY.CE/TCC/CON/HQ/MLG

CEE/CON/NFR

state of art and of proven design

ii) It should be capable to work at Maximum ambient air temperature of 45°C for indoor product in atmosphere like coastal, humid, salt laden and corrosive.

iii) Housing, if not used as a heat sink shall be made of 0.5 mm thick CRCA sheet/Extruded Aluminium(2mm) or pressure die cast(PDC-2 mm) confirming to relevant standards, polyester powder coated of at least 40 microns) and high U.V. and corrosion resistance.

iv) Luminaries should be covered with suitable Glass or diffuser with High Transitivity. Outdoor luminaries shall be with clear toughened glass or clear poly carbonate cover.

v) Lighting fixtures and accessories shall be designed for continuous trouble free operation under diverse atmospheric conditions without deterioration of materials. Degree of protection of enclosure shall be IP rating of luminaire shall be of minimum IP 20.

vi) To be provided with suitable control optics as per need of application and render glare free to user.

vii) Test papers for various parameters i.e. flux, power, efficacy, chromaticity, temperature, protection etc. Issued by certified agency shall be furnished. Estimation on product's life and performance shall also be furnished.

5.2.7.1 Fixture:

The fixture should conform to applicable IS 10322/IEC 60598(All parts & amendments) and should have the associated LM 79 report(for Electrical and photometric test methodology for LED lighting) from accredited lab. Test report shall be submitted along with relevant catalogues. The fixture should have a surge protection of 2 KV.

5.2.7.2 LED (Light Emitting Diode)

LED approved makes are Phillips-Lumileds, Osram, Nichia, Cree/Seoul Semiconductor/Approved Equivalent on specific approval of project authority on basis of test reports and specification in comparision of these standard makes. Manufacturer should have IEC (Illuminating Engineering Society) -LM-80 test report and with projected life as per IEC-LM21. Test report shall be submitted along with relevant catalogues. All LED to be solid state embedded as light sources, arrays and modules.

High lumen efficacy LEDs suitable for the application along with following features shall be used

(i) LED Efficacy at the chip level shall >120 lumen/watt (For High power LED)

(ii) The efficiency of the LED at 85 Degree C junction temperature shall be more than 85%.

(iii) The system luminous efficacy of LED luminaire' shall be as under:
a) Efficacy > 60 lumen/watt for low wattage luminaries (<45W); and
b) Efficacy > 80 lumen/watt for a high wattage luminaries (>45W).

(iv) Adequate heat sink with proper thermal management shall be provided.

(v) Minimum view angle of the LED shall not be less than 120°.

(vi) Power factor of complete fitting shall be more than 0.9.

(vii) LED shall be surface mounted type duly soldered to PCB by Reflow system of COB Type. The Solder used shall be ROHS compatible for environment friendliness.

(viii) Colour rendering index CRI >=70 as specified in the item description.

(ix) Correlated colour Temperature shall be in the range of 3000 K-6500 K as specified in item description

(Manj. Yadav) JE/TECH/CON/HQ	(Ravi Bhushan) AE/TECH/CON/HQ	(T.C. Pal) EEE/CON/MLG	(Ravi Bhushan) DY.CE/CON/HQ/MLG

(R. K. Mehra) CEE/CON/HQ

5.2.7.3 LED driver.

LED driver shall be capable to withstand and work with Input voltage Range from 160V (RMS) to 270 V(RMS) with built in 2KV surge protection. Output voltage of the driver shall be designed to meet the Power requirement of the system. Output voltage ripple should be within 3%. Output over voltage protection should be up to 125 V DC. Full Load Efficiency shall be more than 85%.

Total Harmonic Distortion

- For 0-50 W shall be less than 25%
- Above 50 W rating shall be less than 15%

Current waveform should meet EN 61000-3-2. LED Driver shall be able to withstand voltage of 350V for 2 hours and restore normal working when normal voltage is applied. The driver should comply to CISPR 15 for limits and methods of measurement of Radio Disturbance characteristics and it should comply to IEC 61547 for EMC immunity requirement. The control gear should be compliant to IEC 61347-2-13, IEC 62031 and IEC 62384.

5.2.8 **Outdoor Applications**

i) The product should be latest state of art and compliant to relevant IEC 60598-1,2,3, IEC 62031 and IEC 62612 or their latest edition depending on the type of luminaries. In addition to the above luminaries shall adhere to relevant BIS standards IS 15885, 16101, 16102, 16103, 16104, 16105, 16106, 16107(Part I & II) as per the application. The product shall be of proven design should possess type test certificate /performance certificate from the accredited laboratory. The product and its major components shall be state of art and of proven design.

ii) It should be capable to work at Maximum ambient air temperature of 55°C for outdoor product in armosphere like coastal, humid, salt laden and corrosive.

5.2.8.1 **Technical Requirements of LED**

(i) LED efficacy shall be greater than 100 Lumens/Watt (for luminaire system wattage upto 45W)/120 Lumens/Watt (for luminaire system wattage above 45W) @ 350mA drive current (manufacturer shall submit the datasheet in support). In respect of LEDs of higher power ratings, drive current greater than 350mA can be accepted if the LED's LM 80/IS:16105 test reports support the same.

(ii) LED used should be of SMD type only.

(iii) View angle:Typical 120° (Manufacturer shall submit the datasheet in support).

(iv) Colur temperature of the proposed white color LED shall be 5700K (i.e 5665±355K, as per ANSI standard c78.377A).

(v) Color Rendering Index (CRI): Greater than or equal to 65.

5.2.8.2 **Technical requirements of Driver:**

(i) Min. efficiency of driver, 85% (for drive power output rating<100W), 90% (for drive power output rating>100W)

(ii) Power factor of complete fitting: Greater than 0.90.

(iii) Input Operating Voltage: 140V to 277V AC.

(iv) In-built high and low voltage cut offs: 140V (Low) and 277V (High)

(v) Output Voltage: Shall be designed to meet the Power requirement of the system.

(Manju Tomar) JE/TECH/CORP/HQ	(S.K.Das) AGM/CON/PL/MLG	(D.C.Das) EE/T/CON/M-II	(Ravi Shankar) DY.CEE/CON/HQ/M-II

(R.K.Arora)
CEE/Commercial

(viii) Short circuit protection.

(ix) Open load protection.

(vi) Driver Surge Protection standard: Min 3KV. If a Railway site/ location is prone to lighting and surges, in such case 10 KV surge protection to be provided within the luminaire.

(vii) Total Harmonic Distortion shall be less than 20% at full load.

(viii) Isolated driver should be used.

(ix) The power supply shall be connected to the LED PCBs through proper connectors.

(x) LED driver shall be able to withstand voltage of 350V for 2 Hrs and restore normal working when normal voltage is applied.

(xi) Driver shall comply relevant EMI/EMC standards.

(xii) Driver shall comply safety requirements laid down in IEC: 61347-2-13/ EN: 61347-2-13/ IS: 15885-2-13.

(xiii) Driver shall also comply the performance requirements as per IEC: 62384/IS: 16104.

5.2.8.3 Technical **requirements** of **luminaire**

(i) The min. system lumen efficacy of the luminaire shall be as follows:

(a) 80 lm/W (luminaire system wattage>45)

(b) 90 lm/W (luminaire system wattage>45)

(ii) Color temperature: 5700K (5665±355K, as per ANSI standard C78.377A)

(iii) CRI: Greater than or equal to 65.

(iv) Housing of Luminaire: Pressure die-cast LM6/ADC12/LM24 housing.

(v) Cover type: Toughened glass or UV stabilized polycarbonate cover.

(vi) Housing protection: IP 65. If the LEDs and LED Driver are in different compartments, then the two compartments must be individually IP-65. For achieving IP-65, proper gaskets should be provided.

(vii) Impact Resistance: IK-05

(viii) The luminaire shall comply safety requirements laid down in IEC: 60598-1/IS: 10322: Part 1, IEC: 60598-2-3/ IS: 10322: Part 5: Sec 3.

[illegible] JE/TECH/CON/HQ	[illegible] AT/CON/PL/MUG	[illegible] EE/CON/MUG	[Ravi Bhushan] DY.CEE/CON/HQ/MUG

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NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

Technical Specification No. NFR/ELECT/CON/GS/006(HIGH MAST LIGHTING SYSTEM)

HIGH MAST LIGHTING SYSTEM

6.0 Scope

The scope covers supply and erection of the high mast lighting system of specified height including foundation and other civil works. High Mast System includes all components and accessories, foundation bolts with nuts, washers, anchor plates, templates, LED luminaries (degree of protection of minimum IP65), etc. and provision of luminaries on the head frame of high mast with manual/electrical operation arrangements to lower/raise for maintenance purposes.

6.1 Codes and Standards

Design, manufacture and performance of the High Mast lighting system shall comply with all currently applicable statutory regulations and safety codes and standards in the locality where the equipment is being installed and generally in accordance with the following standards for the loading of the High Mast.

S. No.	CODE	TITLE
1	IS 875 (Part III) 1987	Code of practice for design loads for structures
2.	BSEN 10025/DIN 17100	Grades of MS plates
3.	BS5135/AWS	Welding
4.	BS ISO 1461	Galvanizing
5	TR. No. 7 1996 of ILE UK.	Specification for masts foundations
6.	BS 5135/AWS	Longitudinal weld
7	IS 3646 (Part I): 1992	Code of Practice for interior illumination. Part I- General requirements and recommendation for Welding interiors.
8	SP 72, 2010	National Lighting Code 2010
9.	Railway Board's L/No. 2004/Elect(G)/109/1 Pt. dated 15.02.2006	
10.	Railway Board's L/No. 2004/Elect(G)/109/1 Pt. dated 17.05.2007	
11.	Railway Board's L/No. 2004/Elect(G)/109/1 Pt. dated 18.05.2007	

6.2 High mast shall generally be used in circulating area and yard. Illumination Level are as follows:

SN	LOCATION	Approved lux level for different category of stations		
	Category of Stations	A1/A	B/C	D/E
1	Circulating area(Model Stations)	50	30	20
2	Circulating area(Non-Model Stations)	30	20	20
3	Circulating area(Goods shed loading/unloading area)		20	
4	Open platform (Goods shed loading/unloading area)		30	

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E/TECH/CON/HQ	AFE/CON/P.../M/G	L.L/CON/M/G	DY.CE/CON/HQ/M/G

(R.K.Malviya)
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6.3 Structure

The High mast shall be of continuously tapered, polygonal cross section, presenting an standards to give assured performance and reliable service. The structure shall be suitable for wind loading as per IS 875 Part III of 1987.

6.4 General Constructional Features

The mast shaft shall be made of best steel grade in compliance with BS-EN 10025/DIN 17100 or equivalent, cut and folded to form a polygonal section and shall be telescopically jointed and welded. The welding shall be in accordance with BS 5135/AWS. The top section shall have a flange plate bolted to the head frame. The mast shall be fabricated and butt welded longitudinally to form a tapered section with telescopic friction slip joints. The procedural weld geometry and workmanship shall be exclusively tested on the completed welds. Mast shall be delivered at site in multiple sections. Each section shall be hot dip galvanized (single dip) inside and outside, having uniform coating thickness of 85/65 microns for bottom/top sections respectively. At site the sections shall be jointed together by slip- stressed-fit method. No site welding or bolted joint shall be done on the mast.

6.5 The mast shall have fully penetrated flange, which shall be free from any lamination or incursion. The base plate shall be of single flange and constructed with holes jig- drilled for anchor bolts passage for fixing the high mast on to the concrete foundation. The base flange will be provided with supplementary gussets between the bolt holes to ensure elimination of helical stress concentration of the environmental protection of the mast. The entire fabricated mast shall be hot dip galvanized, internally and externally, having a uniform thickness of 70 microns for the bottom section and 65 microns for the top section.

6.6 The welded connection of the base plate to the mast section shall fully develop the strength of the section. Ultrasonic testing procedure shall be considered as the minimum permissible testing method. The wall thickness of each section shall be designed to withstand the loads to which the high mast will be subjected but in any case it shall not be less than 3 mm and 4 mm at top and bottom respectively. Shaft section shall not be jointed by circumferential weld or bolting.

6.7 All mast components shall be hot dip galvanized, as per BS ISO 1461. Earthing and earthing terminal shall be provided within the access door area of each high mast.
Galvanizing shall be inspected for
(a) Adhesion (b) Mass of zinc coating and (c) Uniformity.

6.8 Mast Design Criteria

a) The high mast and the lowering system with the required number of flood lights and lamp control gears etc. shall be capable of withstanding a sustained basic wind speed the area as per IS-875.

b) The design shall be such that the high mast with accessories is capable of withstanding external forces exerted by wind pressure and shall have a minimum wind load factor of 1.25 and material factor of 1.15.

(Manju Yadav) JE/TECH/CON/HQ	(Illegible) AFE/CON/PI/MAS	[S.C.Jas] CE/CON/W/LG	[Ravi Bhushan] DY.CE/CON/HQ/MLG

[R.K.Atoliya]
CTE/CON/HQ

6.9 Foundations

The mast shall be erected on suitably designed foundation as per high mast manufacturer's design with following typical details.

Type of foundation	as specified by high mast manufacturer.
Size of foundation	As per high mast manufacturer's design
Load bearing capacity of soil	As per soil report of the site at 2 meters depth.
Considered wind pressure (Kg per meter sq)	As per IS-875-1987 or latest
Considered wind speed (KMPH	As per IS-875-1987 or latest

The rate quoted for the high mast shall include the cost of testing of soil bearing capacity and laying of foundation. The contractor shall get the foundation designed accordingly from OEM/other reputed firm as decided by the Railway.

6.10 Lantern carriage

6.10.1 The mobile luminaries' carriage ring shall be of steel tube construction in two segments. The unit shall be joined by bolted flanges with stainless steel bolts and nylon type nuts to enable easy installation or removal from the erected mast. All mobile components of the system shall be located on the mobile part in order to allow visual inspection during each operation. Proper luminary carriage ring support arms shall be provided for supporting the luminaries ring when the latter is lowered for maintenance.

6.10.2 The mobile luminary carriage shall be designed to carry the 6/8/9/12 number of luminaries and control gears as specified in the relevant BOQ item and shall be evenly balanced. Nylon paddle Guide Ring shall be incorporated as a buffer arrangement between mobile luminaries carriage and mast shaft. This is to prevent damage to mast Surface during lowering and raising operation of mobile luminaries' carriage.

6.11 Winch

(a) For installation and maintenance of luminaries and lamps, it is necessary to lower and raise the luminary carriage by means of suitable winching arrangement at the base of the mast. The speed of raising and lowering of lantern carriage ring shall be at least 3.0 meters per minute.

(b) The winch must be of robust design and fully sustaining type without the need of brake shoe, springs or clutches. Winching system with the exception of driving unit shall remain permanently inside the mast with pendant switch control. Each mast shall be provided with a double drum winch suitable for raising and lowering the luminaries ring, with gear ratio 53:1 self lubricating type. It can be removed from the mast for maintenance if the need arises in future. The reduction gear of the winch shall be of endless work gear opening in an oil bath and gear shall be made up of High Carbon steel/ phosphor bronze. The minimum safe working limit of the winch shall not be less than 750 kg at 200 RPM. The operating speed of the winch shall be 180 RPM mechanical or 1400 RPM electrical motor.

(c) The capacity and the operating speed of the winch shall be clearly marked on each winch on an indelible label together with the recommended specification of the

(Manju Tandon) JA/TECH/CON/MLG	(S. Das) AEE/CON/P./MLG	(P.C.Das) EE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Mishra)
CE/CON/MLG

lubricant. A minimum of 6 turns of wire rope shall be on the grooved drum when the mobile luminaries ring is fully lowered to rest on the luminaries supporting arms.

(n) The winch shall be entirely sustaining under all normal circumstances and it is not independent on the brake or restraining device that uncontrolled or dangerous runaway speeds will occur in the event of total failure of this device. Slip test on winch is to be carried out by the manufacturer. All manufacturer's test certificates and reports shall be submitted by the contractor to the Engineer.

6.12 Head frame

The head frame shall include a pulley system to accommodate three stainless steel hoisting wire ropes at any one time and separate pulleys for the passage of electrical cables. The pulleys shall be of non-corrosive material and shall run on self lubricating bearings with stainless steel axles. The complete head frame chassis shall be hot dip galvanized. The pulley assembly shall be fully protected by a galvanized (both internally and externally) canopy. Close fitting guides and sleeves shall be provided to ensure that the ropes and cables do not get dislodged from their respective positions in the grooves. The head frame shall be provided with guides & stops with PVC buffer for docking the lantern carriage.

Note: Pulleys made of synthetic material such as plastic or PVC shall not be accepted.

6.13 Hoisting and Suspension Wire Ropes

a) The high mast shall be fitted with 6 mm dia flexible standard stainless steel hoisting wire ropes of 7/19 construction, with a minimum breaking strength of 2350 kg. The combined lifting capacity of the hoisting wire rope shall have a factor of safety of 7 times the Safe Working Load (SWL) of the winch and shall be entirely suitable for the design application. Center material shall be conforming to DIN 3060.

b) **A transition plate shall be incorporated to:**

i) Connect the three suspension wire ropes to the two stainless winching wire ropes.

ii) Allow fixing of electrical wire cables.

iii) Ensure even distribution of loads between the two stainless steel winching wires by means of an equalizer (necessary thimbles and terminals shall be provided for the steel wire ropes).

iv) Ensure even distribution of loads between the two stainless steel winching wires by means of an equalizer (necessary thimbles and terminals shall be provided for the steel wire ropes).

6.14 Electrical Cable

a) Electrical cable shall be copper, anti-twisting, round and multi cored. The cable shall be suitable to carry the current of the fittings provided. A suitable terminal Board shall be provided at the base compartment of the high mast for terminating the incoming cable. The electrical connections from the bottom to the top shall be made by a special trailing cable. The cable shall be EPR (Ethylene Propylene Rubber) FR PVC insulated and PCP (Polychloroprene) sheathed to get flexibility and endurance. Size of the copper cable shall not be less than 2.5 sq. mm. At the top there shall be weather proof junction Board to terminate the trailing cable. Connections from the top junction Board to the individual luminaries shall

(Manoj Vinayak) JE/TECH/CON/HQ	AEE/CON/P.IV.5	(E.C.Das) LL/CON/M.Q	(Ravi Shankar) DY.CEE/CON/HQ/M.Q

(B.R.Alone) LL/CON/M.Q

be made by using 3 core 2.5 sq. mm flexible PVC cables of reputed make. The system shall have in-built facilities for testing the luminaries while in lowered position.

b) Suitable provision shall be made at the base compartment of the mast to facilitate the operation of internally mounted, electrically operated power tool for raising and lowering of the lantern carriage assembly. The trailing cables of the lantern carriage rings shall be terminated by means of specially designed, metal clad, multi-pin plug and socket provided in the base compartment to enable easy disconnection when required.

6.15 Winch Driving Power Tool

6.15.1 A suitable high powered, electrically driven internally mounted power tool, with normal over ride, together with an operating stand, shall be provided for the raising and lowering of the lantern carriage for maintenance purposes. The power tool shall be of single speed to suit the requirements provided with a motor of required rating, so that vibrations associated with high speed operation are avoided.

6.15.2 The power tool shall be suitable for lifting of the designed load installed on the lantern carriage and shall also be designed such that it will be not only self supporting, but also align perfectly with respect to the winch spindle during the operation. The power tool shall be supplied complete with push button type remote control switch and six meters of additional power cable, so that the operation can be carried out from a safe distance. In case of failure of electrical supply, provision for manual operation shall exist and shall incorporate a torque limiting device. The power tool shall be reversible. Necessary protection against over load, short circuit, earth fault and single phasing etc. shall be provided.

6.16 Control Panel

6.16.1 Control of raising and lowering operations shall be carried out from the mast base by means of a portable control panel. The control panel shall be suitable for 3 phases, 415 volts A. C. supply system and shall consists of:

a) A power supply and control cable of not less than 5.0 meter length.

b) A pendant type control panel equipped with push button for raising and lowering of the mobile part. The push buttons shall operate on the " dead man" principle i.e. action shall seize as the button is released.

c) Steel sheet iron control panel of suitable size and built in type, shall be provided and fixed in the high mast at a suitable height.

6.16.2 The panel board shall consist the following:

- 1 x 63 A TPN MCB switch for incoming
- 1 no. of multiple plug socket 16 amps.
- 3x32 A, SPN MCB for outgoing

6.16.3 Automatic timer switch preferably astronomical timer switch with contactor of suitable rating for control of 50 % & 100% lighting OR as approved.

6.16.4 Intelligent lighting control system shall be provided for remote operation.

6.17 Torque Limiter

a. Model	Electric TD2
b. Lifting Capacity	SWL 750
c. Adjustable/Non-adjustable	- Adjustable.

(Manas Yadav) JE/TLC II/CON/MLG	(Ajay Das) AEE/CON/MLG	(R.C.Das) EE/CON/MLG	(Ravi Bhushan) SE/CTT/CON/ MLG

(R.C.Gadiya)
CE/CON/DER

6.18 Fencing Panel

High mast shall be provided with suitable fencing panel of size 2mX2mX1.5m duly painted for protection of erected high mast as specified in BOQ and as directed by Engineer.

6.19 Earthing:

Earthing shall be provided as per the Indian Electricity Rules, 1956 and earthing specifications. Drawing shall be duly approved by the tenderer.

6.20 Luminaries:

6.20.1 LED Luminaries:

- IP 65 or IP 66 LED outdoor luminaire of suitable wattage to be provided as per the LED specifications and as mention in BOQ.

6.21 One number Aviation light to be provided.

6.22 Suitable lightening arrester as required to be provided on top of the mast.

6.23 Standard height of high masts to be and shall be of 12m, 16m, 20m, 25 and 30m.

(Manju Yadappanavar) JE/TECH/CON/HQ	(Er. [illegible]) AEE/CON/PL/MLG	(P.C.Das) EE/CON/MLG	(Ravi B Salvar) DY.CEE/CON/HQ/MLG

(K.K.Abrol) CE/IT/SR/NFR

NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

Technical Specification No. NFR/ELECT/CON/GS/07(BATTERY CHARGING POINTS, PRE-COOLING POINTS & BATTERY CHARGER,)

BATTERY CHARGING POINTS, PRE-COOLING POINTS AND BATTERY CHARGER.

7.0 SCOPE:

This specification covers the construction and test requirement of Silicon Rectifier battery charging sets for charging lead Acid cells used on Indian Railways and Battery charging and pre-cooling points provided at stations, sick line and pit line.

7.1 Relevant Standard Specifications and Regulations:

S.N.	Material/Equipment	BIS Specification No.
1	MCB	8828
2.	PVC copper conductor cable	694
3.	MCCB	13947
4.	LTXLPE Cable	7098/Pt.1/1985
5.	Industrial type plug socket	13947
6.	PVC insulated copper conductor	694
7.	Mono-crystalline semi-conductor rectifier cells and stack	IS 3895-66
8.	Mono- crystalline semi-conductor rectifier assemblies and equipment	IS4540-68
9.	Direct acting electrical indicating instruments	IS1248-68
10.	Heavy duty composite units of air-break switches and fuses for voltage not exceeding 1000 volts.	IS13947-93
11.	Rectifier transformer	Clause 5 of IS4540-68 & IS2026

7.2 BATTERY CHARGING POINTS:

7.2.1 Battery charging points shall be constructed in two portions in separate enclosures in vertical formation. One portion (upper) shall contain bus bars, MCB, provision for accommodating incoming cable, outgoing looping cable to/from other point and cable connecting to Emergency Feed Terminal(EFT) etc. and other portion (lower) shall contain EFT terminals for cable connections to feed supply to batteries for charging. Doors shall be provided with locking arrangement and openable with special key.

(Mir[illegible] Yonjone) JE/TECH/CON/HQ	(B.R.Das) AEE/CON/PL/MLG	(B.C.Das) FFF/CON/MLG	30/5/16 (Bav Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Maliya)
CEE/CON/NFR

7.2.2 Battery charging points shall be cubicle type, weather proof, out door type, dust & vermin proof, conforming to IS-8623 with degree of protection not less than IP54. Proper canopy shall be provided on top to prevent water entering inside the box. It shall be suitable for operation on 150V DC supply system and fabricated with 14 SWG galvanized CRCA sheet with pedestal of MS channel of size 100 x 50 mm (weight 7.914 kg/m), 1200 mm long, 2 nos. aluminum bus bars of size 40x10mm, complete with one no. incoming MCB DP 63 Amps (DC series) 10 KA. Detachable plate shall be provided on bottom for entry of incoming and outgoing cables with suitably sized gland/s. Channel shall be fixed /welded with the enclosure on back side in the centre of the enclosure at a specified distance from the top.

7.2.3 BFT (as per RDSO drawing already in use in Train Lighting system) feeding terminals shall be of galvanized mild steel, suitably mounted on ebonite/Teflon sheet (approx. 12 mm thick), fixed on the sheet of enclosure.

7.2.4 The feeding terminals shall be marked Red & Black for polarity ("+ve" and "-ve"). Suitable space shall be provided between terminals.

7.2.5 The incoming connections from bus bars to MCB and from MCB to the feeding terminal (BFT) shall be done with single core, 10 sq. mm, copper conductor cable, with suitably sized galvanized MS bolts, nuts and washers.

7.2.6 Enclosure and channel shall be powder coated and of the specified colour. Enclosure shall have double earth terminals.

7.2.7 **Erection**

The channel of the battery charging point shall be grouted vertically in ground 300 mm deep with cement concrete of M-10 (1:3:6) grade. The clearance between the channel and edge of foundation shall be minimum 200 mm and it shall be duly finished and cured. The muffing shall be 200 mm above ground level.

7.3 PRE-COOLING POINTS:

7.3.1 The pre cooling points shall be manufactured in two portions, in separate enclosures, in front and back formation. Bus bar chamber shall be provided on back side of the enclosure and it shall be capable of opening with special type of key. Front portion shall contain switch gears and other items. Detachable plate shall be provided at the bottom for entry of incoming and exit of outgoing cables, with suitably sized cable entry gland/s. Provision for incoming and looping cables from/to other point shall be from bus bar portion. Connections to switch gear shall be done with single core unarmoured aluminium conductor cable of size not less than 120 sq mm. Each enclosure shall have independent hinged flushed doors with sliding type lockable arrangement, as well as concealed lock, openable with special key.

(Manju Yadav) JE/TECH/CON/HQ	(B.K.Das) AEE/CON/PH/MLG	(S.C.Das) EEE/CON/MLG	3/5/16 (Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Malviya) CEE/CON/NFR

7.3.2 The pre-cooling point shall be manufactured from 3.15 mm CRCA sheet. Pedestals (4 nos. on corners), shall be of MS angle of size 65x65x8 mm (900 mm long) with base frame of MS angle of size 40x40x5mm. The enclosure shall have double earth terminals.

7.3.3 Enclosure shall be weather proof, outdoor type, dust and vermin proof with degree of protection not less than IP 54. Proper canopy shall be provided on top to prevent rain water ingress into the box.

7.3.4 The enclosure and pedestals shall be powder coated with specified shade.

7.3.5 Index of protection of socket and plug should not be less than IP 67.

7.3.6 (a) Pre-cooling portion shall be provided with the following, on the front for utilization/operation without opening the front door:

i) One no. 100 A, 4 pole, MCCB 35 kA (Fixed type)
ii) One no. 63A industrial type, iron clad 5 pin (3P +N +E)415 V plug socket with spring locked cover.
iii) One No. 32 A Industrial type iron clad 3 pin (P+N+E) 250 V plug socket with spring locked cover.
iv) Batten Holder fixed on Bakelite sheet base plate with suitable lamp and controlled by 5 A piano type switch.
v) 300 A Aluminium bus bar for Phases & 200 A for Neutral, with epoxy coating/ PVC colour coded sleeves.
vi) Cable entry glands of suitable size
vii) LED indication lights.

b) The connections from bus bars to MCCB and from MCCB to the feeding terminal (Iron Clad Sockets) shall be done with single core, copper conductor cable of suitable rating with suitably sized galvanized MS bolts, nuts and washers.

7.3.7 **Erection**

Pedestals shall be grouted vertically 300 mm deep in ground with cement concrete of M-10 (1:3:6) grade. They shall be 200 mm in diameter, duly finished and cured muffling 200 mm above ground level.

(Manju Agrawal) JE/TECH/CON/HQ	(J.D.Das) AEE/CON/PL/MLG	(S.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Mallick)
CEE/CON/NFR

7.4 **Scheme for cable laying for Pre-Cooling/Battery Charging points**

SN	Circuit (Utility)	Conductor Detail	Size of Cable	Cable Outer Dia. (approx.)	Overall Sec. Dia. Of Total Nos. of Cable (approx.)	HD PVC/GI pipe		Tapping Interval
						Dia.	Nos. of cable	
			sq.mm	mm	mm	mm	No.	mtr.
1	Pre-cooling	S/Core AL. XLPE, Unarmoured. 4 wire (3Ph + N)	120	20	40	100	4	25
2	Battery Charging	S/Core AL. XLPE, Unarmoured. 3 wire (2Ph + N)	185	24	48	100	3	25

Note: Cable shall be laid in HDPVC, GI pipes/ Trenching as required.

7.5 **BATTERY CHARGERS FOR COACHING APPLICATIONS (110V DC, 200A):**

7.5.1 The battery charging sets shall be natural air cooled type with full wave bridge connected silicon rectifier stack and chokes for automatic limiting of variation of charging current due to mains voltage fluctuation. The silicon rectifier diodes shall be of capacity such that when 6 diodes are used for 3 phase rectification, the normal capacity of the bridge shall not be less than 175% of rated rectification capacity. The silicon diodes shall be rated for 200 PIV or more. The silicon rectifier equipment shall conform to IS4540/1968 of rating class-B/air cooled. The maximum permissible temperature rise on winding shall not be more than 85° C.

7.5.2 **Site Conditions:** Height above mean sea level – below 1000M

Maximum ambient temperature	-	45 degree Celsius
Minimum ambient temperature	-	1 degree Celsius
Relative Humidity	-	100%

7.5.3 **Nature of Input Electric Supply:**
AC supply 3 phase, 50 C/s 415V, with neutral earthed.

7.5.4 A maximum of 5% ripple shall be allowed. Surge suppressors and HRC fuses shall be provided for protection of the rectifier diodes. Chokes shall be wound with copper conductors.

(Manju Varlootia) JE/TECH/CON/HQ	T.D. Das AFE/CON/PL/MLG	(S.C Das) LEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/TIC/W_G

(R.K Asthana) CEE/CON/NFR

7.5.5 The rating of transformer provided in the battery charging set shall match the rating of associated rectifier set. The transformer shall be double wound with copper conductor, naturally air cooled, as per IS:2026 with class-F insulation, suitably impregnated to withstand moist tropical climatic conditions. SFU/FSU incorporating HRC fuses and MCCB matching the characteristics of diodes, shall be provided for the control of incoming AC supply. The SFU/FSU & knife switch shall be mounted firmly on a steel frame work below panel sheets. Rewirable fuses shall be provided for pilot lamps and indicating instruments. Two nos. of suitable capacity knife switches shall be incorporated for the control of outgoing DC supply in addition to diode protection type HRC fuses of suitable capacity. (2 nos. of knife switches, each of 200 amp. Capacity, shall be provided for 2 nos. of outgoing cables).

7.5.6 The silicon rectifier battery charging set shall be capable of giving the rated DC output over the entire range of 125 to 150 volts. The output voltage shall be capable of adjustment in this range, for which purpose, coarse, medium and fine control, in not less than 4 steps, shall be provided through suitable rotary control switches incorporated on the transformers.

7.5.7 The arrangement of silicon rectifier stacks, transformers and chokes shall be such that each item can be dismantled independently, without disturbing the other equipments.

7.5.8 The battery charging sets are required for indoor use and shall be portable with 4 wheels. The set shall consists of transformers, chokes, silicon rectifier, control switches, ON/OFF switches, DC Voltmeter, Ammeter of moving coil type, flush pattern, of suitable range and interconnections etc. Cabinet shall be of 14 SWG CRCA sheet steel and powder coated. The bus bars and inter connections shall be of copper conductors.

7.5.9 Suitable earthing terminals shall be provided. To safe guard against accident hazard to the maintenance staff, incoming and the outgoing terminals on charging set shall be provided for enough space on separate installed sheets.

7.5.10 The battery charger shall be rated to give 200A at 150V DC.

7.5.11 Over Loading

7.5.11.1 The rectifier transformer unit capacity shall withstand the following over loading:

i) 50 % over loading - Continuously.
ii) 100% over loading - One hour.

7.5.11.2 The transformer rectifier unit shall be such that on short circuiting the DC side of the rectifier bridge, the short circuit current does not exceed 300% of the nominal rating of the rectifier unit.

(Manju Yadav) IF/TECH/CON/HQ	(U.K.Das) AEE/CON/FL/MLG	(S.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CE/CON/HQ/MLG

(R.K.Arolia)
CEE/CON/NTB

7.5.12 Tests

7.5.12.1 Type Tests: The manufacturer shall submit type test certificates for tests successfully carried out on similar type of sets, to the inspecting authority.

7.5.12.2 The following routine tests shall be carried out by the inspecting authority and results witnessed:

a) Insulation Resistance Test- Insulation resistance shall not be less than 2 mega ohm before and after the high voltage test. The AC and DC side of rectifier set shall be short circuited while testing.
b) Load Characteristic- The battery charger shall give 200V at 150V DC.
c) High Voltage Test- 1 kV shall be applied for 60 sec. and rectifier AC/DC side shall be short circuited before applying the high voltage.
d) Load Test- The battery charger shall be connected to variable resistance of water rheostat and measure the output voltage and current. Check the transformer and temperature after 2 hours run. Check up the core noise or poor lamination or heating.

(Manju Yohannan) EE/TECH/CON/HQ	(B.K. Das) AEE/CON/PL/MLG	(D.C Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K. Malik)
CEE/CON/NHR

NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

Technical Specification No. NFR/ELECT/GS/08(CABLE LAYING)

CABLE LAYING

8.0 General

(a) LT XLPT cables shall be of 1/2/3/4 core/s (as specified in the relevant BOQ item). With aluminium conductor, armoured/unarmoured (as specified in the relevant BOQ item). PVC outer sheathed, conforming to IS: 7098 Pt.1(ISI Marked).

(b) HT XLPE (earthed) cable shall be of single core, aluminum conductor, screened, armoured shielded and PVC sheathed, conforming to IS. 7098/Pt 2 (latest version)(ISI Marked)

(c) IS 1255-1983 shall be followed in general for laying of cables.

8.1 Relevant Standard Specifications and Regulations (latest amendments):

i) I.E.Rules
ii) IS: 7098 Pt.I (ISI Marked)
iii) IS: 7098 Pt.II (latest version) (ISI Marked)
iv) IS: 1255-1983
v) IS: 2629
vi) IS: 4759
vii) IS: 2633
viii) IS: 209-1966
ix) Railway Board's Directives (latest)

8.2 Important Directives:

8.2.0 The cables of all sizes shall be supplied by Railways.

8.2.1 The minimum safe bending radius for all types of cables shall be at least 15 times the diameter of the cable up to 11 kV grade and 20 times the diameter for cables above 11 KV grade

8.2.2 Augmentation of power supply (HT/LT) at stations shall be planned through underground cables.

8.2.3 Adequate measures to be taken to ensure proper clearing of cables running along the walls of station buildings/FOBs and provide cover either made of FRP/Nylon or mild steel as per site condition. Cables running on FOBs should preferably be laid in conduits.

8.2.4 4-core cable instead of 3and ½ core cable shall be used.

8.2.5 **Precautions while undertaking trenching work for laying of cables and pipe lines, excavation for foundation, etc**

a) Before undertaking any underground work on Railway premises, such as laying of cables by the Electrical and S&T Departments and laying of water pipe lines/sewer lines by the Engineering Department, the concerned executing Department after proper site survey shall make a route lay-out plan to scale, indicating the proposed alignment and depth of the cable/pipe line or sewer line. This plan, signed by an officer of the executing Department, shall sent to the other two Departments for their scrutiny and approval. The other twn Departments, before approving, shall indicate on this plan the

(M.Singh) IT/TO/CON/NFR	(B.C.Das) AEE/CON/FL/MLG	(B.C.Das) LLL/CON/MLG	11/5/16 (Ravi Bhushan) Dy.CEE/CON/HQ/MLG

(R.K.Arulraja)
CEE/CON/NFR

existing underground cables/pipe lines or sewer lines of their Departments crossing or in close proximity and likely to be effected by the proposed alignment. The depth of their cable/pipe line or sewer line shall also be indicated thereon. These two Departments shall run the plan duly signed by their authorized officers to the Department executing the work. If necessary joint route survey should be done by electrical, Engineering and S&T officials before final approval of the proposed plan.

b) It Shall be the responsibility of the Department executing the work to advise the other concerned Department in writing, at least 48 hours in advance, as to when it will undertake excavation/construction work in the area where their underground cables/pipe lines or sewer lines as shown on the plan may need protection during excavation. An acknowledgement of this advice shall be obtained from both the other two Departments.

c) During excavation work adjacent to tracks and cables routes in an electrified area, it shall be responsibility of the executing Department to take all necessary precautions to ensure safety of the staff and to avoid damage to the underground cables/rail bonds/pipe lines or other items, if any. The excavation shall not be undertaken in the vicinity of cable routes until the exact position of the cables has been ascertained. However, the Department which has been notified of the work shall also ensure that a senior supervisor of that Department is present at the site during excavation

d) After the cable/pipe line or sewer line is laid, suitable markers (either for cable or for pipe line/sewer line) shall be prominently placed to identify its route properly. The plans made earlier shall be modified, if needed, to indicate the position of the buried cables pertaining to Electrical or S&T Department as well as the pipe line of sewer line of the Engineering Department Completion plans so prepared must be made available to the maintenance officers of all Departments concerned.

8.3 Route

The route of the cable shall be decided before the work of cable laying is undertaken. The drawing indicating the route of the cable shall be prepared by the contractor and got approved from the Engineer. Cable runs/routes shall generally follow the fixed development such as roads, pathways track etc.

8.4 Cables of different voltage grading shall be generally laid in different trenches. In case it is not possible to lay them in separate trenches, due to site constraint, the same trench may be used, but adequate separation within the trench shall be ensured. Specific approval shall be obtained from the Engineer.

8.5 LT and HT cable shall have different route and there shall be adequate distance between HT & LT cables. In case it is unavoidable to separate HT &LT cables, the high tension HT cable shall be laid below LT cable. These cables shall be laid in cable tray with proper cleating to keep the cable separately.

8.6 Wherever the power and telecom cables are to cross each other the same shall be laid at right angles to avoid interference. Wherever it is unavoidable to lay them in proximity, horizontal and vertical clearance between the two shall not normally be less than 600 mm.

(Manju Yadav) IE/TECH/CON/HQ	(S.C.Das) AEE/CON/PL/MLG	(S.C.Das) AEE/CON/M.C	(Ravi Bhushan) Dy.CEL/CON/HQ/M.G

(R.K.Mittal) CEL/CON/N.F.R.

8.7 Laying of Cable

The cable shall be laid in ground, in pipes, under road recess in wall/on surface/clamping with erected pole etc. depending upon the requirement and site conditions.

8.7.1 Laying in Ground

The cable shall be laid in ground, wherever it is passing through open country/along road/lanes etc.

8.7.2 Laying of Cables under road /Bridge etc.

a) Wherever the cable is to cross road/Bridge, Nalla etc. the cable shall be laid through suitable size of pipes as per instructions of the Engineer. Cables may be laid using trenchless technology under road/ Nalla.

b) GI/CI (LA type) /HDPE pipe etc as specified in the BOQ item shall be used for the purpose. Pipes shall be continuous with couplers etc. and clear of any debris. Before drawing of cables, sharp edges at ends shall be smoothened to prevent injury to cable insulation and/or sheathing.

c) All the road crossings to be done by UG cables with spare cable provision. One spare duct with same size dia HDPE/GI/CI(LA type)/ pipe also to be made along with crossing, for future use.

8.7.3 Laying of Cables under Passage/Wall etc.

Passage/wall used for the laying of cables, shall be cut as required and repaired to match with the original finish. In case cable is being laid on the wall, cable should be well supported by J clamp/hooks.

8.7.4 Erection along Erected Pole

For erection of cable along the pole, the cable shall be held vertically with protective G. I./HDPE pipe. The diameter of the pipe shall be adequate for the cable size and length of pipe shall be 3 meters. Cable & G. I./HDPE pipe shall be clamped with the erected pole with 40 x 6 mm Ms flat clamps, not more than 2m apart. End of the pipe should be sealed with suitable putty to avoid entry of moisture and rodents.

8.7.5 Width of Trench

(a) The width of cable trench shall be approx. 350 mm. Wherever one additional cable is laid in the same trench in horizontal formation, the width shall be increased such that inter axial distance between the cables shall be at least 200 mm. There shall be clearance of 150mm between the end cables and sides of the trench.

(b) In addition to the protective cover over the cables laid in the underground trench, a brick on edge shall be laid in between the two juxtaposed cables along the direction of lay of the cables for providing separation.

(Manju Nath) JE/CON/CON/HQ	(B. L. Dost) AEE/CON/PL/MLG	(Ravi Tiwari) ETT/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R. K. Arora)
CEE/CON/NER

(c) Minimum width of cable trench for laying of LT/ HT cable at various locations shall be as indicated here under:

Width of Trench for LT Cables

Location	Width of cable trench	Width of cable trench for one additional cable	
		Width	Remarks
Under-ground	350mm approx.	550 mm approx.	Additional bricks on edge shall be laid in between the two juxtaposed cables.
On platform	350 mm approx.	550 mm approx.	
In wall/floor	To be recessed as per instruction of the Engineer at site.	-	-
Other than above	As per instructions of the Engineer at site.	As per instructions of the Engineer at site.	As per instructions of the Engineer at site.

Width of Trench for HT Cables.

Location	Width of cable trench	Width of cable trench for one additional cable	
			Remarks
Under-ground	350 mm approx.	Additional cable not permitted in trench.	
On platform	350 mm approx.		
Other than above	As per instructions of the Engineer at site.	As per instructions of the Engineer at site.	

8.7.6 Depth of Trench

Normally cables shall be laid in single tier formation and the minimum depth of top of laid cable/pipe at various locations from the ground surface/bottom of sleeper shall not be less than as indicated here under.

Depth of Trench for LT Cable

Location	Minimum Depth of top of laid cable/pipe from the ground surface/bottom of sleeper	Remarks
Under road	1000 mm from ground surface	Cables to be laid in single tier formation
Under-ground	1000 from ground surface	--do--
On platform	750 mm from platform level	--do--
In wall/floor	To be recessed	---do--
Other than above	As per instructions of the Engineer at site	---do--

(Manju Nishant) CTE(C)/CON/GHY	(S.K.Das) AGM/CON/P-I/MLG	(Rajdeo) FA&CAO/CON/MLG	(Amit Srivastava) DY.CLE/CON/II/D/MLG

(R.K.Arulraj)
CTE/CON/NFR

Depth of Trench for HT Cable (above than 440 V)

Location	Minimum Depth of top of laid cable/pipe from the ground surface/bottom of sleeper	Remarks
Under-ground	1100 mm from ground surface	Cables to be laid in single tier formation
Under road	1100 mm from ground surface	--do--
Other than above	As per instructions of the Engineer	--do--

8.7.7 Clearances:

The desired minimum clearances are as follows (Ref: IS:1255-1983)

Power cable to control cable	:	0.2 m
Power cable to communication cable	:	0.3 m
Power cable to gas/water main		0.3 m

Note: For power cable to power cable clearances not necessary. however, larger the clearance, better would be current carrying capacity.

8.7.8 Excavation of Trench

(a) To the extent possible, the trenches shall be excavated in straight lines. Wherever a change in line is required, due to site conditions, suitable curvature shall be provided. As far as possible, mechanical means shall be employed for undertaking excavation. Manual excavation method shall be used if adequate working area is not available. The soil shall be stacked on the side of the trench in such a manner that it does not fall back into the trench.

(b) Due care shall be taken to avoid damage to any existing cables, pipes or other such installations in the proposed route during execution. While excavating, if route markers, bricks, tiles, bare or protective covers are encountered, further excavation shall not be carried out without the approval of Engineer.

(c) In case existing property gets exposed during trenching, the same shall be temporarily supported or propped adequately as directed by the Engineer. The trenching in such case shall be limited to short lengths. Protective pipes shall be laid for passing the existing cables therein, and the trench shall be refilled, in case there is a danger of collapse, or the trench is endangering existing structure the same shall be sufficiently supported before proceeding with the excavation work. The bottom of the trench shall be level, free from brick bats and gravel etc.

(Manoj Tiwari) CE/CC1/CON/HQ	(S.K.Das) SEE/CON/P-I/MUG	(R.G.Rao) EE/CON/MUG	(Ravi Bhushan) DY.CEE/CON/HQ/MUG

(R.K.Ariliya)
CEE/CON/AFR

8.7.9 Laying of Cable

Before and after the cable is laid, the individual cores shall be tested for continuity and insulation resistance and ends of cables shall be sealed suitably to avoid ingress of moisture. Surplus length of approx. 3.0 to 5.0 meters shall be left in the shape of a loop at each termination/joint etc. unless otherwise approved by Engineer.

8.7.10 Protection and Sand Cushioning

a) The cable shall be protected to provide warning to future excavators and also for avoiding any accidental mechanical damage by pickaxe blows etc.

b) The cable shall be protected with well-burnt bricks. The bricks on face shall be so provided that the width of the brick is in the direction of lay of cable. The bricks shall be provided throughout the length of the cable to the satisfaction of Engineer. Wherever more than one cable is laid in the same trench, the protection cover for cable shall protect at least 50 mm on the side of end cables.

c) Protective covering, sand cushioning of LT/ HT Cable & making good surface at various locations shall be as indicated here under.

Protection and Sand Cushioning for LT Cable

Location	Protective Covering	Sand cushioning	Surface
Underground	2nd class Bricks 225 x 100x60 mm (nominal size)width wise on top	Base cushion 80mm under cable & 100 mm above laid cable.	Making good damages and finishing as per original
On platform	-do-	-do-	--do--
Under Road	Through laid pipe	---do--	--do--
In wall/floor	Plastering	--do--	--do--
Other than above	As per the instruction of the Engineer at site.	As per the instruction of the Engineer at site.	As per the instruction of the Engineer at site.

Protection and Sand Cushioning for HT Cable

Location	Protective Covering	Sand cushioning	Surface
Underground	2nd class Bricks 225 x 100x60 mm (nominal size)width wise on top	Base cushion 80mm under cable & 100 mm above laid cable.	Making good damages and finishing as per original
Under Road	Through CI (LA type)/HDPE/GI pipe	---do--	--do--
Other than above	As per the instruction of the Engineer at site.	As per the instruction of the Engineer at site.	As per the instruction of the Engineer at site.

(Manju Yadav)
JE/TECH/CON/HQ

(B.Das)
AEE/CON/TPL/MLG

(B.Das)
EEE/CON/MLG

(Rajesh Kushwaha)
DY.CE/CON/HQ/MLG

R.K.Aradhya
CE/CON/NER

8.7.11 Back Filling of Trench

(a) After excavation and laying of cables, the trench shall be back filled with the excavated earth, free from stone or other sharp-edge debris and shall be watered if necessary. A 100 mm crown of earth shall be left in the center, tapering towards the sides of the trench to allow for subsidence. The trench shall be inspected at regular intervals particularly during wet weather and any settlement of soil shall be made good by the contractor by further filling, if required.

(b) Due to cable laying work, if any disturbance to existing equipments in the area, like roads, pavements and garden takes place, the same shall be made good to original standard /finish after the cable laying work is over.

8.7.12 Cable Route Marker and Joint Indication Marker

8.7.12.1 Route markers shall be provided along straight runs of the cables at locations approved by the Engineer and generally at intervals not exceeding 50 meters. Wherever the cable route is changing or it is entering a fixed installation, route marker must be provided. Route markers shall be properly grouted in concrete or laid along with the cable securily to avoid theft as per directions of the engineer.

8.7.12.2 Joint indication marker shall also be provided at joints of cable.

8.7.12.3 The word cables, the level of voltage, size of cable, depth shall be inscribed on the route marker and joints.

8.7.13 Normally no joints are permitted. Under the circumstances, if joints can not be avoided, specific approval shall be obtained from the Engineer.

8.7.14 Cable Testing

All cable shall be tested jointly at site by the contractor with the engineer, before laying, to ensure that the insulation values of the cable are within limits. The insulation test on the cable shall be conducted with 500 V megger up to and including 1.1 kV grade and with 2500V / 5000 V megger for cables of higher voltage. The cable cores shall be tested for continuity, insulation resistance etc. All cables shall be again tested after laying and before covering.

8.8 Laying on cable tray

8.8.1 This method may be adopted in places like indoor substations, air-conditioning plant rooms, generator rooms etc. or where long horizontal runs of cables are required within the building and where it is not convenient to carry the cable in open ducts. This method is preferred where heavy sized cables or a number of cables are required to be laid. The cable trays may be either of perforated sheet type or of ladder type.

8.8.2 Perforated type cable tray

The cable tray shall be fabricated out of slotted/perforated MS sheets as channel sections, single or double bended. The channel sections shall be supplied in convenient lengths and assembled at site to the desired lengths. The cable trays shall be hot dip galvanized.

[Manju Williams] AGM/CON/MG	[R. K. Das] CEE/CON/FL/MLG	[S. Das] DGM/CON/MLG	[Ravi Bhushan] DY.CEE/CON/HQ/MLG

[R. P. Arolya] CEE/CON/NFR

8.8.3 **Ladder type cable tray**

The ladder type of cable tray shall be fabricated of double bended channel section longitudinal members with single bended channel section rungs of cross members welded to the base of the longitudinal members at a center to center spacing of 250cm. The cable trays shall be hot dip galvanized.

8.8.4 **DESIGN REQUIREMENTS FOR TRAYS (BOTH PERFORATED AND LADDER)**

The hot dip galvanized steel cable trays having rectangular channel section with appropriate depth shall be designed for a uniform load of at least 400N per 1000 mm ladder length tray. The trays shall be fabricated in a length of 2.5 m to 3m.

The cable trays shall be manufactured from good commercial, high grade strength sheet steel having minimum thickness of 2mm and shall be hot dip galvanized according to IS 2629 and IS-4759 suitable for indoor/out door use having moderate humidity and air pollution.

The zinc coating thickness shall works out by applying a 610 gm of zinc per square meter surface with approximate thickness of 80 micron. The zinc coating shall be smooth, clean and uniform thickness and free from defects like ash and dross inclusions, bare patches, black spots, pimples, lumpiness, rust stains, blisters etc. The galvanizing shall not adversely affect the mechanical properties of the coated materials; the quality of the coating will be established by tests as per IS-2633. All manufacturing process including punching, cutting, bending and welding of perforated cable trays shall be completed and burrs shall be removed before the application of galvanization process is applied. Zinc conforming to at least Grade Zn 98 as specified in IS-209-1966 shall be used for the purpose of galvanizing.

The joints of two trays shall be butt construction and shall be made with the help of coupler plates by nuts and bolts. The coupler plate and nuts and bolts shall also be properly hot dip galvanized, where the bends of the trays are required at site the same shall be supplied by the bidder without any extra cost.

While adopting the modules at site if cutting of any length is required the same shall be cut at site and jointed by nuts and bolts with the help of coupler plates.

The cable trays shall be supported on the solid supporting arrangement made from channel of minimum size 100x50mm and angle iron of size 50x50x6mm thick angle approximately at a distance of 1.0 to 1.2m center to center either from ground/wall or ceiling. However, the supporting system shall be designed by bidder suitable to bear the uniform load of 400N per 1000mm ladder length for 300mm wide tray. The calculations in respect of this design shall be supplied by the successful bidder during design stage. M.S angle iron brackets shall be further supported/anchored either to wall or ceiling/ground as per the site requirement. The brackets and supporting system shall be painted with two coats of zinc chromate primer followed by two coats of synthetic enamel paint of approved colour conforming to relevant Indian standard.

Bends, tees and cross connections shall also be designed properly as per site requirement.

[Manju Varma] IT/TECH/CON/HQ	[S. Das] AGE/CON/FL/MLG	[S.C.Das] TEC/CON/MLG	[Ravi Bhushan] DY.CEE/CON/HQ/MLS

[S.C.Arora]
CEE/CON/NFR

The free vertical distance between parallel perforated trays/racks/ladder shall be at least 250mm and the perforated trays shall be 50mm away from the walls. The trays shall be fixed to the brackets with proper nuts and bolts system.

The perforated trays shall be free from sharp edges and burns etc. so that joint between two trays shall be without any clearance and matched in proper shape.

At the bends the curvature in all axes of perforated trays/racks shall be 20R or maximum size of cable. The supporting brackets/fixing bolts size shall be so calculated that the design load as specified in Design Requirements does not exceed. The perforated trays shall be installed in such a way that as far as possible the cables can be laid directly in place rather than be pulled through.

The current carrying cables as HT cables, LT cables, and DC cables shall be laid in different tray. The cables shall be fixed in the perforated trays by means of plastic ties or plastic coated wires etc.

The number of tray shall be sufficient in order to accommodate all the power cables indicated in the specification for cables.

The width of the cable tray shall be chosen so as to accommodate all the cables in one tier, plus 30 to 50% additional width for future expansion. This additional width shall be minimum 100mm. The overall width of one cable tray shall be limited to 800mm.

Factory fabricated bends, reducers, tee/cross junctions, etc. shall be provided as per good engineering practice.

The cable trays shall be measured on unit length basis, along the center line of the cable tray, including bends, reducers, tees, cross joints, etc. and paid for accordingly.

All fabrication of trays shall be in accordance with IS: 800 and as per the approved drawings unless otherwise specified.

The trays should have min 2mm thickness with all connected accessories viz. vertical bends, reducers, tees, cross members etc. as required according to the site.

The running/ arranging of the cables in these trays should be done by duly clamping at regular intervals and undertaking numbering by sticker to the cables for easy identification.

8.8.5 EARTHING:

The cable trays along with their supporting arrangements shall be properly earthed by the contractor with nut and bolts from the earthing risers generally in the vicinity of the tray routing. The earthing shall be as per Technical Specification No.NFR/ELECT/CON/GS/10(EARTHING).

[Manju Vishnoi] JE/TEC./CON/HQ	[D.R.Das] AEE/CON/P-I/MLG	[P.C.Das] DEE/CON/MLG	[Ravi Bhushan] DY.CEE/CON/HQ/MLG

[R.K.Alodiya]
CEE/CON/NFR

NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

Technical Specification No.NFR/ELECT/CON/GS/09 (POLES)

OVERHEAD WORKS & STEEL/GI TUBULAR/GI OCTAGONAL POLES

9.0 SCOPE

The scope covers overhead power lines, including stays and poles, GI cross arms (brackets), ACSR conductors, insulators, earth wire (GI wire), guarding etc All materials, fittings, etc.. used in the installation shall conform to relevant BIS specifications, RDSO specifications and Railway Board guidelines.

9.1 Relevant Standard Specifications and Regulations:

(i) I.E. Rules 1956 (latest amended)
(ii) Central Electricity Authority Regulations.
(iii) Railway Board's letter no. 2004/Elect(G)/109/1 dtd 18/05/2007
(iv) IRSOD 2004
(v) IS:2713
(vi) IS:2141-2000
(vii) IS:1445-1977
(viii) IS.731-1971
(ix) IS:398/pt.II/1996
(x) IS:2551-1982
(xi) IS:278-1978
(xii) IS:2629
(xiii) IS:694(LATEST)
(xiv) 410 SP-3 for 7 meter
(xv) 410 SP-30 for 9 meter
(xvi) IS:8623
(xvii) IS:12032
(xviii) IS:875-part 3: 1987(latest version)
(xix) BSEN-10025grade S 355J0
(xx) IS:1367
(xxi) IS:2633
(xxii) IS:4759
(xxiii) IS:226
(xxiv) IS:2062

9.2 Route of overhead Line

(i) As far as possible, the route of distribution line as well as the location of stay sets shall be decided taking into consideration the present and future requirements of other agencies and utility services affected by it.
(ii) The route of distribution line shall generally follow the route of roads.

(Manish Shrivastava) JE/TELE/CON/HQ	(B.K.Das) ALE/CON/FL/MLG	(R.C.Das) FEE/CON/MLG	(Dev Brushan) DY.CEE/CON/HQ/MLG

(B.K.Mahaliya) CPM/CON/NFR

(iii) Poles for distribution lines may be located alongside the road on the road berm, a little away from the road edge and drain.

(iv) Normally there shall be a pole located at road junction.

(v) The route shall be so chosen as to avoid use of struts and continuous curve as far as possible.

(vi) Junction of main road and service lane shall be preferred for location of pole to facilitate street light of service lane as well.

(vii) Front of enurance to building shall be avoided for locating poles.

(viii) The clearances shall be in accordance with the Indian Electricity Rules, 1956.

(ix) Normally, no road crossing shall be done by overhead lines in Railway Area. For such crossings, technical specification on Power Line Crossing No. NFR/ELECT/CON/GS/01(Power Line Crossings) to be followed.

(x) For angles of deviation of more than 10 degree, double pole structure shall be used.

9.3 Spacing of Poles

Spacing shall be in accordance with Indian Electricity Rules 1956. Normally poles shall be erected at distances as indicated below *:-

i	For street /Road lighting	30 to 35 meters
ii	For distribution line	35 meters
iii	For other location	as decided by the Engineer

* **Note**:-These are general guidelines. However spacing of poles should be chosen judiciously by Railway's Engineer at site so as to ensure specified lux levels is achieved and lighting is uniform as per RB letter no-2004/Elect(G)/109/1 dt 18/5/2007 for station area and as per the requirement of the Division.

For platform lighting, specifications no.NFR/ELECT/CON/GS/03/LUMINAIRES & EQUIPMENT to be followed.

9.3.1 Where distribution line and street lighting fixtures are erected on the same support, the span shall not normally exceed 40 m.

9.3.2 Spans shall be chosen such that in a residential area adequate street lighting is provided as per IS and as approved by Railway/Employer.

9.4 (a) Excavation and back filing for foundation

9.4.1 General

i) The excavation work shall be taken up after the locations of poles/stays are decided.

ii) Every care shall be taken to see that the pits are not oversized while digging.

iii) Suitable caution signals/boards, red lights and other protective measures, as decided by the Engineer, shall be provided near the pit to warn the pedestrians/vehicular traffic till such time the pit is back filled and surface leveled.

(Manju Pandey) JE/TC-I/CON/MLG	(B.K.Das) AEE/CON/PL/MLG	(Bed.Das) LEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Mallya)
CEE/CON/NFR

iv) The size of the pit shall be made as per approved drawing of the foundation OR as specified in the standard tables given below. Wherever specific depth of foundation is not specified, the depth of the pit shall be such that **normally 1/6th of the length of pole is buried in the ground as specified in IS: 2713.**

v) The foundation pit shall be generally excavated in the direction of the lines.

vi) All supports shall be correctly aligned before concreting or the back filling of the pit with excavated earth.

vii) The pit for support/stay/strut shall be filled up or concreted only in the presence of the Engineer.

9.4 (b) Foundation

i) While erecting the poles on platforms and within station limit/area, the latest schedules of dimensions (SOD) as per IRSOD-2004 with latest amendments shall be strictly followed.

ii) Foundation for erection of pole shall be constructed at the approved location. Drawing of pole foundation shall be got approved from the Engineer prior to casting of the foundation and erection. However, the responsibility of adequate design & drawing shall rest with the contractor.

iii) After excavation of pit of suitable size, cement concrete bed of approx. 50mm thickness, using cement concrete of M-10 (1:3:6) grade shall be first provided at the bottom of the pit. Square foundation shall be made with cement concrete of M-10 (1:3:6) grade of size given below:

a) For hot dip Galvanized Pole- as specified in the table of standard dimensions of pole given below. The foundation shall be made up to 150mm above ground level

b) For Steel/GI Tubular poles- as per approved drawing. If approved drawing is not available, square foundation of such size where edge of foundation shall not be less than 150mm from edge of the pole. The depth of the foundation shall be 1/6th of the length of pole. Circular mafling of 150 mm thickness around the mast shall be made for 300 mm height above ground and sloped at the top.

iv) It shall be ensured that the GI/HDPE pipe/s for the cable/s entry is/are placed in position. Muffing shall be plastered, finished and also cured.

v) After foundation work, the pit shall be filled with excavated earth. During back filling of earth, ramming and watering shall be done.

(Manju Gautam) JE/TECH/CON/HQ	(B.K. Das) AEE/CON/TI/MLG	(S.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CLE/CON/TIG/MLG

(B.K.Aditya) CEE/CON/DEB

9.4 (c) ERECTION OF POLE:

(i) The pole shall be erected in plumb and top of all the poles shall be at the same level to maintain uniformity.

(ii) The Hot Dip Galvanized poles shall be erected and bolted on casted foundation with a set of four bolts.

(iii) It should be ensured that Pole caps are in place in all the poles.

9.5 Stays and Staying Arrangement

9.5.1 A stay shall consist of stay rod, anchor plate, bow tightener, thimbles, stay wire and strain insulator. The entire stay assembly shall be galvanized.

(a) **For HT:** The stay wire shall be hard drawn galvanized of 7/3.15 mm dia. GI (as specified in the relevant BOQ item) conforming to IS 2141-2000. The anchor plate shall be of galvanized MS and not less than 30 cm x 30 cm x 8 mm thick and the size of stay rod shall be not less than 1.80 m (6 ft.) long and 19 mm dia.

(b) **For LT:** The stay wire shall be hard drawn galvanized of 7/2.5 mm dia. GI (as specified in the relevant BOQ item) conforming to IS 2141-2000. The anchor plate shall be of galvanized MS and not less than 25 cm x 20 cm x 6 mm thick and the size of stay rod shall be not less than 1.80 m (6 ft.) long and 16 mm dia.

9.5.2 The position of pit shall normally be such that the stay makes an angle within the range of 45 degree to 60 degree with the ground. If the site conditions are such that the angle as stated may not be possible, special stays such as foot stays, flying stays or struts may be used.

9.5.3 The depth and size of the pit shall be suitable for the foundation of stay.

9.5.4 A stay shall be provided at all angle or terminal poles.

9.5.5 The stay rod shall be set in position in the excavation pit.

9.5.6 Stay rod shall be embedded in cement concrete of M-10 (1:3:6) grade vertically with square foundation 300 mm x 300 mm above the anchor plate lying over 15 cm thick cement concrete base. The stay rod shall be bent only at the unthreaded portion such that the stay wire and the bent portion of stay rod are in correct alignment. Care must be taken to avoid sharp bend or danger to galvanization.

9.5.7 After concrete has set, back filling shall be done with excavated earth and ramming in layers of 20 cm using water as required.

9.5.8 The surface of foundation above ground shall be finished and cured.

9.5.9 The stay clamp shall be located near about the center of gravity of the load of the overheadconductors.

(Manju Vartak) JF/TECH/CON/HQ	(B.B.Das) AFF/CON/FI/MLG	(B.C.Das) FEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(S.K.Atolia)
CEE/CON/WR

9.5.10 One end of stay wire shall be fixed to the bow tightener of the stay grip of the stay rod and the other end to the stay clamp fixed to the pole. By means of well spliced joint units, GI thimbles. A strain insulator shall be provided at a height of 3 meters above ground level. For high voltage lines, however, the stays may be directly anchored.

9.5.11 The stay wire shall also be connected and bonded properly to the continuous earth wire.

9.5.12 Normally one stay shall be provided at angle pole.

9.5.13 Double stays shall be provided at all dead ends and at any other place as required by the Engineer. In such cases, these shall, as far as possible, be set parallel to each other at a distance of approx. 600 mm or as approved by the Engineer.

9.5.14 If the stay rod cannot be erected in accordance with the above clauses due to roadways or obstructions of buildings etc. bow stay, fly stay or strut whichever is suitable to the location, shall be used.

9.6 Cross Arm (Bracket)

9.6.1 Cross arm shall be made of GI angle iron of size not less than 50 mm x 50 mm x 6 mm thick (for LT overhead)/ GI channel iron of size not less than 75mm x 40 mm x 6.4 kgs per meter/100x50x6.4 mm for V-type cross arm (for modification of power line track crossings/HT lines) as specified in the BOQ item. The length of the cross arm shall be suitable for accommodating the required number of insulators with the spacing of the conductors being in accordance with the clearances required. A minimum distance of 8 cm for LV/ MV lines and 10 cm for HT lines shall be left from the center of the extreme insulator pin hole to the end of the cross arm. The cross arm shall be complete with clamp made of GI flat of size not less than 50mm x 6mm with necessary GI bolts of 16 mm and nuts & washers. The cross arm shall have holes as required to accommodate insulator pin etc.

9.6.2 The length of cross arm for carrying guard wire shall be such that the guard wire shall always run not less than 30 cm beyond the outer most conductor of the configuration.

9.6.3 The cross arm and the pole clamp shall be treated with one coat of red oxide primer before erection and finished with two coats of approved paint after erection along with other hardware. Iron nuts and bolts shall be used for fixing of clamps.

9.6.4 The cross arms shall be clamped to the support properly, taking into consideration the orientation of the lines.

9.7 Insulators

9.7.1 The porcelain insulator shall conform to IS 1445-1977 suitable for overhead power lines below 1000 volts. The insulator shall be complete with galvanized iron hardware etc. as required.

A) Ball and socket type 11KV Polymeric Composite disc insulator Min.Creepage distance 450mm, section length 430mm, rated mechanical tensile load 70KN, Wet power frequency 1min withstand voltage 48 KV, dry lighting impulse withstand voltage 1000KV including all accessories for fixing on bracket with strain clamps, nuts, bolts, washer as per IEC 1109, ISO 9001:2000.

B) 11KV Polymeric Composite Pin insulator size 146mm, minimum failing load 5KN, Wet power frequency 1min. withstand voltage 35KV (RMS), Dry lighting impulse withstand voltage 75 Kvp(+Ve), including all accessories for fixing on bracket with nut, bolts, washer as per IEC 1109., ISO 9001:2000.

9.7.2 The insulators shall be of the following types as specified in the relevant BOQ item:

a) Pin and shackle insulator for LT & MV lines.
b) Pin and disc type for HV lines.

9.7.3 The minimum size of shackle insulator shall be 90 mm dia x 75 mm high and shall be complete with GI clamps, nuts & bolts etc.

9.7.4 The minimum size of pin insulator shall be 65 mm dia x 100 mm high and complete with GI pin, nuts and bolts etc.

9.7.5 Pin insulator/ shackle insulators/disc insulators shall be erected on the cross arms as specified in the BOQ or as directed by the Engineer.

9.7.6 Shackle insulators shall be erected on cross arms at intermediate support in case of long lines, deviation from straight line, terminal positions, junction poles etc.

9.8 ACSR Conductors

9.8.1 All conductors shall conform to IS: 398/pt. II/1996. Conductors shall be strung with permissible sag and the profile shall be got approved from the Engineer.

9.8.2 Jumpers

9.8.2.1 Sufficient length of conductor shall be kept at shackle termination and Parallel Groove (PG) clamp shall be used for making jumper connections.

9.8.2.2 Jumpers used shall be of the same material as the line conductor and be of adequate current carrying capacity.

9.8.3 Binding of Conductors

9.8.3.1 The binding of conductor to insulator shall be sufficiently firm and tight to ensure that no intermittent contacts develop.

9.8.3.2 The ends of binding wire shall be tightly twisted in a closely spaced spiral around the conductor to ensure good electrical contact and to strengthen conductors.

(Manjit Yengkok) JE/TECH/CON/HQ	(S.R.Das) AEE/CON/PL/MLG	(S.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Atoliya) CEE/CON/NER

9.8.3.3 The insulators shall be bound with the line conductors with the help of aluminum binding wire or tape for ACSR/Aluminium conductors. The size of binding wire shall not be less than 2 mm dia and it shall be of galvanized iron conductors for galvanizedconductors.

9.8.3.4 LT Spacers: To avoid clashing and accidental mutual touching of bare overhead conductors on LT lines, spacers, which can either spiral or composite shall be provided in between conductors at appropriate locations in different spans (particularly for lines having longer spans or lines having large sags encountering high wands).

9.8.4 Guarding

9.8.4.1 General

At all road crossings, crossing of overhead lines, crossing with other lines (telephone lines etc) and between HV and LV/ MV lines carried on the same support, guard shall be provided.GI wire of 8 SWG for guard and 10 SWG for lacings shall be used.

9.8.4.2 The guard wires shall be bonded to earth wire and as per I.E. Rule 88(2) every guard- wire shall be connected with earth at each point at which its electrical continuity is broken.

9.8.5 Earth Wire

9.8.5.1 The size of the continuous earth wire shall not be less than 8 SWG GI.

9.8.5.2 All metal supports and all reinforced and pre-stressed cement concrete supports of overhead and metallic fittings attached there to shall be permanently and efficiently earthed.

9.8.5.3 The continuous earth wire shall be connected to an earth. There shall be not less than 3 connections with earth (earth electrode) per kilometer spaced equi-distantly, as far as possible.

9.8.5.4 Where continuous earth wire cannot be provided, every pole shall be earthed and all metal parts shall be bonded.

9.8.5.5 Junctions at terminal locations and all special structures shall be connected to earth.

9.8.5.6 The lead from earth electrode shall be suitably bonded to the continuous earth wire.

9.8.6 Insulated separater shall be provided between different phases as per requirement.

9.9 Danger Notice Plate and Anti- Climbing Devices

9.9.1 Danger Notice Plate

All supports carrying HV lives shall be fitted with danger notice plates conforming to IS: 2551-1982 at suitable height from ground indicating the voltage of lines.

(Manju Yadava) JE/ELCH/CON/HQ	(D.K.Das) AEE/CON/PL/MLG	(K.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(D.K.Adhikari) CEE/CON/MLG

9.9.2 **Anti Climbing Devices.**

For preventing unauthorized persons from ascending any of the supports carrying HV lines without the aid of a ladder, arrangement for special appliances shall be made as directed by the Engineer. Barbed wire conforming to IS 278-1978 having 4 point barbs spaced 75+/-12 mm apart shall be wrapped helically with a pitch of 75 mm around the limb of the support and tied firmly, commencing from a height of 3.5m up to a height of 5 meters or as directed by the Engineer.

9.10 **Steel/GI Tubular Poles**

9.10.1 Steel/GI tubular poles shall be swaged type with single/double bracket/s for platform/road/level crossing lighting etc. The constructional details shall be as per IS 2713/Pt 1 to 3. The length and designations shall be as per the relevant BOQ item. The diameter of bracket for mounting of luminary shall match with the inlet diameter of the luminary. In case of GI pole, the pole with base plate along with the bracket shall be hot dip Galvanized 80 to 90 microns thickness after the fabrication, as per I.S 2629. The pole shall be with single/double arm bracket of length 1.0mtr and with base plate complete. Dimensions of the pole shall be as per IS, reproduced in table given at 9.10.3. Foundation bolts and base plate sizes shall be:

Base plate of size 300 X 300 X 16 mm
Foundation Bolts: 700x20mm- 4 Nos. with double nut, washer & template.

9.10.2 **Steel Tubular pole with Canopy Type Single/Double Bracket/s 9m for Level Crossing/ circulating area Lighting/Road lighting etc.)**

9.10.2.1 (a) Steel tubular pole shall be swaged type made from steel of ultimate tensile strength 410 MPa (42 kg/mm. sq) as per IS: 2713(Pt. I,II and III) 1980 amended up to date. For specific technical requirement for tubular steel poles, swaged type, Table-I shall be referred to. The portion to be inserted in the ground shall be about 1/6th of total length as per IS: 2713. Pole shall he supplied with canopy type brackets, base plate etc. A hole of 25 mm dia and a rubber bush at required height from the bottom of the pole shall be provided in the lower limb (above the mufling) for drawing/taking the PVC wire from junction box to inside the pole for the connection of luminary. Each pole shall be provided with 16 mm dia GI earth terminals of suitable length for earth connection.

(b) MS square base plate of size 300 x 300 mm and 10 mm thick shall be welded at the bottom of the pole. The base plate shall have a hole of dia. Approx. 50 mm in the center, for draining out of water.

(c) Hot dip galvanized double arm Conical poles with foundation bolts, base plate and bracket can also be used in above place. The pole with base plate along with the bracket shall be hot dip Galvanized 80 to 90 microns thickness after the fabrication, as per I.S 2629.

(Manju Yonzone) JE/ELEC1/CON/HQ	(D.K.Das) AEE/CON/PL/MLG	(J.C.Das) EEE/CON/MLG	(Rav Bhushan) 14/5/16 DY.CEE/CON/HQ/MLG

(R.K.Mohyal)
CEE/CON/NFR

9.10.2.2 **Bracket**

Bracket for accommodating of luminaries shall be canopy type with single/double G.I. pipe class "B" 200 mm long (ISI marked), welded at an angle of 15 degree (horizontal plane). Bracket shall be removable type and adjustable in horizontal plane. Fixing arrangement with pole shall be with 4 nos. bolts & nuts of dia not less than 10 mm. Fixing Arrangements shall be suitable to bear the wind pressure. The dia. Of the bracket pipe shall match with the inlet hole of proposed luminary to be provided on the pole.

Note: The drawing of canopy with pipe bracket/s, fixing arrangement and sample shall be separately got approved from the Engineer.

9.10.2.3 **Junction Box**

(a) Pole Mounting Type MS Junction Box of size 300 x 200 x 125 mm deep, shall be double doors, outdoor type, weather proof with degree of protection no less than IP54 and conforming to IS:8623 & IS:13032, suitable for operation on single phase, 230 Volts Ac, 50 Hz supply system. The Junction Board shall be manufactured with CRCA sheet steel 1.6 mm thick, duly powder coated and complete with 4 nos. copper bus bars of rating 100 amp (for cable terminations/ loop-out system) for looping 4 core 3 nos. LT cables, one no. 4P 6 amp 10 kA, SP MCB, earthing studs etc. Outer door shall be hinged on top in vertical formation, with provision of holding arrangement horizontally. The front cover of the junction box shall be provided with a lock which can be opened with a special key.

(b) The junction box shall be earthed as instructed by the Engineer. Junction box shall be mounted with pole with 2 nos. galvanized MS flat 40 x 5 mm clamps and Nut and bolts not less than 10 mm dia.

(c) Detachable gland plate shall be provided on the bottom of the junction box for entry of incoming and outgoing cables.

(d) The junction box shall be fixed with the pole at a suitable height above ground level as per instruction of the Engineer.

(e) Holes shall be suitably protected with rubber bushes to prevent entry of rain water inside the pole.

9.10.2.4 **Earthing**

i) Earthing shall be as per the technical specification no. NFR/ELECT/CON/GS/10 (Earthing System).

ii) All poles above 650 volts, irrespective of inhabited areas, shall be earthed. For poles below 650 volts continuous earth-wire shall be provided invariably, connected to earth at three equidistant points in one km.

(Manjit Tonechha) JE/TECH/CON/HQ	(T.K.Das) AEE/CON/PL/MLG	(S.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/G.Q/MLG

(P.K.Adhiya) CEE/CON/NFR

9.10.2.5 Painting

Steel Poles shall be given 2 coats of red oxide primer and after erection painted as under:

i) The bottom portion of poles up to a height of 1.5 m above the finished muffs shall be painted with superior quality of black ISI marked paint.

ii) The remaining portion of poles as well as the clamps shall be painted with 2 coats of superior quality of Aluminium Paint (ISI marked).

(Manik Kandpal) JE/TECH/CON/HQ	(U.K.Das) AEE/CON/PL/MLG	(B.C.Das) ELE/CON/MLG	(Ravi Bhushan) DY.CFF/CON/HQ/MLG

(R.K.Aloliya)
CEL/CON/HQ

9.10.3 Table below indicates dimensions of swaged type steel tubular pole as per IS 2713 /Pt 1 to 3, for works on different SEBs, heavy thickness poles shall be used.

Table-1

DESIGNATION	OVERALL LENGTH 'L'	PLANTING DEPTH	LOAD APPLIED FROM TOP AT A DISTANCE OF	LENGTH OF SECTIONS			OUTSIDE DIAMETER AND THICKNESS OF SECTIONS			APPROX WEIGHT OF POLE	BREAKING LOAD	CRIPPLING LOAD	WORKING LOAD		LOAD FOR PERMANENT SET NOT EXCEEDING 13mm	LOAD FOR TEMPORARY DEFLECTION OF 157.5mm
				BOTTOM	MIDDLE	TOP							COL 14	COL 15		
													2	2 - 5		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	(m)	(m)	(m)	(m)	(m)	(m)	(mm)	(mm)	(mm)	(kg)	N(kgf)	N(kgf)	N(kgf)	N(kgf)	N(kgf)	N(kgf)
410 SP-30	9	1.5	0.3	5	2	2	139.7X5.40	114.3X4.50	88.9X4.05	135	4830(492)	2890(295)	1300(133)	1690(172)	2050(209)	882(90)
410 SP-33	9	1.5	0.3	5	2	2	165.1X5.40	139.7X5.40	114.3X4.85	164	6000(612)	3290(335)	2190(217)	2410(246)	2910(297)	1540(157)
410 SP-42	10	1.8	0.6	5.2	2.4	2.4	139.7X5.40	114.3X4.50	88.9X4.05	144	3960(404)	2890(295)	1410(144)	1940(198)	1940(198)	677(69)
410 SP-48	10	1.8	0.6	5.2	2.4	2.4	193.7X5.90	168.3X4.50	139.7X4.50	229	8620(879)	5130(523)	3460(353)	5450(555)	4190(427)	2110(215)
410 SP 60	12	2	0.6	5.8	3.1	3.1	165.1X5.40	139.7X4.50	114.3X3.65	208	4600(469)	3270(333)	1690(165)	1940(158)	2240(228)	598(61)
410 SP 66	12	2	0.6	5.8	3.1	3.1	219.1X5.90	193.7X4.85	165.1X4.50	332	8250(840)	5370(547)	3190(325)	3590(366)	1360(415)	1660(169)
410 SP 76	14.5	2	0.6	6.5	4	4	219.1X5.90	193.7X4.85	165.1X4.50	380	7200(734)	5040(514)	2820(287)	3540(360)	3450(352)	794(81)
410 SP 80	16	2.3	0.6	7	4.5	4.5	219.1X5.90	193.7X4.85	165.1X4.50	404	6440(657)	4570(466)	2280(233)	3580(365)	3130(319)	588(60)

(Manju Vandana) IF/TECH/CON/HQ	(R.K.Das) AEE/CON/PL/MLG	(S.C.Das) EE/CON/MLG	(Ravi Bhushan) DY.CED/CON/HQ/MLG

(R.K.Atoliya)
CEE/CON/N-E

9.11 HOT DIP GALVANIZED OCTAGONAL POLE

9.11.1 GENERAL:

Octagonal Pole shall be manufactured in single section. Manufacturer shall be ISO: 9001/2000 & ISO. 14001 certified. Drawing of pole and bracket/s shall be got approved from the Railway.

9.11.2 DESIGN:

The structure shall confirm to IS: 875-part 3: 1987(latest version) relating to wind load on structures. Pole shall be designed for wind speed 169Km/hr.

The grade of steel used shall be as per BSEN-10025grade S-355JO. or equivalent standards. Yield strength shall be minimum 355N/mm. sq. and tensile strength 490-630N/mm.sq.

9.11.3 POLE SHAFT:

The pole shaft shall have octagonal cross section & shall be continuously tapered with single longitudinal welding. There shall not be any circumferential welding. The welding of pole shaft shall be done by submerged arc welding process. The base plate shall be fixed by welding to the pole shall at two locations i.e. from inside and outside.

Bending of the sheet into polygonal shape shall be done through a CNC controlled. Laser aligned will be as per IS : 1367.

9.11.4 DOOR OPENING:

The octagonal pole shall have door of approximate 500mm length at the elevation of 500mm from the base plate. The door shall be weather proof to ensure safety to inside connections. The door shall be flush with locking facility. There shall also be suitable arrangements for earthing. The pole shall be additionally reinforced with a welded steel section so that the section at door is unaffected and undue bucking of the cut section is prevented.

The base compartment of the built in connector control box shall have provision to have 6 mm thick Bakelite sheet of suitable size to accommodate the required electrical accessories with compression gland for termination of incoming & outgoing supply cables. The connector box shall be provided with 2 Nos. 32 Amp heavy duty connectors (3way) for loop in and loop out of cables, 6 Amp C-Series DP MCB for individual fitting with din channel, earth stud and other required accessories.

9.11.5 GALVANIZING:

Internal and external surface of the octagonal pole shall be single dip, hot galvanized as per IS: 2629 / IS: 2633 / IS: 4759 standards with minimum coating thickness of 65 microns.

(Arup Chatterjee) JE/TECH/CON/HQ	(B.K.Das) AEE/CON/P.J/MLG	(B.C.Das) FFF/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Atoliya) CFF/CON/NFR

BASE PLATE:

Material of base plate shall be Fe 410 conforming to IS: 226/IS: 2062

9.11.6 Standard Dimensions of pole shall be as under:-

STANDARD DIMENSIONS OF Hot Dip Galvanized POLE

Height (Meter)	Top Dia (mm)	Bottom Dia (A/F) (mm)	Sheet Thickness (A/F)(mm)	Base Plate Dimensions (LxDxT)	FOUNDATION BOLT			
					Bolt Size (no.xdia) (mm)	Pitch Circle Dia. (mm)	Bolt Length (mm)	Projected Length (mm)
6.00	70	130	3	200X200X12	4X20 Dia	200	500	100
9.00	70	130	3	220X220X12	4X20 Dia	205	600	100

9.11.8 BRACKETS:

Bracket for accommodating of luminaries shall be **canopy** type with Galvanized single / double arm 200mm long to suit the inlet dia. of luminary as per requirement of BOQ, welded at an angle of 15 degrees (horizontal plane). Bracket shall be removable type and adjustable in horizontal plane. Fixing arrangement with pole shall be with 4 nos. bolts & nuts of dia. not less than 10 mm. Fixing arrangements shall be suitable to bear the wind pressure. The dia. of the bracket pipe shall match with the inlet hole of proposed luminary to be provided on the pole.

(Manish Srivastava) JE/TECH/CON/HQ	(B.K.Das) AEE/CON/PI/MLG	(B.C.Das) EEE/CON/VLG	14/5/16 (Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Acrliya)
CEE/CON/NER

NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

Technical Specification No. NFR/ELECT/CON/GS/10(EARTHING SYSTEM)

EARTHING SYSTEM

10.0 GENERAL.

The earth system shall conform to IS: 3043 and as per approved drawing of the Zonal Railway.

Types of earth systems:

a) Pipe Earth Electrode.
b) Plate Earth Electrode
c) Maintenance Free Earthing for Electrical Installation.

10.1 Relevant Standard Specifications and Regulations (latest amendments):

(i) I.E.Rules 1956 (latest amended)
(ii) IS: 3043-1987 Indian standard code of practice for earthing.
(iii) IS: 1239 PART I Mild steel tubes, tubulars and other wrought steel fittings .
(iv) IEEE 80 IEEE guide for safety in AC sub-station grounding
(v) IEEE 837 Standard for qualifying permanent connections used in substation grounding.
(vi) RDSO draft specification no. RDSO/PE/SPEC/PS/0109-2008 (REV'0'). Amdt.'2' for maintenance free earthing.
(vii) Railway Board's Directives.

(Manoj Sinha) JE/TECH/CON/HQ	(P.K.Das) AEE/CON/P./M.G.	(S.C.Das) CE/CON/M.G.	(Devi Bhushan) Dy.CEE/CON/HQ/M.G.

(R.K.Mallya)
CEE/CON/N.F.R.

10.2 **With the approval of Board (ML), that guidelines on provision of conventional and maintenance free earths for different types of installations are laid down as follows in the table below:**

(Ref: Railway Board's L/No. 2006/Elect(G)/150/5/Pt dated 11.09.2008)

SN	LOCATION/TYPE OF ASSET	APPLICATION/TYPE OF EARTH		
		Conventional earths (GI with charcoal/salt)	Maintenance free earths with ground enhancing materials	Cluster earths with 75% conventional & 25% maintenance free earths with ground enhancing material.
1	Residential buildings/blocks with connected			
	(a) <15KW connected, load	√	-	-
	(b) >15KW connected, load	-	-	√
2	Major service building	-		√
3	Service building	√		
4	(a) Deep well submersible pumping installation minor		√	-
	(b) Pumping installations major	-	-	√
5	Sub-stations (PS)	-	-	√
6	High-masts	-	√	-
7	Individual high end customer interface like PRS,UTS, FOIS,COIS, AVMs, ATMs, Cyber Cafes etc.	-	√	
8	SCADA & RTUs	-	√	-
9	Major Railway station buildings (A or A-1 & other tourism, commercial importance)	-	-	√
10	Minor station buildings (B,C,D,E)	-	√	-
11	Switchgear installed by Railways at incoming supply points from Distribution companies (DISCOMs)	-	-	√
12	TSS, SP/SSPs	-	-	√

10.2.1

a) **Pipe Earth Electrode:** Shall be normally provided for earthing of installations other than sub-stationequipments.

b) **Plate Earth Electrode :** Shall be normally provided for earthing of sub-station equipments.

(Mithu Sen)CPE/ E/TECH/CON/HQ	(Sunil Dosi) AFO/CON/P /MUG	(S.C.Jain) LEE/CON/MUG	(Ravi Bhushan) Dy.CEE/CON/HQ/M.G

(P. C. Arora) CEE/CON/VRR

10.3 Pipe Electrode Earth System

i) The earth electrode shall be made of G.I. pipe of 50 mm dia, medium class (class B) conforming to relevant IS. It shall be 3.0 meter long and tapered at the lower end. The pipe shall be drilled with 12 mm dia. holes at intervals of 75 mm from each other, up to 2.0 meter from the bottom end.

ii) The pipe electrode shall be buried in the ground vertically with its top nearly 200 mm below the top of the enclosure.

iii) A funnel with mesh shall be provided on top of this pipe for watering. Funnel attachment shall be housed in the masonry enclosure.

iv) The top of pipe electrode shall be housed in a masonry enclosure (finished) of not less than 400mm x 400 mmx300mm (internal size). The covers of the masonry enclosures shall be of concrete with handle for lifting.

v) Normally an earth electrode shall not be situated less than 1.5m from any building. Care shall be taken that the excavation for the earth electrode may not affect the column footings or foundations of the building. In such cases, the electrode may be located further away from building. The location of earth shall be such that the soil has reasonable chances of remaining moist. Building entrances, pavements, roads etc. shall be avoided for location of earth electrodes.

vi) Earth resistance shall be reduced by artificial chemical treatment of the soil with sodium chloride (common salt) mixed with soft coke or charcoal in suitable proportion in layers of 150mm. When this treatment is resorted to, the electrode shall be surrounded by the mixture of charcoal/coke and salt.

vii) The earth lead from earth electrode to equipment/pole/main switch etc. shall be of GI wire of size (8 SWG or 25mm X 1mm GI strip). The earth lead for LT panel/feeder pillars shall be of GI strip of size (25mm X 4mm GI strip). Earthing of internal wiring (point wiring, power plug wiring, SDB etc) shall be done by means of PVC sheathed copper wire of same size as that of wire used for relevant point wiring.

viii) Earth lead shall be connected to pipe earth electrode by means of galvanized bolts, nuts, washers & cable sockets.

ix) All materials used for connecting the earth lead with electrode shall be of GI.

x) The earth lead shall be securely connected at the other end i.e. main board/pole/structure/equipment/feeder pillar etc with nuts, bolts, washers etc.

xi) The earth lead from electrode shall be suitably protected from mechanical injury and shall be buried in ground at minimum 300mm depth when located outdoors. The portion within the building shall be recessed in walls/floors at adequate depth.

(M.A. [illegible])	(R.R. Das)	(S.C. Das)	(Ravi Bhushan)
[illegible]	AEE/CON/PL/MLG	CEE/CON/MLG	DY.CEE/CON/HQ/M.G

(R.K. Acharya)
CEE/CON/HQ

xii) No earth electrode shall have resistance greater than 5 ohms. In rocky soil, the resistance may be up to 8 ohms.

xiii) Locations having more than one electrode shall be connected in parallel to reduce the resistance.

xiv) 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 of 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.

10.4 PLATE EARTH ELECTRODE

a) Substation equipments shall be earthed using Plate Earth Electrode. Metallic frame of all equipments such as transformers, HT/LT switchgears/DG sets etc. shall be earthed at two distinct points with GI Plate earth electrodes and neutral points of the transformer/s and DG set/s shall be earthed at two distinct points with copper plate electrodes.

b) Electrodes shall be connected in parallel to minimize resistance.

i) G.I. Plate Earth Electrode

For earthing HT/LT equipments/DG sets, GI plate earth. Electrode shall be 600mmx 600mmx6mm thick and shall be held vertical in ground with its top not less than 3.0 m below ground level. The earth plate shall be embedded in alternate layers of coke and salt of 150mm thickness so as to avail earth resistance not greater than 1.0 ohm.

ii) A watering pipe of 20mm dia of medium class GI pipe shall be provided and attached to the electrode. A funnel with mesh shall be provided on top of this pipe for watering the earth. The watering funnel attachment shall be housed in masonry enclosure of not less than 40cm x 40 cmx30 cm inner size and shall be provided with hinged MS sheet/CI plate 10 mm thick and having locking arrangement.

iii) One end of GI earth strip of size 40mmx6mm or as specified in the relevant BOQ item shall be securely bolted on the GI earth plate with two bolts, nuts, check nuts and washers, all CADMIUM PLATED. Other end shall be brought above ground level vertically. The portion of this strip that runs in ground shall be buried 500 mm below ground level to guard against mechanical damage. The portion within the

(Manjit Singh) DY.CE(CON/HQ/MLG	(R.K.Das) AE/CON/PAL/MLG	(B.C.Das) EE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Adolya)
CE/CON/NLG

building shall be recessed in walls/floors at adequate depth.

iv) The strip shall be connected to the earth terminals of various HT/LT equipments/DG sets etc. by means of cadmium plated nuts, bolts and washers.

10.5 Copper Plate Earth Electrode

i) For earthing of neutral of transformers/DG sets, 600mm x600mmx3mm thick copper plate earth electrode shall be held vertical in ground with its top not less than 3.0 m below ground level. The earth plate is embedded in alternate layers of coke and salt of 150mm layers each, to avail earth resistance less no. greater than 1.0 ohm.

ii) A watering pipe of 20mm dia of medium class GI pipe shall be provided and attached to the electrodes. A funnel with mesh shall be provided on top on this pipe for watering the earth. The watering funnel attachment shall be housed in masonry enclosure of not less than 400 mm x 400mm x300mm inner size and shall be provided with hinged MS sheet/CI plate 10mm thick and having locking arrangement.

iii) One end of copper strip of size 40x5mm or as specified in the relevant BOQ item shall be securely bolted on the copper earth plate by means of two nos. of tinned brass bolts, nuts, check nuts and washers as required. Other end shall be brought above ground level vertically through GI pipe of 50 mm dia or as specified in the relevant BOQ item. The portion of this strip that runs in the ground shall be taken through medium class GI pipe 50 mm dia or as specified in the relevant BOQ item, buried 500 mm under ground level to guard against mechanical damage. The portion within the building shall be recessed in walls/floors at adequate depth.

iv) The strip shall be connected to the neutral terminals of transformer/DG set by means of tinned brass bolts, nuts and washers, as required. To bring down the earth resistance, every earth electrode shall be surrounded by charcoal and salt.

10.6 Every individual earth electrode shall be allotted a serial number and an earth plate of size 10x22 cm of 14 SWG sheet steel (painted black) fixed in a conspicuous position near the earth. The following information shall be displayed with white or yellow paint on the earth plate.

i) Earth No.....
ii) Individual earth resistance.....ohms.
iii) Overall earth resistance.....ohms.
iv) Date of testing.....

(Manoj Kumar) JE/TECH/CON/HQ	(J.K.Das) AEE/CON/PI/MLG	(P.C.Das) EE/CON/MLG	(Ravi Bhushan) DY.CFE/CON/HQ/M.C

(R. Calcidyal)

10.7 The following tests shall be carried out before the installation is commissioned

i) Earth resistance test

ii) Earth continuity test

10.8 Materials and Sizes of Earth Electrodes

Type of Electrode	Material	Size
Pipe	GI medium class	50 mm dia 3.0 m long (without any joint)
Plate	(i) GI	60 cm x 60 cm x 6 mm thick
	(ii) Copper	60 cm x 60 cm x 3 mm thick
Strip	(i) GI	40X6 mm section
	(ii) Copper	40X5 mm section
Conductor		4 mm dia (8 SWG)

10.9 Maintenance Free Earth for Electrical Installation

As per RDSO draft specification no RDSO/PE/SPEC/PS/0109-2008(REV '0'), Amdt.'2'.

10.9.1 SELECTION OF EARTH SYSTEM

S.N.	Installations/ Current Capacity	IR Value Required	Soil Type/Resistivity	Earth System
1.	House hold earthing/5KA	8 ohm	Normal Soil/upto 50 ohm-mtr	Single Electrode
			Sandy Soil/between 50 to 2000 ohm-mtr	Single Electrode
			Rocky Soil/More than 2000 ohm-meter	Multiple Electrode
2	Commercial premises Office buildings/5KA	2 ohm	Normal Soil/upto 50 ohm-mtr	Single Electrode
			Sandy Soil/between up to 2000 ohm-mtr	Multiple Electrode
			Rocky Soil/More than 2000 ohm-meter	Multiple Electrode
3	Transformer, substation earthing, LT line equipment/15 KA	1-2 ohm	Normal Soil/upto 50 ohm-mtr	Single Electrode
			Sandy Soil/between up to 2000 ohm-mtr	Multiple Electrode
			Rocky Soil/More than 2000 ohm-meter	Multiple Electrode
4	Transformer, substation earthing, HT line equipment/40 KA	Less than 1 ohm	Normal Soil/upto 50 ohm-mtr	Single Electrode
			Sandy Soil/between up to 2000 ohm-mtr	Multiple Electrode
			Rocky Soil/More than 2000 ohm-meter	Multiple Electrode

(Manjit Singh) JE/TRD/CON/KTK | (B.K.Das) AEN/CON/PL/MLG | (T.C.Das) SE/CON/MLG | (Ravi Bhushan) DY.CFE/CON/TRD/MLG

(R.K.Meena) CFE/C/CN/NCR

5	Lightning arresters, extra high critical applications etc./50 KA	Less than 1 ohm	Normal Soil/upto 50 ohm-mtr	Single Electrode
			Sandy Soil/between up to 2000 ohm-mtr	Multiple Electrode
			Rocky Soil/More than 2000 ohm-meter	Multiple Electrode
6	PRS, UTS,RTUs, FOIS, COIS, ATMs and data processing centre etc./5KA	Less than 0.5 ohm	Normal Soil/upto 50 ohm-mtr	Single Electrode
			Sandy Soil/between up to 2000 ohm-mtr	Multiple Electrode
			Rocky Soil/More than 2000 ohm-meter	Multiple Electrode

Note :- Single/multiple electrode in above earth system shall be either rod earth electrode or concentric pipe earth electrode.

10.9.2 **Rod earth electrode**

10.9.2.1 High tensile-low carbon steel rod having diameter not less than 17mm complying with requirements of BS 4360 Grade 43A or EN10025 2-004 S275JR, molecularly bonded by 99.99% pure high conductivity copper on outer surface with copper coating thickness 250 micron or more, Length 3000 mm (minimum). Length of the electrode may be increased in multiple of 1 meter to reduce earth resistance if required. To increase the length, pieces of similar rod shall be either exothermally welded to basic 3 meter electrode or connected using socket of suitable size. These sockets shall also be molecularly bonded by 99.99% pure high conductivity copper on inner & outer surface with copper coating thickness 250 micron or more.

10.9.2.2 Copper bus bar of size 250 mm x 50mm x 6 mm having electrical conductivity of 101% IACS, minimum 99.9% copper content shall be exothermically welded to rod with 4 holes of 12 mm dia. (2 on each side) for connecting earthing conductor.

10.9.2.3 **Current carrying capacity:** The design of the electrode should be such as to have more than 15kA current carrying capacity for 1 second.

10.9.3 **Concentric pipe earth electrode:**

10.9.3.1 **Primary conductor**

MS pipe with 25 - 50 mm diameter, class B, ISI mark as per IS-1239, Length 2000 or 3000 mm as per table at para 10.9.3.7

(M.G.Tandekar) JE/TECH/CON/HQ	(S.R.Das) AET/CON/PKG/MLG	(S.C.Das) EEE/CON/MLG	(Rasi Bhushan) SY.CTI/CON/HQ/MLG

(R.K.Adolya)
CET/CON/NGP

10.9.3.2 **Secondary conductor**

MS pipe with 40-100 mm diameter, class B, ISI mark as per IS-1239, Length 2000 or 3000 mm as per table at para 10.9.3.7.

10.9.3.3 **Conductive mixture**

For hermetically filling inside the cavity i.e. between secondary conductor & primary conductor, crystalline compound is to be injected in the electrode assembly. It is a combination of high conductivity metal alloys, copper & aluminium powder, conductive carbon/cement and bonding material etc. mixed in different proportion. The mixture is forced (pressurized) filled inside the earth electrode in the paste form and after solidification of the same, the end caps are welded. The metal alloys shall help in conducting the current and conductive carbon gives anti corrosive property. Bonding material should provide strength to the mixture. Resistivity of the mixture shall be less than 0.2 ohm-meter. Resistivity shall be tested by making a 20cm cube of the material.

10.9.3.4 Complete electrode shall be molecularly bonded by 99.99% pure, high conductivity copper on outer surface with copper coating thickness 300 micron or more.

10.9.3.5 Its surface shall be clean and free from any visible oxide layer or foreign material.

10.9.3.6 Copper bus bar of size 250 mm x 50mm x 6 mm having electrical conductivity of 101% IACS, minimum 99.9% copper content shall preferably be exothermically welded to earth electrode or connected with the help of two number stainless steel nut bolts of appropriate size having 4 holes of 12 mm dia. (2 on each side) for connecting earthing conductor.

10.9.3.7 **Current carrying capacity**: The design of the electrode should be such as to have more than following current carrying capacity in kA (for 1 second):

S.N.	Current Capacity	Primary Conductor diameter	Electrode dimensions (dia. x length)
1.	3 kA	25 mm	40 mm x 2000 mm
2.	5kA	25 mm	40 mm x 3000 mm
3	15kA	25 mm	50 mm x 3000 mm
4	40kA	40 mm	80 mm x 3000 mm
5	50kA	50 mm	100 mm x 3000 mm

Note:- For more than 50KA applications, multiple electrodes of 50KA capacity shall be installed and connected.

(Manju Vajpayee) JE/TECH/CO/MG	(S.R.Das) ATT/CON/PUR/MLG	(S.K.Das) EEE/CO/MLG	(Ravi Bhushan) SY.ETT/CON/HQ/MLG

(R.K.Arulraj) CTT/CO/NER

10.9.4 **Earth enhancement material:**

Earth enhancement material is a superior conductive material that improves earthing effectiveness, especially in areas of poor conductivity (rocky ground, areas of moisture variation, sandy soils etc.) It may contain conductive cement, graphite, hydrous aluminium silicate, sodium montmorillonite etc and shall not contain bentonite. It improves conductivity of the earth electrode and ground contact area. It shall have following characteristics-

i) It should have low resistivity preferably bellow 0.2 Ohm-meters. Resistivity shall be tested by making a 20cm. cube of the material and checking resistance across the opposite face of the cube.

ii) It shall not depend on the continuous presence of water to maintain its conductivity.

iii) It should be a little alkaline in nature with pH value >7 but <9. test certificate from NABL approved laboratory to be provided for the composition so designed

iv) It should have better hygroscopic properties to absorb moisture. It should absorb and release the moisture in dry weather condition and help in maintaining the moisture around the earth electrode.

v) It should have capacity to retain >10% moisture at 105°C. Test certificate from NABL approved lab to be submitted for the composition so designed

vi) It should have water solubility < 5%. Test certificate from NABL approved lab be submitted for the composition so designed.

vii) It should be granular with granule size 0.1 mm to 3 mm.

viii) It should be non toxic, non reactive, non explosive & non corrosive.

ix) It shall be thermally stable between -10 degree centigrade to 160 degree centigrade ambient temperature.

x) It shall not decompose or leach out with time

xi) It shall not pollute the soil or local water table and meets environmental friendly requirement for landfill.

xii) It should expand & swell considerably and removes entrapped air to create strong connection between earth electrode and soil.

xiii) It should be diffuses into soil pores and creates conductive roots enlarging conductive zone of earth pit.

xiv) It shall be permanent & maintenance free and in its "set form", maintains constant earth resistance with time.

xv) It shall not require periodic charging treatment or replacement

xvi) It shall be suitable for any kind of electrode and all kinds of soils of different resistivity.

(Manju Yadav) EE/TECH/CON/HQ	(B.C.Das) AEE/CON/F-I/MLG	(B.C.Das) EE/CON/M.C	(Ravi Bhushan) DY.CEE/CON/HQ/M.Rly 11/5/16

(S.K.Ardil) CEE/CON/N.F.R

xvii) It shall not cause burns, irritation to eye, skin etc.

xviii) Minimum quantity of earth enhancement material to be supplied :

For 5' x5'x 10' earth pit Min. 75 kgs per pit

For 300mm bore type earth pit Min 50 kgs per pit

xix) The Earth enhancement material shall be supplied in sealed, moisture proof bags. These bags shall be marked with Manufacturer's name or trade name, quantity, batch no & date of manufacture.

10.9.5 Backfill material

Normally the excavated soil shall be used if it is free from sand, gravel and stones. In case the excavated soil contains sand, gravel and stones these shall be removed by appropriate methods such as hand picking, sieving etc. Small proportion of sand in the soil may be permissible. Material like sand, salt, coke breeze, cinders and ash shall not be used because of its acidic and corrosive nature. If the excavated soil contains sand, gravel and stone in large proportion and it is not feasible to remove these economically, good quality soil from other place may be used for backfilling.

While backfilling the soil shall be thoroughly compacted with at least 5 kg compactor. In case the soil is dry, small quantity of water may be sprinkled only to make it moist enough suitable for compacting. Large quantity of water may make the soil muddy which is not suitable for compacting and after drying the soil may contain voids which may permanently increase earth resistance.

10.9.6 Equipotential bus & Earthing Conductor

(i) A copper bus bar of size 300mm x 25mm x 6mm to be installed in the equipment room as equipotential bus and must be connected with preferably copper strip of 25mm x 3mm (suitable length) from instrument to the bus bar . The connecting terminal of the earth electrode to the bus bar must be connected by copper strip of 25mm x 3mm (suitable length) buried inside a trench of 300mm width x 600mm depth (from the earth pit to the nearest wall) .It shall be duplicated. However, it shall be ensured that only minimum required length is used and any extra length is cut away to keep the earth impedance minimum.

(ii) It shall be high conductivity copper having electrical conductivity of 101% IACS i.e. minimum 99.9% copper content. The maximum specific resistance of the copper strip earthing conductor shall be 17.241 x 10-7 ohm cm at 20°C.

(iii) At a temperature of 20°C, its density shall be 8.89 gm/cm^3

(iv) Its surface shall be clean and free from any visible oxide layer or foreign materials.

(v) It shall preferably be connected to earth electrode and earth bus bar with the help of exothermic welding or at least two number stainless steel nut bolts of appropriate size.

(Manju [illegible]) EE/CON/PL/MLG	(Sunil [illegible]) AEE/CON/PL/MLG	(R.R.Das) EE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R K Arulija) CEE/CON/NFR

(vi) Normally a single length of copper strip shall be used for each duplicate copper strip earthing conductor and no joint should be used. However in situation requiring greater length one joint in each copper strip shall be permitted. The joints shall be made by exothermic welding of at least 10mm overlapping portion of the strips.

10.9.7 **Construction of unit earth.**

i) Make 5ft x 5ft x 10ft earth pit. If it is not possible to make such a pit due to non availability of clear space at locations like ATM, High mast lighting tower, Passenger information systems, PRS etc. or in rocky soil, min. 300 mm bore up to 10 ft deep can be made using earth auger or any other method. Earth pit larger than specified size can be made, if required.

ii) Sieve the soil digged and remove the gravels and stones. If soil quality is good (without Murum and rocks) then add some quantity of earth enhancement material in the soil for using as backfill.

iii) If the soil seems unusable (containing large quantity of gravel, stones, murum, sad etc.) then replace the soil with black cotton soil.

iv) Insert the electrode at the centre of the earth pit and arrange to keep it vertical in the pit.

v) Arrange for adequate quantity of water supply for the pit.(Approx. 600 litres)

vi) Fill the pit with the backfill and keep on adding the earth enhancement material surrounding the electrode and simultaneously watering the pit.

vii) With a steel bar or pipe, keep on poking the soil gel and stirring intermittently for removing the air pockets and proper settlement of the pit.

viii) The procedure to be repeated till completion of the filling of the earth pit along with the packing material and sufficient watering adequate ramming.

ix) The pit should be very compactly rammed and watering for 2-3 days and addition of soil if required be done.

x) Make trench of 600 mm (depth) x 300 mm (wide) from the earth pit to the nearest point of connection.

xii) Construct inspection chamber with cover for the installation.

xiii) Measure the earth resistance as per IS 3043:1987 code of practice. Earth resistance value shall be less than 1 ohm in non rocky/non-sandy surface by single electrode Installation and in rocky surface by multiple electrode installation (not more than three electrodes & its individual earth pits). For earthing purpose, if solid rocky layer is found within 10 feet from ground level while digging the earth pit then it is considered rocky surface. Coastal area, silt soil, red sandy soil and sandy clay are considered as sandy surface.

(Manju Nair) Dy.CE(El)/CON/HQ	(Jaydas) AEE/CON/PL/MLG	(D.C.Das) EE/CON/MLG	(Ravi Bhushan) DY.CFE/CON/HQ/MLG

(R. K. Kabra)
CFE/CON/HQ

xiv) If required resistance is lower than the resistance of single earth electrode then multiple earths can be constructed and interconnected.

10.9.8 Construction of ring earth by providing multiple earth pits

i) Wherever it is not possible to achieve required earth resistance with one earth electrode/pit due to difficult/rocky soil conditions, provision of ring earth consisting of more than one earth pit shall be done. The number of pits required shall be decided based on the resistance achieved for the earth pits already installed. The procedure mentioned above for one earth pit shall be repeated for other earth pits.

ii) The distance between two successive earth electrodes shall be min. 3mtrs / length of electrode which ever is higher, and max. up to twice the length of the earth electrode.

iii) These earth pits shall then be inter linked using 25X3 mm copper strip to form a loop preferably using exothermic welding or with the help of at least two number of stainless steel nut bolts of appropriate size.

iv) The interconnecting strip shall be buried no less than 600mm (0.6m) below the ground level. This interconnecting strip shall also be covered with earth enhancing compound.

10.9.9 Inspection chamber

i) Prefabricated inspection camber of size 300X300X300 mm (inside dimension) concrete box (wall thickness min. 50 mm) with smooth cement plaster finish shall be provided on the top of the pit. A concrete lid 25 to 50 mm. thick, with pulling hooks, painted black shall be provided to cover the earth pit. PVC sleeve of appropriate size shall be provided in concrete wall to take out earthing connections.

ii) The masonry work shall be white washed inside and outside.

iii) Care shall be taken regarding level of the floor surrounding the earth so that the connector is not too deep in the masonry or projecting out of it.

iv) On backside of the cover, date of the testing and average resistance value shall be written with yellow paint on black background

10.9.10 MARKING:

The marking shall be clear, distinct and visible to the naked eye from a distance of about 1 meter; the size of marking shall be of minimum 25 mm. Following information shall be legibly and indelibly marked on the packed sets:

a) Specification no.

b) Name of the manufacturer

c) Batch no. & Date of manufacturer

d) Current carrying capacity

(Manju Kishore)	(R.C.Das)	(R.C.Das)	(Ravi Shankar)
AEE/CON/HQ	AEE/CON/CTG/MLG	SEE/CON/MLG	DY.GM/CON/HQ/KLG

(R.K.Mallick)
CGM/CON/HQ

10.9.11 TESTS-

Following tests shall be done on one sample-

10.9.11.1 Testing of copper coating shall be done as described below:-

i) The copper coating mentioned in clause 8.1 shall not be less than the prescribed thickness at any point and shall comply with the adherence requirement in para (ii) & (iii) below.

ii) Length of the electrode with one end cut to a 45 degree point shall be driven between two steel clamping plates or the jaws of a vise set 0.04 in (1.02 mm) less than the diameter of the electrode, so as to shear off sufficient metal to expose the bond between the copper coating and electrode. Peeling of the coating by the steel plates or the jaws of the vise is acceptable, but there shall be no other evidence of separation of the coating from the metal core.

iii) At room temperature, a length of the electrode is rigidly held in a clamp or vise and the free end is bent by applying a force normal to the electrode at a distance from the clamping device equal to 40 times the diameter. The magnitude of the force and the direction of application of force shall be such that the electrode is permanently bent through a 30-degree angle. While bending of the electrode there shall be no evidence of cracking of the copper coating.

10.9.11.2 Material composition of rod shall be tested as per standards mentioned in clause no. 10.9.1

10.9.11.3 MS pipes shall be tested as per IS:1239.

10.9.11.4 Copper bus bars of shall be tested for percentage of copper as per IS:14644.

10.9.11.5 Current carrying capacity test on rod electrode shall be done as per clause no. 10.9.3 and for concentric pipe electrode as per 10.9.3.7.

10.9.11.6 **Corrosion Test :** As per IS:2119, salt spray test for analysis of effect of corrosion for the specific electrode shall be done through NABL approved testing lab, preferably for 500 hrs. or more.

10.9.11.7 Exothermic weld material shall be tested as per provisions of IEEE 837.

10.9.11.8 Electrical properties test on conductive mixture as per clause no. 10.9.3.3.

10.9.11.9 Physical, chemical & electrical properties test on earth enhancement material as per clause no. 10.9.4.

(Manju Vishnoi) DY.CE(TECH)/CON/HQ	(D.R.Dosi) AEE/CON/FL/MLG	(S.C.Das) LL/CON/MLG	(Sunil Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Atoliya)
CEE/CON/A-II

10.9.11.10 Toxic content tests for cadmium, lead, mercury, hexavalent chromium, polybrominated biphenyls (PBBs) & polybrominated diphenyl ethers (PBDEs) on conductive mixture & earth enhancement material.

Certificates from NABL approved laboratories shall be submitted with test results of above tests. Test certificates shall not be more than three years old.

For dimension, weight and specific resistance average of 3 readings shall be taken. Average value shall be within specified limits and individual values shall not go beyond double of tolerances.

10.9.12 ACCEPTANCE TESTS

10.9.12.1 Following shall constitute acceptance tests and shall be done on 100% sample basis for all the tests mentioned below except where otherwise indicated–

a) Physical check for earth electrode as per clause no. 10.9.1 for rod type electrode and as per clause no. 10.9.3.7 for concentric pipe type electrode.

b) Physical check for copper bus bar as per clause no 10.9.2 for rod type electrode and as per clause no. 10.9.3.6 for concentric pipe type electrode

c) Dimensional and construction feature tests of inspection chamber (Cl. no. 10.9.9)

d) Earth enhancement material as per clause no. 10.9.4(xviii) & 10.9.4(xix).

e) Earth resistance shall be measured using fall of potential method as per para 27 of IS: 3043.

(Manoj Yadav) JE/TECH-I/CON/HQ	B.K.Das AEE/CON/PI/MLG	D.C.Das, EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

B.K.Andhyal
CE/CON/HQ

NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

Technical Specification No. NFR/ELECT/CON/GS/11(Submersible Pump)

SUBMERSIBLE PUMPS

11.0 System of Supply

The pump shall be, suitable to operate on single phase, 230V or 3-phase, 415 V, 50 Hz, AC supply system depending upon rating.

11.1 General Requirements

Electrically driven submersible pump set shall be ISI marked and star rated multi-stage, suitable for operation in the specified diameter of bore well and capable of continuously pumping clear water at specified capacity at the indicated head. Pump set shall be of 2900 rpm (nominal) submersible electrical motor, suitable to operate on 415 V, 3 phase, 50 Hz, AC supply system equipped with integral non-return valve and all necessary accessories for the application, whether specifically stated or not.

11.2 Relevant Standard Specifications and Regulations:

(i) IS: 8034/2002
(ii) IS: 325
(iii) IS: 8544
(iv) Railway Board's Directive.
(v) RDSO Specification.

11.3 Pump

The Pump shall be of centrifugal type, fitted with multistage impellers, generally conforming to IS: 8034/2002, suitable for trouble free operation in the bore well when submerged and capable of easy installation in bore hole without damage to bore hole lining.

11.3.1 The pump shall be constructed with casing of high-grade cast iron of sufficient strength and hardness for long lasting. Impellers shall be manufactured from high quality bronze and shall be dynamically balanced. The shaft of the impeller shall be of hardened stainless steel for long life. The impeller guide vanes and diffusers shall be of suitable design with special emphasis to improve the efficiency of the pump.

11.3.2 The material used in all the parts of the pump and casing shall be suitable to withstand corrosive action of the liquid to be handled by the pump and shall be designed for long service.

[Manju Yhorenaor] IE/TECH/CON/HQ	[A.K.Das] APE/CON/N/MLG	(B.C.Das) EE/CON/MLG	[Ravi Bhushan] DY.CEE/CON/HQ/MLG

(R.K.Mallick)
CEE/CON/RTH

11.3.3 All bearings/bushes used in the pumps shall be of water lubricating, high loading capacity, synthetic thrust type. The sleeve bearings shall be of special lead bronze having a high bearing load capacity.

11.3.4 The pump shall be complete with a suitable brass strainer at the suction side to prevent any hard material from entering the pump

11.4 Motor

11.4.1 The motor shall be squirrel cage type induction motor, suitable for operation with the pump, capable of running on 230V, single phase or 415 V, 3 phase, 4 wire, 50 Hz, Ac supply system(as specified). The motor shall be suitably rated to withstand any overload due to higher discharge at a lower head and reduction in head up to 25 % of the specified head without getting over loaded.

11.4.2 The motor shall be of "wet type" according to manufacturer's standard design and generally conforming to IS: 325.

11.4.3 The casing shall be of stainless steel, tube treated, so as to prevent corrosion and rust during service. The starter winding shall be provided with one-ageing, waterproof, dense synthetic molecular insulation so as to resist the environmental chemical influence and shall have extremely high percussion strength.

11.4.4 The motor shall be assembled on hardened stainless steel shaft and supported on antifriction thrust bearings of synthetic molecular insulation. The sleeve bearings shall be of special bronze make. All the end thrust bearings shall be constructed from such material as to ensured trouble free service and be water lubricated.

11.4.5 The motor shaft shall be fitted with synthetic rubber sealing rings and sand guard to prevent sand and impurities from entering the motor. The motor shall be directly coupled to the pump and shall be provided with a suitable device to prevent uncoupling when the motor is started occasionally in the wrong direction.

11.4.6 The motor shall be equipped with suitable compensative device in order to protect the water inside the motor from getting mixed up with well water which may contain some quantity of sand etc. In the event of slight expansion of water inside the motor, the device shall give a spongy action, to accommodate it and return to normal when the motor is not working.

11.4.7 The electrical cable shall be connected to the motor by means of perfectly watertight sealing gland, to prevent water from entering the motor. The cable shall be protected by a strong cable guard plate. Waterproof cable of suitable size and length shall be used.

11.5 Control Panel

The control panel shall be wall mounted, cubicle type suitable for outdoor weather proof application with proper gasketing, complete with incomer TPN MCB 10 KA of suitable capacity, starter, single phase preventer, accessories, internal connections with copper conductor cable etc. and fabricated from 16 SWG CRCA sheet steel duly powder coated. Base plate shall be detachable with cable gland/s. Panel shall be earthed with separate earth suitably. Cubical should be IP 67 with rain shed canopy when installed outdoor.

11.5.1 Starter

The starter for the motor shall be push button operated type with under voltage and over load release for direct on line starting and conforming to IS: 8544.

11.5.2 Indicator lamps for input supply for each phase, output supply

11.5.3 Suitable ammeter and voltmeter for each phase shall be provided.

11.5.4 Suitable electronic/microcontroller based motor protection relay with over/under voltage protection, phase sequence, locked rotor, earth fault, over current protection, dry run protection, single phase preventor, suitable timer control and measurement for running time of pump.

11.5.5 MCB's and other device should be suitable for web based automation.

11.6 Accessories

11.6.1 The submersible pump shall be supplied with the following accessories:

a) Non-return valve streamlined for minimum friction and integral in each pump set. The cone of the valve shall be fully quoted on the periphery valve seating shall be renewable rubber ring type.

b) Pressure gauge of suitable size and graduated in kg/sq.cm on the delivery side.

c) The pump shall be supplied along with the test certificates and catalogue etc. issued by manufacturer.

11.7 Pump and control panel should be suitably provided with two independent earthing system.

11.8 For the purpose of lifting of submersible pumps, provision of crowbar arrangement with suitable size of MS joist along the centerline of the opening shall be ensured.

11.9 Automation of Pumps

11.9.1 All pumping installation shall be automated.

11.9.2 Web based pump automation system with General Packet Radio Service (GPRS) along with associated hardware and software may be opted for automation of submersible pumps.

(Manju Yorkzone) JE/TECH/CON/HQ	(B.K.Das) AEE/CON/PL/MLG	(B.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(P.K Aaditya) CEE/CON/NER

NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

Technical Specification No. NFR/ELECT/CON/GS/12(LA)

LIGHTENING ARRESTER

12.0 Lightening arresters shall be provided on the buildings where large public congregates, essential public services are concerned, lightening strokes are prevalent, or in structures which are very tall, isolated, or are historical or cultural importance. The other buildings may also be provided with lightening arrestors as per risk assessment analysis given in the IEC 62305 chapter-2. The lightening arresters are governed as per IEC 62305 and BIS 2309.

12.1 Generally lightening protection in installation having nuclear or sensitive electronics are provided with Level1 Lightening protection whereas buildings housing Data Centre and building taller than 20 meter height in isolated location are provided level 2 lightening protection, other buildings having electronics or human occupancy requires level 3 protection and godown having no electronics will require level 4 lightening protection.

12.2 Relevant Standard Specifications and Regulations (latest amended):

i) IEC 62305
ii) IEC 60364-5-54
iii) IEC 62561-1 to 7
iv) IS : 3043
v) IS : 2309-1989
vi) ISBB 837
vii) BIS 2309
viii) UL 467

12.3 Principle of Protection

The principle for protection of buildings against lightning is to provide a conducting path between earth and the atmosphere above the building through which the lightning discharge may enter the earth without causing damage to the building. If adequately earthed metal parts of proper proportions are provided and spread properly on and around the building, damage can be largely prevented.

The required conditions of protection are generally met by placing all the air terminals, whether in the form of vertical finials or horizontal conductors, on the upper most part of the building or its projections, with lightning conductors connecting the air terminals with each other and to the earth.

[Manju Agrawal] JE/TECH/CON/HQ	[B.K.Das] AEE/CON/PL/MLG	[S.C.Das] EEE/CON/MLG	[Rail Bhushan] DY.CEE/CON/HQ/MLG

[R.K.Adhikari] CEE/CON/MLG 1/6

12.4 Zone of Protection

The zone of protection of a lightning conductor defines the space within which Air Terminal provides protection against a direct lightning strike with probability of protection as per LPL.

12.5 Protective Angle

This cannot be precisely stated, since it depends upon the severity of the stroke and the presence within the protective zone of conducting objects providing independent paths to the earth. All that can be stated is that the protection afforded by a lightning conductor increases as the assumed protective angle decreases.

(a) However, for the practical purpose of providing an "acceptable degree" of protection for an ordinary structure, the protective angle of any single component part of an air termination network, namely, either one vertical, or one horizontal conductor is considered to be 45 degrees.

(b) Between three or more vertical conductors, spaced at a distance not exceeding twice their height, the equivalent protective angle may, as an exception, be taken as 60 degrees to the vertical.

(c) Protective angles of zones of protection for some forms of air termination are illustrated in IS 2309 : 1989.

12.6 Lightning Protection Level(LPL)

LPL is a number associated with a set of lightning current parameters relevant to the probability that the associated minimum & maximum values do not exceed the normally occurring lightning. LPL can be determined by Risk analysis as explained in IEC 62305-2.

Sr No	LPL	Lightening Current Peak Value Min	Lightening Current Peak
1.0	LPL Level 1	3 KA	150 KA
2.0	LPL Level 2	5 KA	150 KA
3.0	LPL Level 3	10 KA	100 KA
4.0	LPL Level 4	16 KA	100 KA

Air termination system is to intercept the Lightning current. It consists of vertical air terminal or Mesh conductor or the combination. No drilling or welding is allowed in the terrace for fixing the air terminal.

(Manju Yonzone) Jr./I-CH/CON/HQ	(R.P.Das) AEE/CON/PI/MIG	(B.C.Das) EEE/CON/IV/LG	(Ravi Bhushan) DY.CEE/CON/HQ/MIG

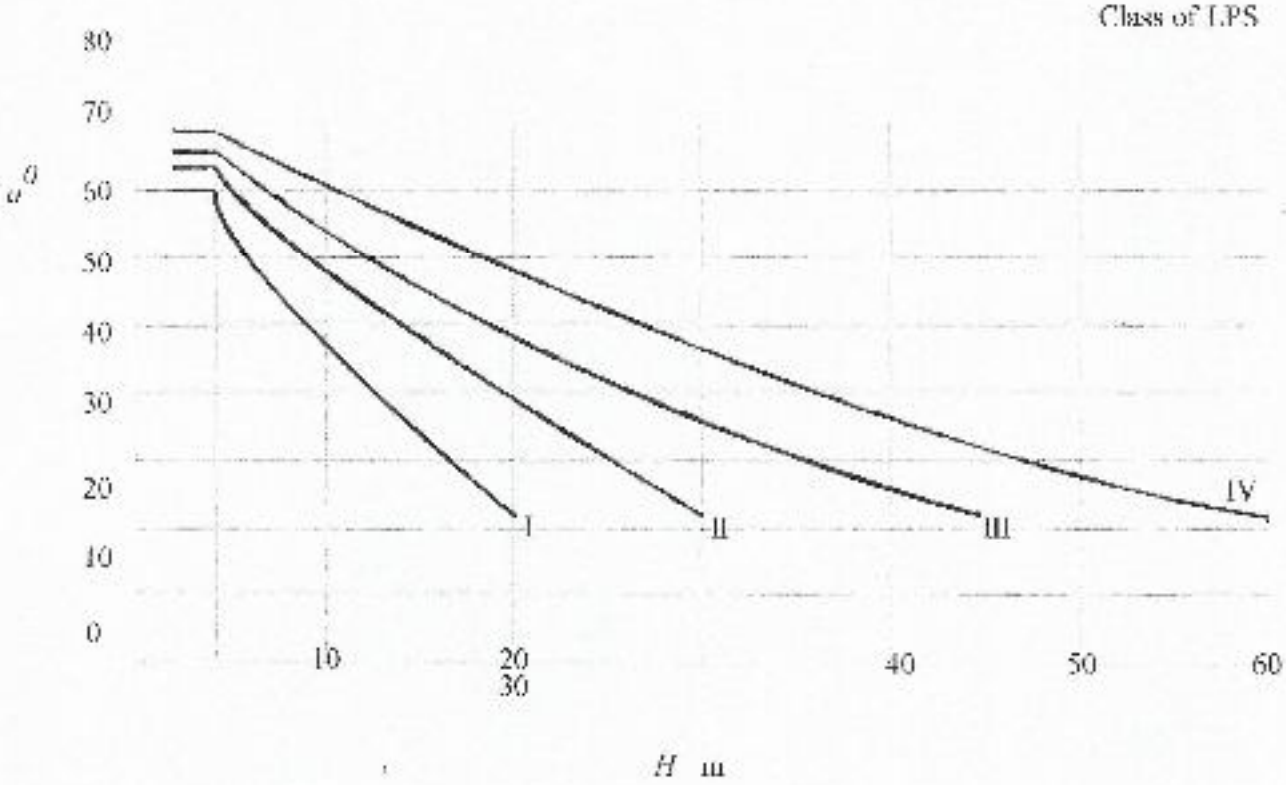
(R.K.Arora) CEE/CON/NFR

12.7 Values of Rolling sphere radius, Mesh size and protection angle as per Class of LPL/LPS.

Class of LPL/LPS	Rollingsphere radius(m)	Mesh size (m) Protection angle	Protectionangle
1	20	5*5	Refer Graph Below
2	30	10*10	
3	45	15*15	
4	60	20*20	

[Manju Nagpal] JE/TECH/CON/HQ	[D.P.Das] AEE/CON/PL/MUs	[R.C.Das] EEE/CON/MUS	[Ravi Bhushan] DY.CEE/CON/HQ/MUs

[R.K.Maliya]
CEE/CON/NH



If the structure height is more than 60 meters, top 20% of the height of the structure shall be protected with a lateral air termination system. This is needed because, the probability of flashes to the side is generally more for structures more than 60 meters in height. For structures of height more than 120 meters, ring has to be formed for every 20 meters height of the building above 60 meters height.

12.8 Principal Components

The principal components of a lightning protective system are :-

(a) Air terminations,
(b) Down conductors,
(c) Joint and bonds,
(d) Testing joints,
(e) Earth terminations, and
(f) Earth electrodes.

12.9 Materials

The materials of air terminations, down conductors, earth termination etc. of the protective system shall be reliably resistant to corrosion, or be adequately protected

(Manju Yadav) IF/TECH/CON/HQ	(U.K.Das) AEE/CON/PI/MUG	(B.C.Das) EE/CON/MUG	(Ravi Bhushan) DY.CEE/CON/HQ/MUG

(B.K.Ahirwar)
CE/CON/NHR

against corrosion. The material shall be one of the following, as specified.

(a) **Copper:** Solid or flat copper strip of at least 98% conductivity conforming to relevant I.S. Specifications shall be used.

(b) **Copper Clad Steel:** Copper clad steel with copper covering permanently and effectively welded to the steel core shall be used. The proportion of copper and steel shall be such that the conductance of the material is not less than 30% of conductance of the solid copper of the same total cross-sectional area.

(c) **Galvanized Steel:** Steel thoroughly protected against corrosion by a zinc coating shall be used.

(d) **Aluminium:** Aluminium, 99% pure, and with sufficient mechanical strength, and protected against corrosion shall be used

12.9.1 Aluminium should not be used underground, or in direct contact with walls.

12.9.2 All air terminations shall be of GI and all down conductors shall be of GI or aluminium, except where the atmospheric conditions necessitate the use of copper or copper clad steel for air terminations and down conductors.

12.9.3 The recommended shape and minimum sizes of conductors for use above and below ground are given in **Table -1 and 2** respectively at Page 14.

12.10 **Layout**

The system design and layout shall be done in accordance with IS 2309: 1989 and specified in the tender documents.

12.10.1 **Air Terminations**

(i) Air termination networks may consist of vertical or horizontal conductors, or combinations of both. For the purpose of lightning protection, the vertical and horizontal conductors are considered equivalent and the use of pointed air terminations, or vertical finial is, therefore, not regarded as essential.

(ii) A vertical air termination, where provided, need not have more than one point, and shall project at least 30 cm, above the object, salient point or network on which it is fixed.

(iii) For a flat roof, horizontal air termination along the outer perimeter of the roof shall be used. For a roof of larger area a network of parallel horizontal conductors shall be installed. No part of the roof should be more than 9 m from the nearest horizontal protective conductor.

(Manju Ranjan) IF/TECH/CON/HQ	(B.K.Das) AEE/CON/PL/MUG	(D.C.Das) EEE/CON/MUG	(Ravi Bhushan) DY.GM/CON/HQ/MUG

(R.K.Atrolliya)
CEE/CON/NER

(v) Horizontal air terminations should be carried along the contours such as ridges, parapets and edges of flat roofs, and, where necessary, over flat surfaces, in such a way as to join each air termination to the rest, and should themselves form a closed network.

(v) All metallic projections including reinforcement, on or above the main surface of the roof which are connected to the general mass of the earth, should be bonded and form a part of the air termination network.

(vi) If portions of a structure vary considerably in height, any necessary air terminations or air termination network for the lower portions should be bonded to the down conductors of the taller portions, in addition to their own down conductors.

12.10.2 Down Conductors

The function of a down conductor is to provide a low impedance path from the air termination to the earth electrode so that lightning current can be safely conducted to the earth. In practice, depending upon the form of a building, it is often necessary to have many down conductors in parallel, some or all of which may be a part of the building structure itself.

In order to reduce the probability of damage to electronic/electrical equipment, the down conductors shall be arranged in such a way that from the point of strike to earth, several parallel current paths should exist & length of the current path should be minimum .Down conductors can be installed separately or more wisely it can be part of natural components of the building Examples are steel reinforcement in RCC columns, metal facades, profile rails, metal doors & windows. Down conductors should be installed at each exposed corner of the structure.

(i) The number and spacing of down conductors shall be as specified, or as directed by the Engineer-in-charge at site.

(ii) **Routing**

(a) A down conductor should follow the most direct path possible between the air terminal network and the earth termination network. Where more than one down conductor is used, the conductors should be arranged as evenly as practicable around the outside walls of the structures.

(b) The walls of light wells may be used for fixing down conductors, but lift shafts should not be used for this purpose.

(Manju Yadav) IF/TECH/CON/HQ	(B.K.Das) AFF/CON/PL/MLG	(B.C.Das) FFF/CON/MLG	(Ravi Bhushan) DY.CFE/CON/HQ/MLG

(R.C.Aeliya)
CEE/CON/NHR

(c) Metal pipes leading rainwater from the roof to the ground may be connected to the down conductors, but cannot replace them, such connections should have disconnecting joints.

(d) In deciding on the routing of the down conductor, its accessibility for inspection, testing and maintenance should be taken into consideration.

(ii) **Provision when External Route is Not Available**

(a) Where the provision of external routes for down conductors is impracticable, for example, in buildings of cantilever construction from the first floor upwards, down conductors should not follow the outside contours of the building. To do so would create a hazard to persons standing under the over hang. In such cases, the down conductors may be housed in an air space provided by a non-metallic and non- combustible internal duct and taken straight down to the ground.

(b) Any suitable covered recess, not smaller than 76 mm x 13 mm, or any suitable vertical service duct running the full height of the building may be used for this purpose, provided it does not contain an unarmoured or a non-metal sheathed cable.

(c) In cases where an unrestricted duct is used, seals at each floor level may be required for fire protection. As far as possible, access to the interior of the duct should be available.

12.11 Installation

12.11.1 General

(i) The entire lightning protective system should be mechanically strong to withstand the mechanical forces produced in the event of a lightning strike.

(ii) Conductors shall be securely attached to the building, or other object to be protected by fasteners, which shall be substantial in construction, not subject to breakage, and shall be of galvanized steel or other suitable materials, with suitable precautions to avoid corrosion

(iii) The lightning conductors shall be secured not more than 1.2 m apart for horizontal run, and 1 m for vertical run

(Manju Yadava) JE/TECH/CON/HQ	(S.Das) ALL/CON/PL/MLG	(B.e'Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(D.K.Atoliya) CEE/CON/NER

1.11.2 **Air Terminations**

All air terminals shall be effectively secured against overturning either by attachment to the object to be protected, or by means of substantial bracings and fixings which shall be permanently and rigidly attached to the building. The method and nature of the fixings should be simple, solid and permanent, due attention being given to the climatic conditions and possible corrosion.

12.11.3 **Air terminal holder**

Conductors shall be securely fixed on the terrace by means of air terminal holder which is fixed on the roof by adhesive of good quality taking care of varying weather conditions. Air conductor holder is an insulator & should be of minimum 50 mm height so that even small amount of water logging on terrace is below the level of conductor holder. Air terminal holder shall not be more than 0.5 m apart for a flat conductor & 1m for round conductor of atleast 8mm diameter & 1.0 meter apart for vertical run.

Recommended distance between air terminal holders.

Arrangement	Recommended distance For ROUND
Horizontal conductor on horizontal surface.	1000 mm
Horizontal conductor on vertical surface	1000 mm
Vertical conductor from Ground to 20m height	1000 mm

If antenna, air cooler or any other electrical equipment is present above terrace level, the same have to be protected by using vertical air terminal after calculating the safety or separation distance. The vertical air terminal has to have suitable supports to hold it. Vertical air terminal must be connected to horizontal air terminal by using suitable connectors.

At the crossings of the horizontal air terminals, suitable T or Cross connector has to be used for secure connection.

12.11.4 **Safety or Separation distance.**

It is must to calculate safety or separation distance in order to avoid flash over to the electrical equipment when the lightning current is passing through the vertical air terminal

Safety/Separation distance (S) in m = (ki * kc*L) / km

Coefficient ki depends on class of LPL/LPS. ki = 0.08 for LPL1,
ki = 0.06 for LPL 2,

[Manju Priyadarshi] JE/TECH/CON/HQ	[B.K.Das] AEE/CON/PL/MLG	[R.C.Das] EEE/CON/MLG	[Ravi Bhushan] DY.CEE/CON/HQ/MLG

[B.K.Adolya]
CE/CON/NER

ki = 0.04 for LPL 3 and 4

Coefficient kc depends on no of down conductors: kc = 0.66 for 2 down conductors
kc = 0.44 for 3 or more down

conductors Value of coefficient

km = 1

Value of L is the total distance between the equipment to be protected (for e.g. Antenna) to the equi-potential bonding bar situated just above the ground.

12.11.5 Need for Expansion piece

In order to take care the expansion of the metal in summer and contraction of the metal in winter, expansion piece with suitable connectors have to be used at every 20m distance of horizontal air terminal.

12.11.6 Down Conductors

(i) The down conductor system must, where practicable, be directly routed from the air termination to the earth termination network, and as far as possible, be symmetrically placed around the outside walls of the structure starting from the corners. In all cases consideration to side flashing must always be given.

(ii) (a) Practical reasons may not sometimes allow the most direct route to be followed. While sharp bends, such as arise at the end of roof are inescapable (and hence permissible), re-entrant loops in a conducter can produce high inductive voltage drops so that the lightning discharge may jump across the open side of a loop. As a rough guide, this risk may arise when the length of the conductor forming the loop exceeds 8 times the width of the open side of the loop.
(b) When large re-entrant loops as defined above cannot be avoided, such as in the case of some cornices or parapets, the conductors should be arranged in such a way that the distance across the open side of a loop complies with the requirement indicated above. Alternatively, such cornices or parapets should be provided with holes through which the conductor can pass freely.

(iii) ***Bonding to Prevent Side Flashing***

Any metal in, or forming a part of the structure, or any building services having metallic parts which are in contact with the general mass of the earth, should be either isolated from, or bonded to the down conductor. This also applies to all exposed large metal items having any dimension greater than 2 m whether connected to the earth or not.

(Manju Yahgane) JE/TECH/CON/MG	(S.K.Das) AEE/CON/PL/MLG	(D.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.EEE/CON/HQ/MLG

(R.K. Ardley)
CEE/CON/NFR

Material configuration and Min cross sectional area of air terminal and down conductors

Material	Type	Min cross section area	Remarks
Copper	Solid tape	50 sq mm	2mm min thickness
Copper	Solid round	50 sq mm	8mm dia
Aluminum	Solid tape	70 sq mm	3 mm min thickness
Aluminium	Solid round	50 sq mm	8 mm dia
Stainless steel	Solid tape	50 sq mm	2 mm min thickness

Value of distance between down conductors as per Class of LPL / LPS.

Class of LPL/LPS	Typical distance (m)
1	10
2	10
3	15
4	20

12.11.7 Joints and Bonds

(a) Joints:

(i) A lightning protective system should have as few joints as possible. The lightning protective system shall have as few joints. As far as possible, air terminal & down conductor have to be straight. Where it is not possible, it should NOT be bent at 90 degree (right angles) & should have a curved path of 45 degree.

(ii) Joints should be mechanically and electrically effective, for example, clamped, screwed, bolted, crimped, riveted or welded.

(iii) With overlapping joints, the length of the overlap should not be less than 20 mm for all types of conductors.

(iv) Contact surfaces should first be cleaned, and then inhibited from oxidation with a suitable non-corrosive compound.

Joints of dissimilar metals should be protected against corrosion or erosion from the elements, or the environment and should present an adequate contact area

[Manju. Vaidya] IF/TECH/CON/HQ	[S.K.Das] AEE/CON/PLNG	[B.C.Das] EEE/CON/MIG	[Ravi Bhushan] DY.CFE/CON/HQ/MIG

[P.K.Mahapatra] CFE/CON/NHR 1/6

(b) Bonds:

(i) Bonds have to join a variety of metallic parts of different shapes and composition, and cannot

therefore be of a standard form

(ii) There is the constant problem of corrosion and careful attention must be given to the metals involved, i.e. the metal from which the bond is made, and those of the items being bonded.

(iii) The bond must be mechanically and electrically effective, and protected from corrosion in, and erosion by the operating environment.

(iv) External metal on, or forming part of a structure, may have to discharge the full lightning current, and its bond to the lightning protective system should have a cross-sectional area not less than that employed for the main conductors.

(v) Structures supporting overhead electric supply, telephone and other lines must nor be bonded to a lightning protective system without the permission of the appropriate authority.

Gas pipe in no case shall be bonded to the lightning protective earth termination system.

12.11.8 Test Joints

Each down conductor should be provided with a test joint in such a position that, while not inviting unauthorized interference, it is convenient for use when testing.

12.11.9 Earth Termination Network

(i) An earth station comprising one or more earth electrodes as required, should be connected to each down conductor. This shall be specified.

(ii) Each of the earth stations should have a resistance not exceeding the product given by 10 ohms multiplied by the number of earth electrodes to be provided therein. The whole of the lightning protective system, including any ring earth, should have a combined resistance to earth not exceeding 10 ohms without taking account of any bonding [as per 21.9.3(iii)].

(iii) If the value obtained for the whole of the lightning protection system exceeds 10 ohms, a reduction can be achieved by extending or adding to the electrodes, or by interconnecting the individual earth terminations of the down conductors by a conductor installed below ground, sometimes referred to as a ring conductor. Buried ring conductors laid in this manner are considered to be an integral part of the earth termination network, and should be taken into account when assessing the overall value of resistance to earth of the installation.

[Manjit Nagendra] JE/TECH/CON/HQ	[B.P.Das] AEE/CON/PL/MLG	[B.T.Das] SEE/CON/WLG	[Ravi Bhushan] DY.CEE/CON/HQ/MLG

[R.K.Atolya] CE/CON/NER 7/6

(iv) A reduction of the resistance to the earth to a value below 10 ohms has the advantage of further reducing the potential gradient around the earth electrode when discharging lightning current. It also further reduces the risk of side flashing to metal in, or of structure.

(v) Earth electrodes should be capable of being isolated and a reference earth point should be provided for testing purposes.

For earth termination system, 2 basic types of earth electrode arrangements are applicable:

Type A & Type B arrangement.

Earthing system should meet the requirements according to IS 3043, IEC 60364-5-54, IEC 62561-1 to 7, IEC62305 as well as UL 467. Earthing system should offer resistance less than 1 ohms throughout the year. For this purpose, earthing system vendor should do the soil testing and provide the necessary recommendation. In places where Soil resistivity is more, multiple earth electrodes are to be installed to get the required value. In case of multiple earth rods, vendor should provide possible resistance value of each earth pit. This value remains without any change for at least one year. Recommended value should be less than 10 ohms. In places where resistance of each pit is more than 10 ohms, special care needs to be taken. In such cases, Earth Enhancing compound need to be used for the vertical rods as well as horizontal conductors.

High-grade solid steel rods of SAE 1035 molecular bonded with 99.9% pure electrolytic copper with minimum coating thickness of 250 microns should be used as earth electrode. The rods must be UL listed as well as tested according to IEC62561-2 and comply to the requirements of IEC 60364-5-54. The rods also should withstand short circuit currents as per the chart below. All fasteners used should confirm to the requirements of the above standards. Earth enhancing compound (Soil conductivity improver) should be tested according to IEC62561 – 7 from an NABL accredited laboratory. Exothermic welding material used shall be tested as per IEEE 837

A hole of 100 to 125 mm dia. shall be augured / dug to a depth of about 2.8

meters. Earth electrode shall be placed into this hole.

It will be penetrated into the soil by gently driving on the top of the rod. Here natural soil is assumed to be available at the bottom of the electrode so that min 150 mm of the electrode shall be inserted in the natural soil.

(Manju Tongaonkar) JE/TECH/CON/HQ	(S.K.Das) AEE/CON/PL/MLG	(B.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Mohanty)
CEE/CON/NFR

Earth Enhancing material (min. approx. 30 to 35 KG) shall be filled in to the augured /dug ole in slurry form and allowed to set. After the material gets set, the diameter of the composite structure (earth electrode + Earth Enhancing material) shall be of minimum 100 mm dia. covering entire length of the hole.

Remaining portion of the hole is filled with backfill soil which is taken out during auguring / digging

All the joints to the earth electrode shall be exothermically welded
In places where short-circuit level is more than 10 KA, (eg all panel boards, body) a copper strip of 25 mm * 6 mm with a minimum length of 150 mm need to be exothermically welded to the solid rod. All further connections need to be done to this copper flat.

For interconnection of earth pits, SOLID copper conductors with a size of 25* 3 mm flat or 10 mm copper bonded round steel conductors are to be used for Lightning Protection/ General purpose. In places where short circuit currents of more than 10 KA are expected, copper flats of 25 *6mm or 50 * 6 mm need to be used depending upon the expected short circuit level. In places where short circuit current requirements are more than 10 KA, Exothermic / Aluminothermic welding are only allowed for jointing earth electrode with round / Flat conductor. Connections with nut and bolt need to be completely avoided in applications under ground level, instead exothermic / alumino.hermic welding need to be performed.

12.12 Lightening STRIKE recorder with six digit with min current sensitivity of 0.15 KAmps through to a maximum of 220 KA @ 8/20 Micro Second impulse and operates by means of an inductive pick up loop. With a polycorbonate IP67 protection. The complete system should have earth resistance less than less than 10 ohm.

(Manju Nigam) IE/TECH/CON/HQ	(B.K.Das) AEE/CON/NER/MLG	(B.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(B.K.Atoliya)
CEE/CON/NER

TABLE-1

Shapes and Minimum Sizes of Conductors for Use Above Ground

Sr No	Material and Shape	Minimum size
1	Round copper wire or copper clad steel wire	6 mm diameter
2	Stranded copper wire	50 sq. mm or (7/3.00 mm dia)
3	Copper strip	20 mm x 3 mm
4	Galvanized iron strip	20 mm x 3 mm
5	Round aluminium wire	8 mm diameter
6	Aluminium strip	25 mm x 3 mm

TABLE-2

Shapes and Minimum Sizes of Conductors for Use below Ground

Sr No	Material and Shape	Minimum size
1	Round copper wire or copper clad steel wire	8 mm diameter
2	Copper strip	32 mm x 6 mm
3	Galvanized iron strip	32 mm x 6 mm
4	Round Galvanized iron wire	10mm X 6 mm
5	Aluminium strip	25 mm x 3 mm

[Manjula Das] JE/TECH/CON/HQ	[B.B.Das] AEE/CON/PL/MLG	[E.C.Das] EEE/CON/MLG	(Ravi Bhushan) DY.CFE/CON/HQ/MLG

[R.K.Mallick] CEE/CON/NFR 1/6

NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

Technical Specification No. NFR/ELECT/CON/GS/13(MV FEEDER PILLAR , SWITCH BOARD & DISTRIBUTION BOARD)

MEDIUM VOLTAGE FEEDER PILLAR , SWITCH BOARD (OTHER THAN SUB-STATION WORK) AND DISTRIBUTION BOARD

13.0 Scope:

This specification covers the detailed requirements for medium voltage feeder pillar , switch board other than sub-station work and distribution board.

13.1 Relevant Standard Specifications and Regulations (latest amended):

(i) IS: 13942/Pt.1
(ii) IS: 5082/1998
(iii) IS: 1897/1983
(iv) IS: 13947/Pt-2/1993
(v) IS: 13947/Pt.III/1993
(vi) IS: 2705 (Part I,II,& III)
(vii) IS: 8623
(viii) IS: 13032
(ix) IS: 13947/Part I/1993
(x) IS. 8828
(xi) IS: 13947/Pt-3/1993 (Ics-100%Icu)
(xii) I.E.Rules 1956(latest amended)

13.2 Feeder Pillar

13.2.1 General

a) Medium voltage feeder pillar shall be cubicle type, floor mounted, free standing type, dust and vermin proof, totally enclosed, of uniform height and for outdoor utilization and suitable for 3-phase, 4 wire, 415 V, 500 Hz AC, solidly earthed neutral, electric supply system complete with 4 nos. pedestals, accessories, inter-connections, bus bar chamber with copper/aluminium bus bar (as specified in the relevant BOQ item), ON/OFF indication, CTs, switchgears (as specified in the relevant BOQ item), timer etc. in position duly wired up with copper conductor cable with colour coding, etc. and other accessories though not mentioned here but necessary to complete the equipment in all respects.

b) The manufacturer shall have ISO: 9001 certification with testing arrangement and powder coating facilities in the works.

13.2.2 Digital Time switch (Timer) of suitable rating and contactors (as specified in the relevant BOQ item) shall be provided in the feeder pillar to operate pump/street lights etc. and this shall be controlled with independent switchgear/s.

[Manju Yadav] JE/TECH/CON/MLG	[S.Das] AEE/CON/PI/MLG	[S.Das] DEE/CON/MLG	[Ravi Bhushan] Dy.CEE/CON/HQ/MLG

[P.K.Atoliya]
CEE/CON/MLG

13.2.3 Construction

13.2.3.1 The feeder Pillar shall be fabricated from 2.0 mm thick CRCA sheet steel. The shroud & partitions shall be of minimum 1.6 mm thickness and shall be fabricated from CRCA sheet steel. The feeder pillar shall be powder coated in approved shade by seven tank process. The degree of protection shall not be less than IP 65 as per IS: 13942/Pt.1. Feeder pillar shall have a canopy at top to prevent water ingress.

13.2.3.2 Pedestals and base frame shall be of MS angle of 75mm x 75mmx 8 mm (nominal size). The Feeder Pillar shall have the provision of flush doors on front and back in two equal parts with hinges and concealed lock openable with special key.

13.2.3.3 The following minimum clearances shall be maintained:

i)	Between Phases	-	32 mm
ii)	Between Phases & Neutral	-	26 mm
iii)	Between Phases & Earth	-	26 mm
iv)	Between Neutral & Earth	-	26 mm

13.2.3.4 All functional units shall be arranged in multi-tier formation & each such unit shall be fully compartmentalized. Vertical cable alley shall be provided. Each compartment shall have its own individual door with concealed hinges & the door shall have interlocking so that it can only be opened after switching off the module.

13.2.4 Bus Bars

13.2.4.1 The bus bars shall be made of high conductivity aluminium/copper (as specified in BOQ) conforming to the requirement of IS 5082/1998 for aluminium and IS: 1897/1983 for copper. The bus bars shall have uniform cross section (basis of bus bar cross section will be maximum of 1000 A/sq. inch for copper and 630A/sq. inch for aluminium). The cross-section of the neutral bus bar shall be same as that of the phase bus bar.

13.2.4.2 Bus bars shall be supported on suitable non-hygroscopic, non- combustible, material such as DMC/SMC.

13.2.4.3 Bus bars shall be insulated with PVC tapes/ tubes (heat shrink type) with colour ending (Red/Yellow/Blue/ Black) to withstand the test voltage of 2.5 kV for one minute.

13.2.5 Molded Case Circuit Breakers (MCCB)

13.2.5.1 MCCB shall be TPN of rating as specified in the relevant BOQitem and shall conform to IS- 13947/Pt-2/1993 (Ics = 100%Icu or as specified in relevant BOQ item) with thermal release setting 70/80%-100% or fixed type (as specified in the relevant BOQ item) with breaking capacity of not less than 25 kA for load currents up to 200 amp. & 35 kA for load currents above 200 amp rating. MCCBs shall be suitable for three phase, 415 Volt, AC supply.

(Manju Yadav) IF/TECH/CON/HQ	(D.K.Das) AEE/CON/PL/M.G	(D.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/VIG

(R.K.Arolia) CFE/CON/MFR

1/6

13.2.5.2 Tripping unit shall be of thermal – magnetic type provided in each pole and connected by a common trip bar such that tripping of any one pole operates all the poles and they open simultaneously.

13.2.6 Miniature Circuit Breakers (MCB)

13.2.6.1 Miniature Circuit Breakers for lighting circuits shall be of "B" series and for inductive loads shall be of "C" series. Circuits feeding discharge lamps (HPMV/MH/HPSV) halogen lamps, all power outlet points, equipment/machinery shall be of "C" series (Motor Circuit) type. All miniature circuit breakers shall be of 10 KA rated rupturing capacity unless otherwise specified. MCBs shall generally conform to IS: 8828. They shall be suitable for snap fixing on a standard DIN rail.

13.2.6.2 Three phase MCBs shall have common trip bar so that all the poles make and break simultaneously. Miniature circuit breakers shall be quick make & quick break type with trip free mechanism. They shall have thermal & magnetic short circuit protection.

13.2.7 Current Transformers

13.2.7.1 Current transformers shall be in conformity with IS: 2705 (Part I, II & III). Current transformers shall be rated for 1 kV. Current Transformer shall have rated primary current, rated burden and class of accuracy. The rated secondary current shall be 5 A. The acceptable minimum class of various applications shall be as given below:

Measuring : Class 1
Protection : Class 5 P10

13.2.7.2 The VA rating of the CTs shall be not less than 5 VA.

13.2.8 Cable Termination

13.2.8.1 Cable entries shall be provided with metal glands to prevent damage to the insulation of the cable and terminals shall be provided to suite the number, type and size of aluminium conductor power cables.

13.2.8.2 Provision shall be made for bottom entry of cables through removable gland plates.

13.2.9 Tests at Manufacturers' Works

13.2.9.1 All routine tests shall be carried out in the presence of the inspecting Engineer.

13.2.9.2 Original test certificates of all equipments/ instrument shall be submitted by the contractor along with the supply of panel board after the Inspecting Officer passes the feeder pillar.

(Manju Yadav) JE/TECH/CON/HQ	(B.Das) AEE/CON/PL/MUs	(S.C.Das) EEE/CON/W.G	(Ravi Bhushan) DY.CEE/CON/HQ/MUs

(R.K.Mollya)
CLE/CON/NHR

13.2.10 Testing and Commissioning at Site

Following tests shall be carried out prior to Commissioning:

a) Insulation test

b) Trip Tests & Protection Tests

13.2.11 Erection

Brick masonry platform of suitable size with 450 mm height (approximate) shall be constructed in the specified location and cement finish. Feeder pillar shall be erected on this platform by grouting of pedestals as approved by the Engineer.

13.2.12 Danger Notice:

Danger notice shall be affixed on front door at conspicuous position in Hindi, English & local language with a sign of skull & bone as per provision of I.E. Rules.

13.2.13 Earthing:

Each Feeder Pillar shall be earthed at two points from the distinct source of earth as per IE Rule.

13.3 SWITCH BOARD (OTHER THAN SUBSTATION)

13.3.1 General

a) Medium voltage switch board shall be cubicle type, floor mounted, free standing type, dust and vermin proof, totally enclosed, of uniform height and for indoor utilization and suitable for 3- phase, 4 wire, 415 V, 50 Hz Ac, solidly earthed neutral, electric supply system complete with accessories, inter connections, bus bar chamber with copper/ aluminium bus bar (as specified in the relevant BOQ item), ON/OFF indication, CTs, switchgears (as specified in the relevant BOQ item) timer etc. in position duly wired up with copper conductor cable with colour coding and other accessories though not mentioned here but necessary to complete the equipment in all respects.

b) The switch board manufacturer shall have ISO: 9001 certification with testing and powder coating facilities in the works.

13.3.2 Digital time switch (Timer) of suitable rating and contactors (as specified relevant BOQ item) shall be provided in the panel to operate pump/street lights etc. and shall be controlled with independent switchgear/s.

13.3.3 Construction

13.3.3.1 The panel shall be fabricated for 2.0 mm thick CRCA sheet steel. The shroud & partitions shall be minimum 1.6 mm thickness and shall be fabricated from CRCA sheet steel. The panel shall be powder coated in approved shade by seven-tank process. The degree of protection shall not be less than IP 42 as per IS: 13947/Pt.1.

The following minimum clearances shall be maintained:

i) Between Phases - 32 mm
ii) Between Phases & Neutral - 26 mm
iii) Between Phases & Earth - 26 mm
iv) Between Neutral & Earth - 26 mm

13.3.3.2 All functional units shall be arranged in multi-tier formation & each such unit shall be fully compartmentalized. Vertical cable alley shall be provided. Each compartment shall have its own individual door with concealed hinges & the door shall have interlocking so that it can only be opened after switching off the module.

13.3.4 Bus Bars

13.3.4.1 The bus bars shall be made of high conductivity aluminium/copper (as specified in BOQ) conforming to the requirement of IS 5082/1998 for aluminium and IS: 1897/1983 for copper. The bus bars shall have uniform cross section (basis of bus bar cross section will be maximum of 1000 A/sq. inch for copper and 630A/sq. inch for aluminium). The cross-section of the neutral bus bar shall be same as that of the phase bus bar

13.3.4.2 Bus bars shall be supported on suitable non-hygroscopic, non- combustible, material such as DMC/SMC.

13.3.4.3 Bus bars shall be insulated with PVC tapes/ tubes (heat shrink type)with colour coding (Red/Yellow/Blue/ Black) to withstand the test voltage of 2.5 kV for one minute.

13.3.5 Molded Case Circuit Breakers (MCCB)

13.3.5.1 MCCB shall be TPN of rating as specified in the relevant BOQitem and shall conform to IS- 13947/Pt-2/1993 (Ics = 100%Icuor as specified in the relevant BOQ item) with thermal release setting 70/80%-100% or fixed type as specified in the relevant BOQ item) with breaking capacity of not less than 25 kA for load currents up to 200 amp. & 35 kA for load currents above 200 amp rating. MCCBs shall be suitable for three phase, 415 Volt, AC supply.

13.3.5.2 Tripping unit shall be of thermal – magnetic type provided in each pole and connected by a common trip bar such that tripping of any one pole operates all the poles and they open simultaneously.

13.3.6 Miniature Circuit Breakers (MCB)

13.2.6.1 Miniature Circuit Breakers for lighting circuits shall be of "B" series and for inductive loads shall be of "C" series. Circuits feeding discharge lamps (HPMV/MH/HPSV) halogen lamps, all power outlet points, equipment/machinery shall be of "C" series (Motor Circuit) type. All miniature circuit breakers shall be of 10 KA rated rupturing capacity unless otherwise specified. MCBs shall generally conform to IS: 8828. They shall be suitable for snap fixing on a standard DIN rail.

13.2.6.2 Three phase MCBs shall have common trip bar so that all the poles make and break simultaneously. Miniature circuit breakers shall be quick make & quick break type with trip free mechanism. They shall have thermal & magnetic short circuit protection.

13.3.7 Current Transformers

13.3.7.1 Current transformers shall be in conformity with IS: 2705 (Part I, II & III). Current transformers shall be rated for 1 kV. Current Transformer shall have rated primary current, rated burden and class of accuracy. The rated secondary current shall be 5 A. The acceptable minimum class of various applications shall be as given below:

Measuring : Class 1
Protection : Class 5 P10.

13.3.7.2 The VA rating of the CTs shall be not less than 5 VA.

13.3.8 Cable Termination

13.3.8.1 Cable entries shall be provided with metal glands to prevent damage to the insulation of the cable and terminals shall be provided to suite the number, type and size of aluminium conductor power cables.

13.3.8.2 Provision shall be made from bottom for entry of cables through removable gland plates.

13.3.9 Tests at Manufacturers' Works

13.3.9.1 All routine tests shall be carried out in the presence of the inspecting Engineer.

13.3.9.2 Original test certificates of all equipments/ instrument shall be submitted by the contractor along with the supply of panel board after the Inspecting Officer passes the feeder pillar.

13.3.10 Testing and Commissioning at Site

Following tests shall be carried out prior to Commissioning:

a) Insulation test
b) Trip Tests & Protection Tests

13.3.11 Danger Notice:

Danger notice shall be affixed on front door at conspicuous position in Hindi, English & local language with a sign of skull & bone as per provision of I.E. Rules.

(Manju Yamgar) JE/TECH/CON/HQ	(B.K.Das) AEE/CON/PL/MLC	(B.C.Das) EE/CON/MLG	(Pavi Bhushan) DY.CFE/CON/HQ/MLG

(R.K.Atolia)
CFE/CON/NFR

13.3.12 Erection:

As per clause no. 13.2.11 or otherwise as suitable depending on site conditions. While erection, as per IE Rules , a clear space of not less than 1m shall be provided in the front. Space behind the switchboard shall be either less than 20cm or more than 75cm. If the space behind exceeds 75cm, there shall be a passageway from either end of the switchboard clear to a height of 1.8m.

13.3.13 Earthing:

Each switchboard shall be earthed at two points from the distinct source of earth as per IE Rules.

13.4 DISTRIBUTION BOARD

13.4.0 GENERAL

a) Distribution boards for power and light circuit distribution shall be pre-wired, factory built, duly powder coated and complete with copper bus bars, MCB/MCCB/RCBO/RCCB etc. (as specified in the relevant BOQ item) and shall be suitable for 415 V, 3 – phase or 230 V, single-phase supply (as per BOQ item). The distribution boards shall conform to IS: 8623 and IS: 13032 as applicable

b) However, if none of the types readily available from the approved makes meets the requirements, alternative makes may be offered with technical literature and test certificates, for approval of the Engineer.

c) Separate distribution board shall be provided for light and power circuits in quarters of category Type- IV and above & in service buildings, as approved by the Engineer.

13.4.1 Type

a) The Distribution Board shall be single/double door type (as specified in the relevant BOQ item) suitable for flush installation. The boards shall be of cabinet design, totally enclosed and shall have a degree of protection not less than IP54 as per IS: 13947/Part1/1993.

b) Each DB shall have multiple LED type indicating lamps complete with fuses on the in-comer and all outgoing feeders denoting power availability in the board after the switch.

c) Circuit diagram indicating the load distribution shall be pasted on the inside of the DB as instructed. Each circuit shall be clearly numbered from left to right to correspond with wiring diagrams.

d) All the terminals shall have adequate current rating and size to suit individual feeder requirement.

e) All the circuits shall have an independent neutral wire, one per circuit, and shall be numbered and marked.

(Mrinmoy Yadav) IE/TECH/CON/HQ	(Bijit Das) AEE/CON/PL/MLG	(B.C.Das) EFE/CON/MLG	(Ravi Bhushan) DY.CFE/CON/HQ/VLG

(B.K.Mallick) CEE/CON/NFR

13.4.2 Miniature Circuit Breakers (MCB)

13.4.2.1 Miniature Circuit Breakers for lighting circuits shall be of "B" series and for inductive loads shall be of "C" series. Circuits feeding discharge lamps (HPMV/MH/HPSV) halogen lamps, all power outlet points, equipment/machinery shall be of "C" series (Motor Circuit) type. All miniature circuit breakers shall be of 10 KA rated rupturing capacity unless otherwise specified. MCBs shall generally conform to IS: 8828. They shall be suitable for snap fixing on a standard DIN rail.

13.4.2.2 Three phase MCBs shall have common trip bar so that all the poles make and break simultaneously. Miniature circuit breakers shall be quick make & quick break type with trip free mechanism. They shall have thermal & magnetic short circuit protection.

13.4.3 Residual Current Circuit Breakers (RCCB), Residual Current Circuit Breaker with Overload, short circuit & earth leakage Protection (RCBO)

13.4.3.1 RCCB/RCBO shall be used in distribution boards as per BOQ item. The RCCB/ RCBO shall be rated for 30/100/300 mA fault circuit tripping as specified in the relevant BOQ item or as per site requirement. RCCB and RCBO shall conform to relevant IS.

13.4.4 Molded Case Circuit Breakers (MCCB)

MCCB shall be TPN and of rating as specified in the relevant BOQ item. It shall conform to IS: 13947/Pt-3/1993(Ics-100% Icu) with thermal release (fixed type) and breaking capacity of not less than 25 KA. MCCBs shall be suitable for 3-phase, 415 V, AC supply.

13.4.4.1 Tripping unit shall be of thermal-magnetic type provided in each pole and connected by a common trip bar such that tripping of any one pole results in simultaneous operation of all the poles.

13.4.5 Danger Notice:

Danger notice shall be affixed on front door at conspicuous position in Hindi, English & local language with a sign of skull & bone as per provision of I.E. Rules.

13.4.6 Erection:

As per clause no. 13.2.11 or otherwise as suitable depending on site conditions. While erection, as per IE Rules, a clear space of not less than 1m shall be provided in the front. Space behind the Distribution Board shall be either less than 20cm or more than 75cm. It may be recessed as per site requirements.

13.4.7 Earthing:

Each Distribution Board shall be earthed at two points from the distinct source of earth as per IE Rules.

(Manju Yadav) JE/TECH/CON/HQ	(B.B.Das) AEE/CON/PL/MLG	(B.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CFE/CON/HQ/MLG

(R.K.Arora)
CFE/CON/NFR

NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

Technical Specification No. NFR/ ELECT/CON/GS/14(APFC)

AUTO POWER FACTOR CORRECTION (APFC) PANEL

14.0 GENRAL:

14.1 Principle function of APFC

i) To continuously sense and monitor the load conditions.
ii) To automatically switch ON and switch OFF relevant capacitors steps to ensure consistent power factor near unity.
iii) To ensure easy user interface for enabling reliable understanding of system operation, such as display of real time power factor, number of switching operation carried out etc.
iv) To protect against any electrical faults in a manner that will ensure safe isolation of the power factor correction equipment.

14.2 The APFC panel shall be totally enclosed, made of mild steel sheet 14 SWG, free standing, floor mounting, indoor type, with degree of protection not less than IP42. The panel shall be compartmentalized, fixed type, manufactured as per IS 8623 Pt. I & II/1993 & powder coated with specified colour. The panel shall be suitable for operation on 3-phase, 4-wire, 415V, 50 Hz, AC supply system, with automatic or manual switching arrangement for multi-step power factor correction, to achieve power factor near unity. The capacitor bank shall be complete with inter-connections. A continuous GI earth bus bar shall run at the bottom.

14.3 It shall comprise of the following items:

i) Capacitors
ii) Busbars
iii) Switchgears
iv) Microprocessor based intelligent power factor control relay
v) Cables and cable gland
vi) Current Transformers
vii) Contractors
viii) Suitable size of cooling fans

Note: (However, any other item, not specifically listed above, but required for meeting the site requirement, shall also be deemed to be included.)

14.4 Capacitors shall be low loss, self-healing MPP type as per IS 13340

14.5 Capacitors shall have suitable discharge device to reduce the residual voltage.

14.6 Microprocessor based Automatic Power Factor Control Relay shall switch ON & OFF the relevant capacitor units to ensure consistent power factor near unity.

14.7 The control panel shall display electric parameters like power factor, current, voltage etc.

(Vani Gopinath) JE/ELCTT/CON/MLG	(S.Das) AEE/CON/FL/MLG	(B.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/ TQ/MLG

(R.K.Mallick)
CEE/CON/NFR

14.8 The control panel shall provide:

i) No voltage cut off
ii) Over voltage protection
iii) Remote status and alarm
iv) Digital display of maintained power factor
v) Manual switching facility
vi) Auto manual selectivity
vii) LED status indications for each capacitor and power ON & OFF.
viii) Automatic correction of PF should be done to achieve minimum 0.95 PF at different loads.

14.9 Inter connection of capacitor duty contactors to bus bars with suitable size PVC copper conductor cable of 1.1 kV grade, with suitable lugs. Lugs, wherever required, for control wiring of relays, meters, equipments and indicating light etc. Inter connection from MCCB with suitable size copper bus bars, as required.

14.10 LT XLPE armoured cable conforming to IS7098/Pt.1/1988 for connection of control panel to main bus bar of LT switchboard. The cable shall be connected with suitable size of lugs and glands.

14.11 Suitable metering, indication and other accessories, as per site requirement.

14.12 Selection Chart for Capacitor is given below in Table I

Table I

Capacitor Selection Chart

Present Power Factor	Required Power Factor				
	0.85	0.90	0.95	0.98	Unity
	Multiplying Factor				
0.50	1.112	1.248	1.403	1.529	1.732
0.55	0.899	1.035	1.190	1.316	1.519
0.60	0.714	0.849	1.005	1.131	1.334
0.65	0.549	0.685	0.840	0.966	1.169
0.70	0.400	0.536	0.691	0.811	1.020
0.75	0.262	0.398	0.553	0.673	0.882
0.80	0.130	0.266	0.421	0.541	0.750
0.85	-	0.136	0.291	0.417	0.620
0.90	-	-	0.155	0.281	0.484
0.95	-	-	-	0.126	0.329

Required KVAR = KW x Multiplying factor.

(Manju Yonzone) JE/TECH/CON/HQ	(B. Das) FEE/CON/PL/MLG	(R.Chetia) FEE/CON/MLG	(Ravi Dhushan) DY.CEE/CON/HQ/MLG

(R.K.Pradhan) CE/CON/NER

NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

Technical Specification No. NFR/ELECT/CON/GS/20/HIGH VOLTAGE PANEL

HIGH VOLTAGE PANEL

20.0 SCOPE

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

20.1 Relevant Standard Specifications and Regulations (latest amended):

i)	IS: 13118-1991	Specification for High- Voltage Alternating- Current Circuit- Breakers.
ii)	IS: 3427-1997	A.C. Metal Enclosed Switchgear and Controlgear for Rated Voltages Above 1kV and Upto and Including 52kV
iii)	IS: 2705-1992	Current Transformer
iv)	IS: 3156	Voltage Transformer
v)	IS: 375	Marking and arrangement for switchgears bus-bars, main connections and auxiliary wiring.
vi)	IS: 1248	Direct Acting Indicating Analogue Electrical Measuring Instruments and Their Accessories.
vii)	IS: 722	Specifications for ac Electricity Meters.

viii) IEC 62271-100
ix) IEC 62271-200
x) I.E. Rules 1956 (latest amended)

20.2 VACUUM CIRCUIT BREAKER

20.2.1 H.V. PANEL

20.2.2 The Panel board shall be of indoor type, having the incoming sectionalisation and outgoing switch gears as per IS 13118 : 1991 of VCB, IEC 62271-100 for Breakers and -200 for Panels/ IS 3427 of switch board. The degree of enclosure protection shall be IP-4X.

(Manju Vedi) JE/TECH/CON/HQ	(B.P.Das) AEE/CON/PL/MLG	(S.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Aroliya)
CEE/CON/NFR

20.2.3 **Rating**

All panels assembled to form a board shall be suitable for the nominal operation voltage and rupturing capacity as specified. They should be rated as specified with a minimum of 630 Amps. and suitable for operation on 11 KV, 3 phase 50 Hz system. Type test certificate for the breaking capacity of the panel shall be supplied. A circuit breaker for a given duty in service is best selected by considering the individual rated values required by load conditions and fault condition.

20.2.4 **Type**

The HV Panel Board shall be metal clad, indoor, floor mounting, free standing type. It shall be totally enclosed dust, damp and vermin proof.

20.3.5 **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 any one 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, presenting a neat and pleasing appearance. 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.

20.2.6 **General Design Aspects**

The HV panel board shall be designed such that the switchgear, instruments, relays, bus bars, small wiring etc. are arranged and mounted with due consideration for the following:-

i) Facility for inspection, maintenance and repairs of testing terminals and terminal boards for ease of external connection.

ii) Minimum noise and vibrations.

- Risk of accidental short circuits and open circuits.
- Secured and vibration proof connections for power and control circuits.

iii) Risk of accidental contact and danger to personnel due to live connections.

iv) Mountings at approachable height.

(Manju Pahuja) TE/TECH/CON/HQ	(D.K.Das) ACE/CON/PL/WLG	(R.C.Das) EEE/CON/MLG	22/5/16 (Ravi Bhushan) DY.CEE/CON/HQ/MLG

(B.K.Mallya)
CEE/CON/NFR

20.3 CIRCUIT BREAKER

20.3.1 General Arrangements

The circuit breaker panels shall be complete with the following:

a) Racking in / Racking out mechanism.

b) Isolating plugs and sockets.

c) Mechanical inter-locks and safety shutters.

d) Mechanical ON/OFF indicator.

e) Minimum of 4 NO and 4 NC Auxiliary contacts directly operated by the circuit breaker. Additional NO & NC contacts can be provided with auxiliary contractors.

f) Anti condensation space heaters suitable for operation on 240V, 1o 50 Hz A.C. for each panel wherever specified.

g) Suitable tripping arrangement.

h) Mechanical counter to assess the total number of operations of the breaker (if asked for specifically).

20.3.2 Type

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

20.3.3 Breaker Truck

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 wheels, moving on guides, designed to align correctly and allow easy movement of the circuit breaker and for removing the carriage for inspection and maintenance purposes. Vacuum interrupters shall be hermetically sealed and shall be designed for minimum contact erosion, fast recovery of dielectric strength, maintenance free vacuum interrupter, suitable for auto-reclosing. The drive mechanism shall preferably be provided with facility for pad locking at any position namely, "Service", 'Test" and "Fully Isolated". It should be possible for testing the circuit breaker for its operation without energizing the power circuit in the "Testing" position. The contacts shall be made only after the breaker is inserted into service position. Interlocking should prevent contacts from being disconnected if circuit breaker is tried to be moved from service position.

20.3.4 General Features

Single break contacts are provided in sealed vacuum interrupter.

20.3.5 Rating

The circuit breakers shall be continuously rated as specified with a minimum rated current of 630 Amps. with voltage rating and breaking capacity as specified.

20.3.6 Operating Mechanism

The operating mechanism shall be one of the following as specified:-

Manually operated spring charged / motor wound spring charged with both mechanical and electrical release for closing. The operating mechanism shall be trip free.

20.3.7 External auxiliary supply shall be made available for charging motors & heaters operation.

20.4 BUS BAR SECTION

20.4.1 General Requirement

The switch board shall be single bus bar pattern with air insulated encapsulated bus bars housed in a separate compartment, segregated from other compartments.

20.4.2 Material

The bus bars shall be of high conductivity electrolytic copper rated as specified with a minimum rated current of 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.

20.5 CURRENT TRANSFORMER

20.5.1 General Requirements

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

20.5.2 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 one of the following as specified;

(a) 400/200/5/5 (b) 300/150/5/5

(c) 200/100/5/5 (d) 100/50/5/5

such other as required

Note: CT ratio shall be compatible with the loading pattern on HV side.

(Manju Yadava) IF/TECH/CON/HQ	(B.B.Das) AFF/CON/PI/MIG	(S.C.Das) CEE/CON/MIG	[Ravi Bhushan] DY.CEE/CON/HQ/MIG

[R.K.Aduliya] CEE/CON/NFR

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 of 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 of accuracy class 5 P 10 of IS 2705- Part III-1992.

The metering CTs shall conform to the metering ratio and accuracy class 0.5 of IS 2705-1992 for incomer and class 1 for outgoing panels.

20.6 VOLTAGE TRANSFORMER

20.6.1 General Requirements

A voltage 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 VT shall be class 0.5 as per IS 3156 Parts I to III for incomer and class 1 for outgoing panels.

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

20.7 PROTECTION AND TRIPPING ARRANGEMENT

20.7.1 Protection

The Relays shall be microprocessor based numerical relays with O/L, E/F and S/C protection Tripping relay shall be used for tripping signal to the Shunt Trip Coil of Circuit Breaker operating on 24 V/ 30 V D C supply / Power pack / 110 V VT supply.

Note: - 24V/ 30V DC shall be provided through 2 No. SMF batteries of 12/ 15 volts of minimum 26 AH capacity with a battery charger as per recommendation of the manufacturer both for protection as well as indications.
Alternatively Power Pack converters fed through PT/ 230V externally could be provided with 2 Nos., 12/ 15 volt, 7 AH SMF batteries (Power pack with condenser/ capacitor backup are also available which do not need batteries, these should not be used) for tripping. In cases where tripping is fed through PT, VA burden of PT shall be suitably increased (say 200 VA) as recommended by the manufacturer depending upon the number of panels and connected controls. In addition external 24 volt / 30 volt DC supply shall be provided for indications etc. through 2 No. SMF batteries of 12/ 15 volts of minimum 26 AH capacity with a battery charger as per recommendation of the manufacturer.

(Manju Yoncopar) JC/TECH/CON/HQ	(B.R.Das) AEE/CON/PL/MLG	(B.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Atoliya) CEE/CON/NTR

20.7.2 **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.

20.8 **SMALL 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, Grey 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 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 RTD relay wiring, power supply etc.

20.9 **METERING INSTRUMENT, PANEL ACCESSORIES (DIGITAL)**

20.9.1 **Metering**

Energy metering shall be done either on the incomers or on the feeders as specified in BOQ.

20.9.2 **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. This will be necessary when energy metering is done on individual feeders or where VT supply is used for trip circuits. Alternatively PT's shall be provided on both the bus sections (incomers) with individual metering on each incomer.

20.9.3 **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.

20.9.4 **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

(Manju Yonzone) JE/TECH/CON/HQ	(B.R.Das) AEE/CON/PL/MLG	(B.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Agrawal) CEE/CON/NFR

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) The panel assembly shall also take care of the following requirements:

i) Lamp indication shall be provided to indicate ON/ OFF (by red green respectively) of switch gear.

ii) Panel illuminating lamp.

iii) Mechanical indication for spring charged status. If possible an indicating lamp could be provided.

iv) Lamp indicating 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, 1 phase, 50 Hz A.C. for each panel if specified.

viii) Where there is more than one incomer and bus sections, these shall be castle key interlocked as per interlocking scheme as specified.

20.10 CABLE BOXES

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

20.11 CABLE ENTRY

Provision for top (bus ducts preferred for top entry) / 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.

20.12 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 Earthing specifications.

(Manju Yonzone) JE/TECH/CO/VIIQ	(B.R.Das) AEE/CON/PL/MLG	(B.C.Das) EEL/CON/MLG	(Hari Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Mahanta) CEL/CON/NER

20.13 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.

20.14 TESTING AND COMMISSIONING

Procedure for testing and commissioning of relay shall be in general accordance with good practice.

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 and lubrication of all moving parts.

b) Interlock function checks

c) Continuity checks of wiring, fuses etc as required.

d) Insulation tests.

e) Trip test and protection gear tests.

f) The complete panel shall be tested with 5000 V megger for insulation between poles and poles to earth. Insulation test of secondary of CTs and VT to earth shall be conducted using 500 V megger.

g) Any other tests as may be required by the Licensee / Inspector shall be conducted.

h) Where specified, the entire switch board shall withstand high voltage test after installation.

i) Any other test required by the consignee/ inspecting officer.

(Manju Yenzone) JE/TECH/CON/HQ	(D.R.Das) AEE/CON/PL/MLG	(B.C.Das) EEE/CON/MLG	(Ram Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Atoliya)
CEE/CON/NFR

NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

Technical Specification No. NFR/ELECT/CON/GS/21/TRANSFORMERS

TRANSFORMERS

21.0 **SCOPE**

This section covers the detailed requirements regarding supply, installation, testing, commissioning and handing over of transformers required for the sub-station.

i) Oil cooled transformers. These transformers shall be used for all types of capacity of transformer.

ii) Cast resin dry type transformer. These transformer shall be used for all types of capacity of transformer.

21.1 **Relevant Standard Specifications and Regulations (latest amended):**

i) IS 2026 - Part I to V - power transformers.

ii) IS 335 - Transformer oil.

ii) IS 10028 (Part II & III) - Installation and Maintenance of Transformers.

iv) IS 2099 - Bushings.

v) IS 2705 - Current Transformers.

vi) IS 6600 - Guide for loading of oil immersed transformers.

vii) IS 11171 : 1985 - Dry type power transformers.

viii) I.E. Rules 1956 (latest amended)

21.2 **GENERAL**

i) The transformer shall conform to relevant IS

ii) The transformer can be oil filled or dry type depending on requirements. In indoor installations, installation under stilts, rooftops and underground installations the transformer shall be only dry type.

iii) Energy efficient transformers made of high grade cold rolled grain oriented (CRGO) steel or amorphous material shall be used. Scrap CRGO material shall not be used for manufacturing of transformers

iv) The maximum losses of oil filled distribution transformers shall not exceed as that for at least three star rated transformers specified by Bureau of Energy Efficiency (BEE), wherever applicable.

v) The maximum losses for dry transformers shall not be more than the values specified in latest Energy Conservation Building Code (ECBC) of BEE.

(Manju Vashisht) JE/TECH/CON/HQ	(B.K.Das) AEE/CON/PI/MLG	(D.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CFE/CON/HQ/MLG

(R.K.Atoliya)
CEE/CON/NFR/MLG

vi) The transformer may be single phase or three phase. The cooling shall be ONAN for oil filled transformers.

vii) The 33/0.433kV distribution transformers shall normally have standard rating of 100, 160, 200, 315, 400, 500, 630, 1000, 1250, 1600, 2000, or 2500 kVA depending on requirement. Lower ratings can also be used for rural and lightly populated urban areas.

viii) The 11/0.433kV distribution transformers shall normally have standard rating of 6.3, 7.5, 10, 16, 25, 63, 100, 160, 200, 315, 400, 500, 630, 1000, 1250, 1600, 2000, or 2500 kVA depending on requirement. Lower ratings can also be used for rural and lightly populated urban areas.

ix) Rods, nuts, washers etc. of all HV and LV bushing must be of brass only.

x) All bushings shall conform to IS 2099/1973 or its latest version.

xi) **Design parameter of Distribution sub-station:**

Parameter	33kV	11kV	0.415V
Nominal system voltage (kV)	33	11	0.415
Highest system voltage (kV)	36	12	0.450
System earthing	Solidly earthed sytem	Solidly earthed sytem	Solidly earthed sytem
Frequency (Hz)	50	50	50
Lightning impulse withstand voltage (kVpeak)	170	75	-
Power frequency withstand voltage (dry) (kVrms)	70	28	3

21.3 OIL COOLED TRASFORMERS

The transformer shall be suitable for operation in tropical climate and for mixed load and for continuous operation. It shall be natural cooled, outdoor/indoor type (as specified in the relevant BOQ item) and star rated. The PF at full load shall not be less than 0.8 lagging. Distribution transformers shall conform to IS: 2026 (Pt. 1 to Pt. IV)/1997 for more than 100 KVA rating and IS:1180 upto 100 KVA rating. The efficiency of the transformer shall not be less than 98% at full load. It shall be supplied with first filling of inhibited mineral oil conforming to IS: 12463-1988 capable of withstanding 50 kV (rms) voltage as per IS: 6792/1972.

21.3.1 TRASFORMER CORE

The transformer core shall be built up of cold rolled grain oriented plain strip laminations fully processed and stress relieved and annealed having low loss and good ageing characteristics. The laminations may be bolted together and the whole core fixed through bolts to the steel frame adequate dimensions or also the construction may be tie rod type but in either case, the design should be such that it prevents undue vibrations and noise in service. Wooden frame for core fixing is not acceptable and contractor offer shall be specific about this.

The transformer shall be suitable for over fluxing due to the combined effect of voltage and frequency upto 12.5% on any tap without injurious heating. The maximum working flux density at point shall not exceed 19000 lines per square centimeter on the basis M4 and M6 grade.

(Manju Nirjara) IE/TECH/CON/HQ	(B.Das) AEE/CON/PL/MLG	(R.C.Das) EFE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(B.K.Agrawal) CEE/CON/HQ

21.3.2 **WINDINGS**

The winding shall be with double copper wound delta connected on primary, star with neutral brought out for earthing purpose on secondary. The copper wires conforming to IS 7404 (Part 1 and 2)/1974 or the latest version for paper covered conductors shall be used for HV and LV coils. The insulation of the conductors of the HV as well as LV coil shall be double paper coverage (DPC).The vector group unless other wise stated in the appendix 'A', shall be DY 11.

Class of insulation for winding shall be 'A' class.

The LV wiring shall be circular and concentric with HV winding on the outside. Vertical duct shall be provided for both HV and LV windings. The arrangements of the windings must be such that there is no electrical and magnetic balance under conditions of operation. The design shall permit free circulation of oil to ensure absence of hot posts. All similar coils shall be inter- changeable. It is essential that the windings are subjected to a thorough shrinking and seasoning process during manufacture so that no further shrinkage of windings occur during early years of service. Adjustable screws shall be provided for taking up possible shrinkage of windings after a number of years of service. The general design and construction of transformer and bracings of the windings shall be such that no mechanical movements of the coils will be possible a dead shot on either sides of the transformer.

The short circuit ratings of the transformer shall be as per relevant clause of IS 2026/1977 or latest.

The clearance between windings/live parts and nearest earthed parts shall be adequate for sustained voltage of 110% of the rated operating voltage. The clearance between LT bushing internal terminal windings and cord shall be adequate so as to facilitate interposing of protective element if required.

21.3.3 **TERMINAL ARRANGEMENTS**

a) For out door type transformers: Bushing terminals shall be on HV side and cable end box on LV side.

b) For in door type transformers following arrangement shall be provided.
HV side: A trifurcating box for three core XLPE Cable suitable size and voltage. LV side: A Cable box of suitable size and voltage to take a four core LT Cable.

21.3.4 **Insulation Oil**

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

21.3.5 **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.

(Manju Yonzone) JE/TECH/CON/HQ	(B.K.Das) AEE/CON/P./MLG	(D.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Agarwal)
CEE/CON/NFR

21.3.6 Capacity and Rating

The KVA ratings for three phase transformers shall be as per the site requirements.

21.3.7 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.

21.3.8 Tap Changing Device

i) 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% -10% (if required)

ii) For transformer of capacity upto 100KVA tap changing shall be + 2.5% & - 5%

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

21.3.9 Voltage Ratio

Unless otherwise specified, the transformer shall be suitable for a voltage ratio of 11 KV/433 V.

21.3.10 VECTOR GROUP

In case of step down transformers, the winding connections shall conform to vector group dy. 11 unless otherwise specified.

In case of step up transformer the vector group unless otherwise specified shall be star/ delta.

21.3.11 Cooling

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

21.3.12 Accessories

The transformer shall be a single tank type with termination on bushings or cable end box as specified both on HV and MV side. The MV side shall be suitable to receive bus bar trunking or MV cable inter-connection suitable for full load current of the transformer.

(Manju Yoa/Gnie) JE/TECH/CON/MG	(D.N.Das) AEE/CON/P.J/MLG	(B.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Arotiya)
CEE/CON/NER

21.3.13 FITTINGS

The transformer shall be complete with the following fittings: -

a) Oil conservator with oil level indicator, minimum level marking and drain plug for all transformers of capacity 50 KVA and above.

b) Off circuit type tap changer with position indicator and locking arrangement for all transformers.

c) Thermometer pocket with plug for all transformers of capacity 100 KVA and above.

d) 100 mm dial type /stem type thermometer with metal guard Dial type thermometer may have max. temperature indicator and resetting device for all transformers of capacity 250 KVA and above.

e) Lifting lugs for all transformers.

f) Bi-directional /Unidirectional Rollers to be specified.

g) Rating diagram and terminal marking plate for all transformers.

h) Explosion vent for all transformers of capacity 400 KVA and above.

i) Additional Neutral separately brought out on a bushing for earthing for all transformers.

j) Earth terminals (2 Nos.) for body earthing for all transformers.

k) Valves for filtration, drainage and filling etc. with necessary plugs for all transformers.

l) Radiator assembly for all transformers.

m) Silica gel breather for all transformers.

n) Air release plug for all transformers.

o) First filling of oil to IS 335:1993 including make-up fill during installation for all transformers.

p) Facility to connect up Buchholtz relay for all transformers of capacity 800 KVA and above.

q) Inspection covers on tank cover for access to terminal connections for all transformers.

r) Bushing terminations or cable box terminations as specified.

s) Necessary hardware, clamps, lugs etc. for termination on HV/MV etc. for all transformers.

21.3.14 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

(Manju Manzoor) JE/TECH/CON/IIC	(B.K.Das) AEE/CON/PL/MLG	(D.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CFE/CON/HQ/MLG

(R.K.Aroliya) CFE/CON/NFR

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.

21.3.15 **Accommodation for Auxiliary Apparatus**

Where specified, such as, for restricted earth fault protection, facilities shall be provided for the mounting of a neutral current transformer.

21.3.16 **RATING AND DIAGRAM PLATES**

The following plates shall be fixed to Transformer in a 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.

21.3.17 **Joints and 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 such other good material.

21.3.18 **GAS AND OIL ACTUATED (BUCHHOLTZ) RELAYS**

Buchholtz Relay shall be provided for transformers of capacity 800 KVA 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 scaled together to prevent seepage of oil entering connection boxes used for cables or wiring.

21.3.19 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.

(Manju Agrawal) JE/TECH/CON/HQ	(Jai Das) AEE/CON/PL/MLG	(S.C.Das) EE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Atoliya)
CEE/CON/NFR

21.3.20 Parallel Operation

For parallel operation of transformers, the transformers shall have the same percentage impedance, same voltage ratio, same vector group, phase sequence etc.

21.3.21 Tests

21.3.21.1 Tests 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 consultation with the Inspector at the firm's cost.

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

21.3.21.2 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 energization. The following tests are to be particularly done before cable jointing or connecting up the bus bar trunking:

a) Insulation test between HV to earth and HV to MV with 5000 volts Megger.

b) Insulation test between MV to earth with 500 volts 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.

21.3.22 Installation and Commissioning

21.3.22.1 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.

(Manjari Pilgaonkar) JE/TECH/CON/HQ	AEE/CON/PL/MLG	(B.C.Das) EE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Arolkar)
CEE/CON/NER

21.3.22.2 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 upto the correct level required.

21.3.22.3 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 on earthing of these specifications.

21.3.22.4 Drying out of transformer winding will be necessary when the di-electric strength of the oil is lower than the minimum value as per IS10028 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.

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

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

21.3.22.7 All tests specified in 21.3.21 of these specifications shall be carried out by the contractor in the presence of inspecting officer/consignee free of cost.

21.3.22 **Maximum Allowable Power Transformer Losses**

Power transformers of the proper ratings and design must be selected to satisfy the minimum acceptable efficiency at 50% and full load rating. In addition, the transformer must be selected such that it minimizes the total of its initial cost in addition to the present value of the cost of its total lost energy while serving its estimated loads during its respective life span.

(Vanju Gohain) JE/TECH/CON/HQ	(B.B.Das) AEE/CON/FI/MLG	(B.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Ahuja)
CEE/CON/NFR

Total losses for oil filled transformers should conform as per the following table:

Maximum allowable losses for oil filled distribution transformer with highest voltage for equipment 36 kV, at 50% and 100% of the load

Transformer Capacity (kVA)	*Maximum Allowable losses at 50% kVA or load*	*Maximum Allowable losses at full load/Rated kVA*
100	1.04%	1.80%
160	0.96%	1.38%
200	0.93%	1.35%
250	0.89%	1.27%
400	0.79%	1.12%
500	0.75%	1.05%
630	0.70%	0.99%
1000	0.70%	0.98%
1600	0.65%	0.98%
2000	0.64%	0.98%

21.4 CAST RESIN DRY TYPE DISTRIBUTION TRANSFORMERS

21.4.1 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 under go the seven tank process. Finally the external and internal surfaces of the enclosure shall be powder coated with the required paint shade.

(Manju Yadava) JE/TECH/CON/HQ	(D.P.Das) AEE/CON/PL/MLG	(S.C.Das) EEE/CON/MLG	(Ravi Sinalkar) DY.CEE/CON/HQ/MLC

(R.K.Arolia)
CEE/CON/NTR

21.4.2 **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.

21.4.3 **Capacity and Rating**

The KVA ratings for three phase transformers shall be as per the site requirements.

21.4.4 Indoor transformers shall be suitable for IP-23 protection; outdoor transformers shall confirm to IP-33 protection.

21.4.5 (A) Tap Changing Device

Preferred tapping range is +5% to -10% 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.

(B) Terminal Markings Connections

Relevant provisions of IS 2026 (Part-IV): 1977 shall be applicable.

21.4.6 **Voltage Ratio**

Unless otherwise specified, the transformer shall be suitable for a voltage ratio of 11 KV/ 433 V

21.4.7 **Vector Group**

In case of step down transformers, the winding connections shall conform to vector group Dy 11 unless otherwise specified.

In case of step up transformer the vector group unless otherwise specifi ed shall be star / delta.

21.4.8 **Cooling**

Unless otherwise specified the transformer cooling shall be air and naturally cooled (AN).

21.4.9 Accessories

The transformer shall be with enclosure or without enclosure with HV and MV terminations as specified both on HV and MV side. The MV side shall be suitable to receive bus bar trunking or MV cable inter-connection suitable for full load current of the transformer.

(Manju Gautam) IF/TECH/CON/HQ	(S.K.Das) AEE/CON/PI/MIG	(B.C.Das) EEE/CON/MIC	(Ravi Bhushan) DY.CEE/CON/HQ/MIG

(R.K.Mishra) CEE/CON/NER

21.4.10 **Fittings**

The transformer shall be complete with the following fittings: -

a) Off load type tap changing link or tap switch.

b) RTD temperature controller.

c) Lifting lugs for all transformers.

d) Bi-directional / Unidirectional Rollers to be specified.

e) Rating diagram and terminal marking plate for all transformers.

f) Additional Neutral separately brought out on a bushing for earthing for all transformers.

g) Earth terminals (2 Nos.) for body earthing for all transformers.

h) Necessary hardware, clamps, lugs etc. for termination on HV/MV etc. for all transformers.

21.4.11 **Rating Plates**

A rating plate of weather proof material bearing the data specified in clause-8 of IS 11171: 1985.

21.4.12 Joints and **Gaskets**

All gaskets used for making gas tight joints shall be of proven material.

21.4.13 **Parallel Operation**

For parallel operation of transformers, the transformers shall have the same percentage impedance, same voltage ratio, same vector group, phase sequence etc.

Where ever more than one Transformer is to be installed in the same Sub-Station, capacity of each Transformer shall preferably be same.

21.4.14 **Tests**

21.4.14.1 **Tests at Works**

All routine and other tests prescribed in IS 11171 : 1985 shall be carried out at the manufacturer's works before the dispatch of the transformer in the presence of inspecting officer. 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 11171 : 1985 for purpose of record. If no impulse test was done in an earlier unit of the same design and

(Manju Vij Singh) JE/TECH/CON/HQ	(B.K.Das) AEE/CON/PL/MLG	(R.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Mallick)
CEE/CON/NFR

type, one transformer will be subjected to impulse test in consultation with the Inspector at the firm's cost. Copies of the certificates of type test for short circuit shall be supplied to the Department.

21.4.14.2 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 shall be done before energization. The following tests are to be particularly done before cable jointing or connecting up the bus bar trunking.

a) Insulation test between HV to earth and HV to MV with a 5000 volts Megger.

b) Insulation test between MV to earth with 500 volts Megger.

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

21.4.15 Installation and Commissioning

21.4.15.1 The transformer shall be installed in accordance with IS 10028-Code of practice for Installation and maintenance of transformer. Necessary support channels shall be grouted in the flooring.

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

21.4.15.3 Wiring of devices shall be carried out as per drawings; Earthing of neutral and body of the transformer shall be done in accordance with section (7) of these specifications.

21.4.15.4 All devices shall be checked for satisfactory operation.

21.4.15.5 All tests specified in 21.1.14 of these specifications shall be carried out by the contractor in the presence of inspecting officer/ consignee free of cost.

21.4.16 Maximum Allowable Power Transformer Losses

Power transformers of the proper ratings and design must be selected to satisfy the minimum acceptable efficiency at 50% and full load rating. In addition, the transformer must be selected such that it minimizes the total of its initial cost in addition to the present value of the cost of its total lost energy while serving its estimated loads during its respective life span.

(Manju Yadav) IF/TECH/CON/HQ	(B.C.Das) AEE/CON/PL/MLG	(B.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/IIC/MLG

(R.K.Atoliya)
CEE/CON/NER

Total losses for dry type distribution transformers should conform as per the following table:

Maximum allowable losses for dry type distribution transformer with highest voltage for equipment 24 kV, at 50% and 100% of the load		
Transformer Capacity (kVA)	*Maximum Allowable losses at 50% kVA or load*	*Maximum Allowable losses at full load/Rated kVA*
100	1.88%	2.44%
160	1.61%	2.07%
200	1.50%	1.90%
250	1.36%	1.73%
400	1.19%	1.51%
500	1.12%	1.45%
630	1.06%	1.40%
1000	0.90%	1.20%
1600	0.79%	1.05%
2000	0.75%	1.00%

(Manju Yanzone) JE/TECH/CON/MLG	(B.Das) ACE/CON/PL/MLG	(R.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(D.K.Baliya)
CE/CON/NER

21.5 Foundation and Fencing

Suitable foundation, fencing for the transformer shall be provided as specified in the BOQ. The typical details for foundation and fencing (wherever required) shall be as under:

(i) Foundation

M10 (1:3:6) type foundation shall be constructed with 20mm course aggregate. The size of foundation shall be as per the approved drawing based on Transformer dimensions but shall not be less than 2 x1.5mt Length x breadthX 600mm (height above ground level) duly plastered and finished surface. Curing shall be done as per code applicable. Excavation shall be done complying with Code of Safety as per IS 3764/1992(Latest Version).

(ii) Fencing

Fencing shall be made in rectangular formation as required with M.S. angle iron 50x50x8mm spaced at about 2 meters and 12 SWG GI wire. The design of the fencing panel shall be as approved by Railway. MS strip not less than 15x3mm size shall be provided and welded above the GI wire along the angle frame to hold the GI wire mesh. Height of fencing shall be 2 meter above ground level. The portion of MS angle to be grouted in foundation shall be 500mm.

The fencing panels shall be erected on foundation constructed of size 200mmx200mmx500mm deep with cement concrete M10 grade (1:3:6).

(iii) Iron gate: Iron gate shall be fabricated with M.S. angle 50x50x8mm iron frame with iron grill etc as approved. The size of the gate shall be 2.0 m height X 3.5 m width and fabricated in two parts of aprox size 1.75m each. Gate shall be provided with suitable sliding lock with padlock. Gate shall be fixed on channels of size not less than 100 X 50 mm (weight 7.90 kg/m). Channels shall be erected on foundation constructed of size 300mm X 500mm deep with M10 grade (1:3:6) cement concrete.

(iv) Painting: MS portions of enclosure (fencing and gate etc) shall be painted with two coats of red oxide primer and two coats of enamel paint of approved shade.

(v) Approval of Drawing of Fencing:

Drawing of the fencing with gate etc shall be got approved from the Engineer prior to start of the work.

(Manju Yadav) JE/TECH/CON/HQ	(S.K.Das) AFF/CON/PI /MLG	(D.C.Das) EE/CON/MLG	(Ravi Bhushan) DY.EE/CON/HQ/MLG

(R.K.Atodiya)
CEE/CON/NFR

NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

Technical Specication No. NFR/ELECT/CON/GS/22(MV PANELS)

MEDIUM VOLTAGE PANELS
(for sub stations)

22.0 Scope:

This specification covers supply/erection/testing and commissioning of medium voltage switch panel for 415 V, 3 Phase, 50 Hz, 4 wire system.

22.1 General

(a) Medium voltage switch board shall be cubicle type, floor mounted, free standing type, dust and vermin proof, totally enclosed & compartmentalized design of uniform height and of multi-tier construction for indoor utilization and suitable for 3 phase, 4 wire, 415 V, 50 Hz AC, solidly earthed neutral, electric supply system complete with accessories, inter connections, continuous GI earth strip, bus bar chamber with copper/aluminium bus bar (as specified in the relevant BOQ item), ON/OFF & trip indication, all instruments, CT's energy meters, switchgears etc. (as specified in the relevant BOQ item) in position, duly wired up with copper conductor cable with colour coding, code numbering etc. and other accessories though not mentioned here but necessary to complete the work in all respects.

(b) LT panel shall conform to IS: 8623/Pt-I/1993

(c) The panel manufacturer shall have ISO: 9001 certification with testing arrangement as per IS: 8623 and power coating facilities in the works.

22.2 Relevant Standard Specifications and Regulations(latest amended):

(i) I.E.Rules 1956 (latest amended)
(ii) IS: 13942/Pt.1
(iii) IS: 5082/1998
(iv) IS: 1897/1983
(v) IS: 13947/Pt-2/1993
(vi) IS: 13947/Pt.III/1993
(vii) IS: 2705 (Part I,II,& III)/1992
(viii) IS: 8623/Pt-I/1993
(ix) IS: 694

(Manju Yonzone) JE/TECH/CON/HQ	(B.Das) AEE/GOR/PL/MLG	(B.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Aoliya) CEE/CON/MLG

22.3 Construction

22.3.1 The panels shall be fabricated from 2.0 mm thick CRCA sheet steel. The shroud & partitions shall be minimum 1.6 mm thick CRCA sheet steel. The panels shall be powder coated in approved shade. The degree of protection shall not be less than IP42 as per IS: 13942/Pt. 1.

22.3.2 Height of panel shall not be more than 2400 mm and operating height of switchgears shall be between 300 to 1700 mm. Continuous GI earth bus bar shall be of size not less than 50 x 6 mm.

22.3.3 The following minimum clearances shall be maintained:

i)	Between Phase	-	32 mm
ii)	Between Phases & Neutral	-	26mm
iii)	Between Phases & Earth	-	26 mm
iv)	Between Neutral & Earth	-	26 mm

22.3.4 All functional units shall be arranged in a multi-tier formation & each such unit shall be fully compartmentalized. Vertical cable alley shall be provided. Cable alley shall have hinged doors & suitable cable clamping arrangement. Vertical bus bars shall be housed in between two feeder compartments in a separate bus chamber. The openings between the bus chambers & feeder compartments shall be covered with Bakelite/hylem sheet of minimum 4.0 mm thickness. All the interconnecting links to the feeders shall be shrouded by means of phenolic barriers to avoid accidental contact. Each compartment shall have its own individual door with concealed hinges & the door shall have interlocking so door can only be opened after switching off the module.

22.4 Bus Bars

22.4.1 **Rating:**
Bus bars shall be made of wrought aluminium or aluminium alloy, or electric grade copper, conforming to relevant Indian Standard, as specified. The ratings of the bus bars shall be 100A, 200A, 300A, 400A, 500A, 600A, 800A or as specified.

22.4.2 **Current Density:**
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 aluminium 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 I.

(Manju Yonzone) JE/TECH/CON/HQ	AEE/CON/HQ/MLG	(D.C.Das) EE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Agrawal) CEE/CON/NFR

TABLE I

Aluminium/ Copper Bus Bar Sections

Current Ratings In amps. upto	Recommended Rectangular Cross-section			
	Aluminium		Copper	
	No. of Strips/ Phase	Size in mm	No. of Strips/ Phase	Size in mm
100	1	20 x 5	1	20 x 3
200	1	30 x 5	1	25 x 5
300	1	50 x 5	1	40 x 5
400	1	50 x 6	1	50 x 5
500	1	75 x 6	1	60 x 5
600	1	80 x 6	–	–
800	1	100 x 6	–	–
1000	1	100 x 10	–	–
1200	1	125 x 10	–	–
1600	2	100 x 10	–	–
2000	2	125 x 10	–	–
2500	3	125 x 10	–	–

Note:

(i) In larger bus bars of sizes above 1000 amps, the sections can be accepted in other rectangular cross-sections and numbers also, provided the total cross- sectional area offered is not less than the total cross-sectional area shown in the above table against the respective bus bar rating.

(ii) With aluminium bus bars, only aluminium wire/ solid bar connections shall be made for incoming/ outgoing mountings on the switchboards.

(iii) With copper bus bars, only copper wire/ solid bar connections shall be made for incoming/ outgoing mountings on the switchboards.

(Manjit Singh) JE/TECH/CON/HQ	(B.C.Das) AEE/CON/PI/MLG	(B.C Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Malviya)
CLL/CON/NER

22.4.3 Cross Section of Bus Bars:

The cross section of the neutral bus bar shall be the same as that of the phase bus bar .

22.4.4 Insulation:

Each bus bar shall be suitably insulated with PVC sleeves/ tapes.

The insulation of the rising mains shall be capable of withstanding the voltage of 660 V of AC.

22.4.5 Bus Bar Supports:

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 with-stand the dynamic stresses due to short circuit currents. The spacing between two insulators should be provided by the manufacturers according to the design approved by CPRI for their bus bar supports.

22.4.6 Bus Bar Clearances:

i) The minimum clearance to be maintained for enclosed indoor air insulated bus bars for medium voltage applications shall be as follows:

Between	Min. Clearances
Phase to earth	26 mm
Phase to phase	32 mm

Note: For strip connection from bus bars to switchgear, the above clearances don't apply.

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

(b) High tensile bolts, plain and spring washers shall be provided to ensure good contact at the joints.

(c) The overlap of the bus bars at the joints shall be not less than the area of the cross section of the bus bars.

22.4.7 Bus bars are to be provided in sections as per requirement for feeding essential/non-essential load and domestic/commercial load as per the approved drawing.

22.4.8 Provision shall be made in the switch board to take in main bus bar trunking from top for LT panels to be provided with transformers of capacity above 750 KVA.

22.4.9 All bus bars shall be insulated with PVC tapes/tubes (heat shrink type) with colour coding (Red/Yellow/Blue/Black) to withstand the test voltage of 2.5 kV for one minute.

(Manju Yonzone) JE/TECH/CON/HQ	(R.R.Das) AEE/CON/PL/MLG	(B.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/TIQ/MLG

(R.K Atoliya) CEE/CON/APT

22.5 Moulded Case Circuit Breakers (MCCB)

22.5.1 MCCBs shall conform to IS13947/Pt-2/1993 (Ics = 100%Icu) with thermal release setting 70/80%-100% and shall have ON, OFF & TRIP indications with breaking capacity as specified in the relevant BOQ item. MCCBs shall be 3 pole/4 pole (as specified in the relevant BOQ item) and suitable for three phase, 415 Volt, AC supply. MCCB shall overall conform to IS13947/Pt II/1993.

22.5.2 Tripping unit shall be of thermal-magnetic type provided in each pole and connected by a common trip bar such that tripping of any one pole operates all the poles to open simultaneously.

22.6 Air Circuit Breaker (ACB)

All Air Circuit Breakers shall be 3/4 pole with minimum 50 KA breaking capacity (35 MVA at 433V) conforming to IS 13947 (Part-II). Rated current shall be as per capacities specified. The equipment shall be comp'ete with the following: -

a) Necessary circuit breaker carriage with 3 position (isolate, test, service) draw-out mechanism.

b) Necessary isolating plugs and sockets.

c) Necessary mechanism interlock and automatic safe shutters gear with arrangement for pad locking.

d) Necessary independent manual spring mechanism with mechanical On/Off indication as well as electrical On/Off indication.

e) Necessary bus bars with bolted type neutral links.

f) ACB shall be provided with microprocessor based releases having built in over load, short circuit & earth fault protection. Microprocessor release shall be EMI (Electro Magnetic Induction)/ EMC (Electro Magnetic Compatible) certified.

g) Necessary set of auxiliary switches.

h) Necessary set of CTs with ratios as specified.

i) Necessary identification, metering requirements as specified i/c. ON/ OFF indication lamps, selector switches, fuses, ammeter, voltmeter etc.

j) In case of 4 pole breaker neutral shall be fully rated with adjustable settings from 50% to 100% of In.

k) ACB terminals shall be suitable/ suitably brought out for direct aluminum termination as per IS 13947 Part-II.

Note: Wherever fixed type circuit breakers are required, it shall be referred as specified below for further guidelines.

Preferred Specification/Selection of Air Circuit Breaker and Moulded Case Circuit Breakers;

MCCBs: MCCBs should preferably be used for loads below 800 Amperes.

i) Upto 160 A MCCBs shall be of > 20 Ka (Ics=Icu) at 433 V Short CKt. Current rating and should be Thermal Magnetic.

ii) From 200 A- 250 A MCCBs shall be of > 35 Ka (Ics= Icu) at 433 V Short Ckt. Current rating and should be Thermal Magnetic.

iii) From 200 A-250 A MCCBs shall be of > 50 Ka (Ics= Icu) at 433 V Short Ckt. Current rating and should be microprocessor based having over load and short circuit protection. If used as incomer should also have earth fault protection & time delay. Earth leakage modules are not acceptable.

22.7 Fuse Switch/ Switch Fuse Unit

Fuse switch/switch fuse unit shall be heavy duty, TPN double break of rating as specified in the relevant BOQ item, utilization category AC 23, conforming to IS: 13947/Pt. III/1993 with HRC fuses conforming to relevant IS and one neutral link.

22.8 On load change over Switch 4 pole

On load changeover switch shall be 4 pole, heavy duty of rating (as specified in the relevant BOQ item), utilization category AC 23, conforming to IS:13947/Pt.III/1993.

22.9 ACB Bus Coupler

ACB bus coupler shall be 4 pole (fixed type) of rating as specified in the relevant BOQ item, overall conforming to IS: 13947/Pt. II/1993. The circuit breaker shall have minimum breaking capacity of 45/50 kA(as specified in the relevant BOQ item).

22.10 Indication lights

On all the incomers of M.V panels, ON/OFF indicating LED lamps shall be provided and shall be suitable for operation on AC supply. Phase indicating LED lamps shall be associated with necessary ON/OFF toggle switch.

22.11 Measurement Instruments for Metering

All voltmeters and ammeters shall be flush mounted of size minimum 96 mm conforming to class 1.5 of IS 1248 for accuracy. All voltmeters shall be protected with MCB.

R-Y-B-OFF selector switches shall be used.

22.12 Current Transformers

22.12.1 Current transformers shall be in conformity with IS: 2705 (Part I, II &III)/1992. Current transformers shall be rated for 1 kV at rated primary current, rated burden. The rated secondary current shall be 5 A. The acceptable minimum class of

(Manju Yadav) IF/TECH/CON/HQ	(S.P.Das) AEE/CON/PL/MLG	(B.C Das) ELE/CON/MLG	(Ravi Bhushan) DY.CFF/CON/HQ/MLG

(R.K.Arolya)
CFF/CON/NFR

various applications shall be as given below:

Measuring : Class 1 Protection
: Class 5 to P10

22.12.2 Separate CT shall be provided for measuring instruments and protection.

22.12.3 The current transformers shall be mounted such that they are easily accessible for inspection, maintenance and replacement. The wiring for CT's shall be copper conductor, FR insulated wires with proper termination lugs and wiring shall be bunched with cable straps and fixed to the panel structure in neat manner. The VA rating of the CTs shall be 5 VA.

22.13 Miscellaneous

Control switches shall be of the heavy-duty rotary type with plates clearly marked to show the operating position. They shall be semi-flush mounting with only the front plate and operating handle projecting.

22.14 Cable/Bus Trunking Termination

22.14.1 Cable entries shall be provided with metallic glands to prevent damage to the insulation of the cable and terminals shall be provided in the switchboard to suit the number, type and size of power cables and copper conductor control cables.

22.14.2 Provision shall be made from top for bus trunking terminations/ from bottom for entry of cables through removable gland plates.

22.14.3 Barriers or shrouds shall be provided to permit safe working at the terminals of one module without disturbing of other modules.

22.15 Control Wiring

All control wiring shall be carried out with 1100/660 Volt grade, single core FR PVC insulated cable conforming to IS: 694 having stranded copper conductors of minimum 1.5 sq. mm size for potential circuits and 2.5 sq. mm for current circuits. Wiring shall be neatly bunched, adequately supported and properly routed to allow for easy access and maintenance. Numbering ferrules at each end shall identify wiring. All control fuses shall be mounted in front of the panel and shall be easily accessible.

22.16 Danger Notice:

Danger notice shall be affixed on front door at conspicuous position in Hindi, English & local language with a sign of skull & bone as per provision of I.E. Rule clause No.35.

22.17 Erection:

Foundation shall be designed based on total weight of the panel or otherwise as suitable depending on site conditions. While erection, as per IE Rules clause 51c, a clear space of not less than 1m shall be provided in the front. Space behind the switchboard shall be

either less than 20cm or more than 75cm. If the space behind exceeds 75cm, there shall be a passageway from either end of the switchboard clear to a height of 1.8m.

22.18 Earthing:

Each switchboard shall be earthed at two points from the distinct source of earth as per IE Rule clause 61.

22.19 Test at Manufacturer's Works

22.19.1 All routine tests shall be carried out in the presence of the inspecting Engineer.

22.19.2 Original test certificates of all equipments/instruments shall be submitted along with the supply of panel board after the Inspecting Officer passes the LT panel board.

22.20 Testing and Commissioning

Following tests shall be carried out prior to commissioning of the panel:

a) Insulation test: When measured with 500 V megger, the insulation resistance shall not be less than 100 mega ohms.
b) Trip test & protection test.

Note: Each panel shall be displayed with feeder name plate.

[Manju Pohjerel] JE/Tech/CON/HQ	[D.K.Das] AEE/CON/PL/MLG	[D.C.Das] EEE/CON/MLG	[Ravi Bhushan] DY.CEE/CON/HQ/MLG

[R.K.Atoliya]
CEE/Cons/NFR

NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

Technical Specification No. NFR/ELECT/CON/GS/23/RISING MAINS & BUS TRUNKING

RISING MAINS AND BUS TRUNKING

23.1 A. Rising Mains

(i) Application

(a) The rising mains are essentially used in electrical distribution system in building 2 storied and above. These are only for indoor applications. For vertical power distribution, this is a preferred method, compared to rising cable system and is more reliable and safe from point of view of fire hazard.

(b) Tap-off arrangements shall be provided on the rising mains with tap-off boxes.

(c) 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.

(d) The rising main shall conform to IS 8623 and IEC 439 and shall be suitable for 415 V, 3 phase, 50 Hz supply and insulation of rising mains shall be capable of withstanding the voltage of 660 volt AC. Degree of IP protection and short circuit rating shall be specified.

(ii) Enclosure

The enclosure shall be made from sheet steel of 1.6 mm thickness.

(iii) Bus bars

(a) Rating

Bus bars shall be made of wrought aluminium or aluminium alloy, or electric grade copper, conforming 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) Current Density

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 aluminium 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 I.

(Manish Gorakhpuri) JA/TECH/CON/HQ	(D.K.Das) ALE/CON/PL/MLG	(S.C Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K Agrawal) CEE/CON/N-E

TABLE I

Aluminium/ Copper Bus Bar Sections

[Clause 23.1 (iii)(b)]

Current Ratings in amps. upto	*Recommended Rectangular Cross-section*			
	Aluminium		*Copper*	
	No. of Strips/ Phase	*Size in mm*	*No. of Strips/ Phase*	*Size in mm*
100	1	20 x 5	1	20 x 3
200	1	30 x 5	1	25 x 5
300	1	50 x 5	1	40 x 5
400	1	50 x 6	1	50 x 5
500	1	75 x 6	1	60 x 5
600	1	80 x 6	–	–
800	1	100 x 6	–	–
1000	1	100 x 10	–	–
1200	1	125 x 10	–	–
1600	2	100 x 10	–	–
2000	2	125 x 10	–	–
2500	3	125 x 10	–	–

(e) **Cross Section of Bus Bars**

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.

(f) **Insulation**

Each bus bar shall be suitably insulated with PVC sleeves/ tapes.

The insulation of the rising mains shall be capable of withstanding the voltage of 650 V of AC.

(Manju Yadav) JE/TECH/CON/HQ	(L.C.Das) ALE/CON/HQ/MLG	(L.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(B.K.Mahajan) CEE/CON/HQ/MLG

(e) Bus Bar Supports

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 with-stand the dynamic stresses due to short circuit currents. The spacing between two insulators should be provided by the manufacturers according to the design approved by CPRI for their bus bar supports.

(f) Bus Bar Clearances

(i) The minimum clearance to be maintained for enclosed indoor air insulated bus bars for medium voltage applications shall be as follows:

Between	Min. Clearances
Phase to earth	26 mm
Phase to phase	32 mm

Note: For strip connection from bus bars to switchgear, the above clearances don't apply.

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

(b) High tensile bolts, plain and spring washers shall be provided to ensure good contact at the joints.

(c) The overlap of the bus bars at the joints shall be not less than the area of the cross section of the bus bars.

(d)

(g) Bus Bar Marking

Bus bars and main connections shall be marked by color or letter as per Table II.

TABLE II

Marking for A.C. Bus Bars & Main Connections

	Bus Bar and Main Connections	Colour	**Letter/Symbol**
(i)	Three Phase	Red, Yellow, Blue	R.Y.B.
	Two Phase	Red, Blue	R.B.
	Single Phase	Red	R
(ii)	Neutral connection	Black	N
(iii)	Connection to earth	Green	E
(iv)	Phase variable (such as connections to reversible motors)	Grey	Gy.

Note: In the wiring diagram, positive and negative should be indicated by '+' and '-' respectively.

(iv) Expansion Joint

Expansion joint made of aluminium/copper strips shall be provided wherever necessary, to take care of expansion and contraction of the bus bars under normal operating conditions. This shall be invariably provided whenever the length of the rising mains exceeds 15 m.

(v) Thrust Pads

(a) The bus bars shall be provided with thrust pads so that the expansion of the conductors is upwards only.

(b) 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.

(vi) Mounting

(i) Incoming cable will be connected to the rising main through an end feed unit, consisting of switch fuse unit with HRC fuse/ MCCB/ ACB of required capacity and cable end box

(ii) Tap-off boxes at specified intervals and height shall be provided on rising main to tap power. The box shall consist of set of HRC fuses or MCCB/ Switch fuse unit, so that power from rising main can be switched ON/OFF and provided with suitable overload/ short circuit protection.

(iii) Distribution boards/ switch boards will not be mounted on rising main. Such boards will be separately erected on floor/ wall and connected to tap-off box with suitable copper conductor cable.

(vii) Construction Features

(a) The rising mains shall be manufactured in convenient sections to facilitate easy transportation and installation. The sections shall be connected to form a vertical run at site. Each section shall be provided with suitable wall straps at convenient intervals for fixing to the wall.

(b) The enclosure shall be sturdy so as to withstand the internal and external forces resulting from the various operating conditions.

(c) The front covers shall be detachable. Neoprene gaskets shall be provided between the covers and the side channels.

(d) The enclosure shall have a degree of protection not less than IP 42

(e) The rising main shall be designed for temperature rise not exceeding 40 degree C over ambient temperature of 45 degree C.

(f) Built-in fireproof barriers having 2 hr. fire rating shall be provided to restrict the spread of fire through the rising mains from one section to the adjacent section.

(g) Necessary provisions for ventilation shall be made at suitable intervals. These shall be complete with welded non-ferrous metallic mesh to prevent entry of vermin.

(h) Two numbers of copper earth strips of 20 x 3 mm (for Rising Main upto 400 Amp.) and 20 x 5 mm (for Rising main above 400 Amp. and upto 800 Amp.) shall be provided alongside the rising mains enclosure, and shall be bolted to each section of the rising mains.

(viii) Installation of Rising Mains

(i) Rising mains shall be installed on walls, to which the foundation bolts shall be suitably grouted (in a shaft of adequate size for rising main and floor distribution panel). The foundation bolts shall be provided by the contractor without extra payment.

(ii) (a) No structural member in the building shall be damaged/ altered, without prior approval from the competent authority through the Engineer-in-charge.

(b) Structural provisions like openings, cutouts, if any, provided by the department for the work, shall be used. Where these require modifications, or where

(Manju Vandana) IF/TECH/CON/HQ	(B.K.Das) AEE/CON/PL/MUG	(B.C.Das) EE/CON/MUG	(Ravi Bhushan) 06.06.16 DY.CEE/CON/HQ/MUG

(B.K.Mallick) CEE/CON/NHR

fresh provisions are required to be made, such contingent works shall be carried out by the contractor at his cost.

(c) All such openings in floors provided by the Department shall be closed by the contractor after installing the cables/ conduits/ rising mains etc. as the case may be, by any suitable means as approved by the Engineer-in-charge without any extra payment.

(d) All chases required in connection with the electrical works shall be provided and filled by the contractor at his own cost to the original architectural finish of the buildings.

(ix) Commissioning

Before connecting mains supply after installation, pre-commissioning checks comprising, megger test, checking the tightness of connections, body earth connection etc. shall be carried out and recorded.

23.2 BUS TRUNKING

23.2.1 CONVENTIONAL BUS TRUNKING

23.2.1.0 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.

23.2.1.1 **Relevant Standard Specifications and Regulations (latest amended):**

i) IS: 8623-1993 Part I & II
ii) IS: 694:1990
iii) IS: 2147
iv) IEC 60439

23.2.1.2 **Materials**

23.2.1.2.1 **Enclosure**

Sheet steel of minimum 2 mm thickness shall be used for fabricating the enclosure.

23.2.1.2.1 **Bus Bars and Supports**

Bus bars and their supports shall comply with clauses 22.4 of technical specification no. NFR/ELECT/CON/GS/22 (MV PANELS). The current rating shall be as specified in individual cases.

(Manju Gupta) JE/TECH/CON/HQ	(U.K. Das) AEE/CON/PL/MLG	(S.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(A.K.Katiyar) CHE/CON/NFR

23.2.1.3 Construction

23.2.1.3.1 Enclosure

i) The enclosure shall be of bolted type, box type, welded type or any other type as per the manufacturer's standard practice, and shall be made out from sheet steel of minimum 2 mm thickness. The front cover only shall be detachable. The section of the bus duct shall be rectangular. The enclosure shall be sturdy so as to withstand the internal and external forces resulting from the various operating conditions.

ii) The bus trunking enclosure shall be fabricated in convenient sections for easy transportation and installation. The sections shall be connected to form horizontal and vertical runs as required at site. The enclosure shall be provided with flanged ends with drilling arrangements to suit the flanges at the switchgear and transformer terminals. All flanges shall be provided with gaskets, nuts, bolts, washers etc.

iii) The entire bus trunking enclosure shall be designed for dust and vermin proof construction. The enclosure for outdoor installation shall be additionally in weatherproof construction. The enclosure shall have a degree of protection not less than IP 42 for indoor application, and IP 54 for outdoor application in accordance with IS 2147.

iv) Bus trunking, if required to be installed outdoors, shall be provided with a metallic protecting canopy of adequate size above the bus trunking, fabricated as part of the enclosure.

v) Neoprene gaskets shall be provided to satisfy the operating conditions imposed by temperature, weather etc. and durability.

vi) Provisions for ventilation shall be made at suitable intervals. These shall be complete with welded non-ferrous metallic mesh to prevent entry of vermin.

vii) Two numbers of Copper earth strips of appropriate size shall be provided alongside the bus trunking enclosure and shall be bolted with each section of the bus trunking (See Table III).

(Manju Yadav) E/TECH/CON/HQ	(R.K.Jha) AEE/CON/PI/MLG	(B.C.Das) EEE/CON/MLG	6/6/16 (Devi Shankar) DY.CEE/CON/I.Q/MLG

(R.K.Aditya)
CEE/CON/NTR

TABLE III

Earth Continuity Strip for **Bus Trunking** and **Rising** Main

S.No.	Type of Installation	Material of Main Conductor	Earth Strip
1.	Bus trunking up to 2500 Amp capacity	Copper/ Aluminium	2 Nos. 25 x 5 mm copper strip
2.	Bus trunking above 2500 Amp capacity	Copper/ Aluminium	2 Nos. 32 x 5 mm copper strip
3.	Bus trunking for connecting generating set and LT panel	Copper/ Aluminium	2 Nos. 25 x 5 mm copper strip
4.	Rising main up to 400 Amp capacity	Copper/ Aluminium	2 Nos. 20 x 3 mm copper strip
5.	Rising main above 400 Amp and up to 800 Amp capacity	Copper/ Aluminium	2 Nos. 20 x 5 mm copper strip

23.2.1.3.2 **Expansion Joint/ Flexible** Termination

i) Flexible connections shall be provided by braided or multi-leafed conductors for terminations at transformer bushing and switchgear.

ii) Expansion joints made of aluminium/copper strips shall be provided wherever necessary, to take care of expansion and contraction of the bus bars under normal operating conditions. This shall be invariably provided whenever the length of the rising mains exceeds 15m.

23.2.1.3.3 **Installation**

(i) Each section of the enclosure shall be suspended from the ceiling slab with suitable MS suspenders and support angles/ channels. The runs shall be neat and the route shall be as directed by the Engineer-in-charge.

(ii) The bus trunking shall be supported such that its weight does not come on the terminations.

(iii) Danger notice boards shall be provided on the bus trunking enclosure at suitable intervals in every room through which it passes.

(iv) The earthing strips shall be properly terminated to the earth bars at both ends.

(v) Pre-commissioning checks shall be conducted.

23.2.2 COMPACT BUS TRUNKING

23.2.2.1 There are two types of compact BUS TRUNKINGS available commercially:

(1) Air Insulated and
(2) Sandwich insulated.

23.2.2.2 AIR INSULATED COMPACT BUS TRUNKING / RISING MAINS

The Bus Trunking/ Rising Mains are suitable for distributing 3 phase, 50 Hz, 415/ 450 volts A.C. supply. These are available with Aluminium as well as Copper Conductors.

23.2.2.3 CONSTRUCTION

Enclosure will be manufactured from CRCA sheet steel powder coated to shade RAL 7032 (or such other specified) or GI. Enclosure will be rectangular in shape. Bus bars will be placed over insulators (Class F) located every 250 mm (Such other suitable length) along its length. On front face of the enclosure, tap off points for inserting plug in boxes will be provided at regular interval (500 mm or so). Each plug in point will have provision for closing with shutter assembly, which is integral part of enclosure, when not occupied by plug in box.

Bus bars will be aluminium conductor 63401 / WP grade aluminium alloy or copper conductor ETP grade with 99.9% pure copper, with radicalised edges. For ease in handling, length of largest section will be restricted to 3 Mtrs nominally (floor to floor height). Neutral cross section unless specified for reduced cross section will be same as phase cross section unless specified for reduced cross section. Bus bars will not be drilled and so placed in insulators that when placed vertically they do not slide out of enclosure.

Joints between bus bars of one section to adjacent section will be through Uniblock Joint assembly operated by single bolt or clamped connections located in an insulated housing operated by single screw. Uniblock joint system will be removable and inserted as a separate sub-assembly to isolate adjacent sections without disturbing or moving bus bars.

Fire barriers of two hours rating will be provided at each floor crossing as per UL 1479 or as per IEC 60439 and test certificate provided.

The enclosure will have protection degree IP-54 as per IEC.

(Manju Yonzone) JE/TECH/CON/HQ	(D.D.Das) AEE/CON/PL/MLG	(S.C.Das) EEE/CON/MLG	(Ravi Dhushen) DY CEE/CON/HQ/MLG

(R.K.Atoliya) CEE/CONTRACT

23.2.2.4 PLUG IN BOXES

These are required for Rising Mains. Plug in boxes will be of draw out type. Contacts will be of silver plated copper and spring loaded. Earth connection will be the first to make and last to break during insertion and withdrawal. Plug in box will be made from 1.6 mm CRCA sheet steel powder coated or GI. Inside the plug in boxes MCCB or SFU with fuses will be located as per requirements. The operating handle will be interlocked with plug in box cover so that MCCB can be operated only with suitable cover in closed position. If required the plug in box will be interlocked with bus bar trunking so that it could be inserted or removed with the plug in box lid opened. MCCB/ SFU will be of 4 pole type unless otherwise specified in BOQ. Short circuit breaking capacity of MCCB in PIB should preferably be same as short circuit withstand for one second of bus bar trunking .

23.2.2.5 END FEED UNIT

The End feed unit will be manufactured from 1.6 mm thick sheet steel with powder coating to shade RAL 7032 or of GI. Inside the End feed unit MCCB of required rating and specifications or SF unit with HRC fuses will be located. End feed units at top will be connected to Bus bars of Rising Mains through solid connections. Terminals at the bottom will be provided to accept cable connections as required. The operating handle of MCCB/ SFU will be interlocked so that the door can be opened only when MCCB or SFU are in off position. The current rating of MCCB should correspond with current rating of bus bar trunking and short circuit breaking capacity with one second short circuit withstand of bus bar trunking .

23.2.2.6 BRACKETS

Mounting Brackets, which can be shifted anywhere on Bus Bar Trunking should be provided to fix bus bar trunking on to assembly grouted in wall where these brackets rest.

23.2.2.7 EARTH STRIP

Earth strip of copper or aluminium are to be provided, one on each side all along the Rising Mains of size dependent on short circuit withstand for one second of Rising Mains specified as per derivation given below (IEC 60439/1). Earth strip should be firmly fixed to the body of Rising Main at regular intervals.

$$SP = \frac{\sqrt{I^2 t}}{K}$$

SP is cross sectional area in sq mm (total for both strips).

I = Rms value of A.C. fault current in amperes.

(Manju Yadav) JE/IT-CP/CON/HQ	(T.U.Das) AEE/CON/PL/M-S	(B.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Agrihotri)
CEE/CON/NFR

t = Operation time of operating / disconnecting device which may be taken as one second.

K = Factor depending on material of conductor. For aluminium it is 116, for copper it is 176.

23.2.2.8 SHORT CIRCUIT WITHSTAND

Bus bars offered should be tested for short circuit withstand specified. Generally specified in KA RMS for one second.

23.2.2.9 Bus bar system should be designed for an ambient temperature of 40 deg. C and temperature rise restricted to 45 deg. C max.

23.2.2.10 Other technical parameters to be met are:

- Max operating voltage : 1000 Volts.
- Insulation voltage : 1000 Volts.

23.2.2.11 Expansion joints will be provided after length of 30 Mtrs. for aluminium conductor bus trunking and after 40 Mtrs. for copper conductor bus trunking

23.2.2.12 SANDWITCH INSULATED BUS TRUNKING AND RISING MAINS

23.2.2.13 SUPPLY VOLTAGE

For 3 phase, 4 wire, 50 cycles AC supply, operation voltage 415/440 volts.

23.2.2.14 CONSTRUCTION

The enclosure will be made from 16 SWG GI/ CRCA sheet steel powder coated to shade RAL 7032 (or such other shade). Bus bars would be in 'Sandwich' construction and the conductors will be individually insulated with 4 layers of insulation film. Inner layer will be of glass MICA and outer layer of polyester material Class 'F'. Alternatively extrusion of Class 'F' material in form of epoxy insulation may be provided. No drilling of bus bars is permitted. Aluminium conductors will be of 19501 grade and copper conductor of 99.9% purity and ETP grade with radialised edges. Length of section will be limited to max. 3 Mtrs. Bus bars of one section will be connected to bus bars of adjacent section by multiblock joint system removable as separate sub-assembly, so that it can be inserted or removed without disturbing the adjacent sections.

23.2.2.15 **Installation**: Normally manufacturer's recommendations should be followed.

For installation as Rising Mains / Vertical installation, at each floor, a set consisting of two Spring Hangers will be provided for fixing it on channels grouted in wall. At the start of run, Hangers without springs may be used for rigid support. In addition Horizontal supports will be provided (2 Nos. per floor) to hold bus bars in position. On Rising Mains, on front face of the bus bar trunking tap off points will be provided for inserting plug in boxes. Number of tap off points at each floor will be as per requirement given in BOQ but minimum distance between tap off points may be kept around 500 mm. Each Tap off opening will be closed by insulated shutters forming part of BBT, when not occupied by Plug in Boxes. Neutral cross section will be same as phase cross section.

Enclosure will be tested for protection degree IP 54.

Necessary Vertical / Horizontal bends / Tees will be provided as required by layout.

Bus bars trunking will be rigidly fixed to the side walls or suspended from ceiling by supports as per requirement detailed in the layout.

At the termination either on the transformer side or on generator end or on switchgear panel, bus duct will be provided with flange ends, adopter box and copper flexible (preferably multispeed types) to connect bus bars of bus duct to bus bars of switchgear panel or transformer terminals or generator terminals.

All the components like Busbar ducting, Bends, hanger ends, Adopter Boxes etc. will be made from CRCA or GI sheets. Two earth strips of copper or aluminum of size as mentioned in IEC 60439, dependent on short circuit withstand capacity required will be provided throughout the length.

Expansion units are to be installed after every uninterrupted run of 50 Mtrs. for composite expansion of complete Bus trunking run.

23.2.2.16 **TECHNICAL PARAMETERS FOR COMPLIANCE**

1. Bus trunking will be designed to withstand short circuit current for one second.
2. Bus bar system should be designed for an ambient temperature of 40 deg. C and temperature rise restricted to 55 deg. C max. above ambient on conductors above ambient.

   Temperature rise of the enclosure 40 deg. C maximum. Temperature rise at terminals 70 deg. C max.
3. Maximum operating voltage = 1000 Volts. (600 Volts).
4. **Insulation** voltage = 1000 Volts.

(Manju Yerla) JE/TECH/CON/HQ	(B.K.Das) AEE/GEN/PL/MLG	(B.C.Das) ---/CON/MLG	6/6/16 (Ravi Bhushan) DY.CFE/CON/HQ/MLG

(B.K.Mallick)
CEE/CON/NHB 7/6

5. Bus trunking will be suitably chosen to give permissible voltage drop.

6. Rated impulse withstand voltage 12 KV at 1000 V (600 Volts).

23.2.2.17 PLUG IN BOXES

Plug in Boxes will be of draw out type. Contacts will be of silver plated copper and spring loaded. Earth connection will be the first to make and last to break during insertion and withdrawal. Plug in Box will be made from 1.6 mm CRCA sheet steel powder coated or GI. Inside the plug in Boxes MCCB or SFU with fuses will be located as per requirements. The operation handle will be interlocked with plug in Box cover so that MCCB can be operated only with suitable cover in closed position. If required the plug in Box will be interlocked with Bus bar trunking so that it can not be inserted or removed with the plug in Box lid opened. MCCB / SFU will be of 4 pole type unless otherwise specified in BOQ. Short circuit breaking capacity of MCCB in PIB should preferably be same as short circuit withstand for one second of Bus Bar Trunking.

23.2.2.18 LIST OF TEST TO BE CARRIED OUT

Type Tests : Copies of the following certificates should be submitted.

1. Verification of Temperature Rise limits.
2. Verification of dielectric properties.
3. Verification of short circuit strength.
4. Verification of degree of protection.

23.2.2.19 ROUTINE TESTS

1. Verification of insulation resistance.
2. Inspection of assembly, interlocks, locks etc.
3. Check on wiring if provided.
4. Dielectric test.

(Manju Vondoor) JE/TECH/CDO/NR	(S.A.Das) AEE/CON/P /MLG	(S.C.Das) SEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(B.K.Mahanta) CEE/CON/NR

NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

Technical Specification No. NFR/ELECT/CON/GS/24/(TRUNKING CABLE MANAGEMENT SYSTEM)

TRUNKING CABLE MANAGEMENT SYSTEM

24.0 Scope

This chapter covers the requirements of mini trunking (casing wiring) and adaptable metallic or PVC trunking ("otherwise also called wire ways").

24.1 Adaptable trunking shall be used for power cables and data cables to run parallel in two different compartments with partition

24.1.1 Mini Trunking is suitable for surface wiring work indoors where necessitated, either due to aesthetics or technical requirements, such as case of extension of existing wiring, avoidance of recessed wiring in RCC columns etc. PVC insulated cables and / or other approved insulated cables conforming to IS 694 : 1990 shall be used in this type of work.

Wherever data cables are used for information outlets, adaptable trunking shall be used.

24.1.2 (i) This system using PVC trunking shall be adopted in residential buildings, or office building where there is a need of tidy wiring system.

(ii) PVC trunking for distribution of Voice Data and Power should be used for cable management and should accept RJ45 Data socket and Power socket or other wiring accessory like switches, indicators etc.

(iii) Where the trunking has to be necessarily adopted in situations under (i) above, PVC trunking shall be used.

(iv) Preferred size of the mini trunking should be 25 x 16 mm, 32 x 16 mm, 40 x 25 mm, 40 x 40 mm and for adaptable trunking it should be 100 x 34 mm or 100 x 50 mm or 160 x 50 mm or 200 x 50mm for making upto four isolated compartments.

(v) Trunking should be equipped with rail on its surface on which clip-on partition can be clipped which should accept frames/plates for wiring devices upto 6/8 modules.

(vi) Trunking should have insulation rating of 5 mega Ohm. Trunking should have the following fire resistance characteristics:

- Operating temperature between 40 Deg to 60 Deg. C
- Glow wire test 960 Deg. C
- Oxygen index – 50 ± 5
- UL94 VO

24.2 **Material**

24.2.1 The mini trunking and adaptable trunking shall be of the same material, viz. either PVC or anodized aluminium in extruded sections.

24.2.2 The mini trunking shall have a square or rectangular body. The trunking cover shall be "CLIP-ON" type with double grooving in the case of PVC wire-ways, and CLIP-ON type for the metallic wire ways. All surfaces shall have smooth finish inside and outside. The top of the side walls of the body shall be suitable for the above types of fixing arrangement of trunking. PVC trunking or Aluminium trunking should have uniform thickness throughout its length and shall be of factory finish.

24.2.3 PVC trunking shall be of good quality PVC, free from defects like deformation, unevenness, blisters, cavities etc.

24.2.4 **Dimensions**

i) The sizes of mini trunking for the various sizes of cables and the maximum number of 650/1100 V grade PVC insulated aluminium / copper conductor cables that can be carried in one trunking are given size wise in Table 1.

TABLE 1

Maximum Number of PVC Insulated 650/1100 Volt Grade Aluminium/Copper Conductor Cable conforming to IS 694 : 1990
[Clause 6.2.4(i)]

Nominal Cross Section Area	*10/15 mm x 10 mm*	*20/15 mm x 16 mm*	*25/15 mm x 16 mm*	*32 mm x 16 mm*	*40 mm x 25 mm*	*40 mm x 40 mm*
1.5	3	5	6	8	12	18
2.5	2	4	5	6	9	15
4	2	3	4	5	8	12
6		2	3	4	6	9
10		1	2	3	5	8
16			1	2	4	6
25				1	3	5
35					2	4
50					1	3
70					1	2

Note : Dimensions shown above are outer dimensions of mini trunking.

ii) The thickness of the mini trunking & adaptable trunking shall be 1 mm minimum.

iii) When mini trunking cover is clipped onto the trunking body, cover should completely overlap on the base (casing).

24.2.5 Outlet Boxes

The outlet boxes such as switch boxes, regulator boxes and their phenolic laminated sheet covers shall be as per requirements.

24.3 Installation

24.3.1 Attachment to Wall and Ceiling

i) The mini trunking and adaptable trunking shall be fixed by means of suitable screws to approved type of asbestos or fibre fixing plugs, at intervals not exceeding 60 cm for all sizes for mini trunking. In case of Adaptable trunking, the screwing distance shall be such that the weight of the trunking & cable hold firmly on the wall or ceiling. On either side of the joints, the distance of the fixing arrangement shall not exceed 15 cm from the joint.

ii) All trunking body shall be fixed directly on wall or ceiling as above.

iii) Trunking shall be used only on dry walls and ceiling, avoiding outside walls as far as possible and shall not be buried in walls not fixed in proximity to gas, steam or water pipes or immediately below the heater.

iv) Adaptable trunking shall be with pill off cover for protection against dust. Pill off cover shall be removed only on completion of painting of walls.

24.3.2 Passing through Floors or Walls

When conductors pass through floors, the same shall be carried in an approved PVC conduit, or heavy gauge steel conduit properly bushed at both ends. The conduit shallbe carried 20 cm above floor level and 2.5 cm below ceiling level and neatly terminated into the casing. Steel conduit pipes wherever accessible shall be securely earthed.

24.3.3 Joints in Casing and Capping

i) The wire ways in straight runs should be in single piece as far as possible so as to avoid joints. Trunking shall be of 2 m or 3 m standard length for the ease of installation.

ii) All joints shall be scarfed or cut diagonally in longitudinal section, and shall be smoothed down by filing to make the joints a very close fit as far as possible and without burrs. They shall be screwed at joints with two or more screws as would be necessary.

iii) Joints arising out of bends or diversion shall be done using standard accessories like Internal angle, External angle, Flat angle (elbows), Flat junction (T) and end caps. For the separation of data and power cables there shall be partition in both

trunking and accessories. Internal and external angle shall have variable angle for the alignment at the wall corners. In no case the radius of curvature of the cables inside a bend shall be less than 6 times their overall diameter.

24.3.4 Trunking should be of white colour in case of PVC trunking and of white or grey colour in case of Aluminium trunking.

i) Mini Trunking attached to ceiling shall be carried completely across the ceiling/ wall whenever required by the Engineer-in-charge, instead of being stopped at an outlet location and in all such cases, dummy mini trunking must be provided.

24.3.5 **Attachment of Capping**

i) Wherever required by the Engineer-in-charge, capping shall not be fixed until the work has been inspected with the wires in position and approved. The inspection will be done from time to time as the work progresses.

ii) Cover shall be attached to body after all the insulated wires are laid inside.

iii) No screws or nails shall be used for fixing PVC cover to the body.

iv) Aluminium cover shall be fixed by using cadmium plated flat head / round head screws with an axial spacing not exceeding 30 cm.

24.3.6 **Installation of Cables**

i) For ease of maintenance, cables carrying direct current or alternating current shall always be bunched so that the outgoing and return cables are drawn in the same trunking.

ii) Mini trunking shall be of such a design that it holds the wires inside the trunking body (casing) at suitable intervals, so that at the time of opening of the trunking cover (capping), the wires may remain in position in the trunking body (casing) and do not fall out.

24.3.7 **Earth Continuity**

A protective (earth continuity) conductor shall be drawn inside for earthing of allmetallic boxes of the installations as well as for connections to the earth pin of the socket outlets.

i) In the case of metallic trunking there shall be a metallic link between adjacent trunking covers with screw connections, and also connections from the end casing to the earth terminal of metallic boxes / outlets / switch boards as per the case may be, for the complete body earthing of the system.

(Manjit Kaur) F/TECH/CON/HQ	(B.B.Das) AEE/CON/PI/MLG	(G.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Aloriya)
CE/CON/NHR

NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

Technical Specification No. NFR/ELECT/CON/GS/25/COMPACT SUB-STATION

UNITISED / COMPACT SUB-STATION

25.1 Compact Sub-Station shall be prefabricated substation, fully designed, tested and ready to install.

25.2 Compact Sub-station shall consist of 11 KV SF6 Insulated compact switchgear with VCB as protection to Transformer, Transformer and L.T. Switchgear with all connection accessories, fitting & auxiliary equipment in a pre-fabricated enclosure to supply Low-voltage energy from high-voltage system as detailed in this specification. The complete unit shall be installed on a sub-station plinth (base) as Outdoor sub-station 11 KV Load Break Cable Switches control incoming – outgoing feeder cables of the 11 KV ring/ radial distribution system. The Vacuum Circuit Breaker shall be used to control and isolate the Distribution transformer. The transformer's L.T. side shall be connected to L.T. Switchgear. The connection cables to consumer shall be taken out from the L.T. switchgear(s).

The pre-fabricated compact sub-station shall be designed for

a) Compactness,

b) Fast installation,

c) Maintenance free operation,

d) Safety for worker/ operator & public.

e) Appealing aesthetics.

25.3 **OUTDOOR ENCLOSURE**

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

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

25.3.3 The structure of the substation shall be capable of supporting the gross weight of all the equipment & the roof of the sub-station compartment shall be designed to support adequate loads.

25.3.4 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.

25.3.5 The complete design shall be modular in design i.e. small sheets shall be joined together to make a big sheet. This helps in avoiding skewing, bending, bending of the single sheets on doors and sides due to its own load under service. The doors shall be provided with proper interlocking arrangement for safety of operator.

25.3.6 **Public Nuisance Protection**

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 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 cannot be tampered with.

25.3.7 **Interconnection**

The connection of HT switchgear to Transformer shall be with the help of suitable size of cables, from Transformer to LT switchgear with the help of suitable size of Copper/ Aluminium bus bars. The interconnection inside the unit shall be the responsibility of the supplier.

25.3.8 **Internal Fault**

Failure within the unitised sub-station due either to a defect, an exceptional service condition or mal-operation may initiate an internal arc. Such event may lead to the risk of injury, if persons are present. It is desirable that the unit shall be tested for Internal Arc fault test as per latest IEC 61330.

25.3.9 **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.

(Manju Verporia) JE/ELECT/CON/HQ	(B.K. Das) AEE/CON/PL/MLG	(L.C.Das) LEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/PL/MLG

(R.K.Agarwal) CE/CON/NHQ

25.3.10 **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 sub-station,

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.

25.3.11 **Internal Illumination**

There shall be arrangement for internal lighting activated by associated switch on doors for HV, Transformer & LV compartments separately.

25.3.12 **Labels**

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

25.3.13 **Painting and Fabrication Process**

a) 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.

b) Special care shall be taken by the manufacturer to ensure against rusting of nuts, bolts and fittings during operation. All bushings and current carrying parts shall be cleaned properly after final painting.

c) The fabrication process shall ensure that there are no sharp edges on the GI 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.

(Manju Yohzone) JL/TLCT/CON/HQ	(B.Das) ALL/CON/PL/MLG	(D.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(K. Chandra Sekhar)
CEE/CON/NCTPP

25.4 **11 KV SWITCHGEAR (Gas Insulated Compact Switchgear)**

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

25.4.2 **Load Break Cable Switch**

Load Break Cable Switch with integral earth switch both having full making capcity 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 shall be mechanically interlocked to its corresponding cable switch for safety of the operator.

25.4.3 **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.

25.4.4 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 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 IEC and ensure the gas leakage upto 0.1% per year as per IEC.

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

25.4.6 **General Finish**

Totally enclosed, metal enclosed, vermin and dust proof suitable for tropical climate use as detailed in the specification

(Manju Yadav) JE/TECH/CON/HQ	(B.K.Das) AEE/CON/FL/MLG	(B.C.Das) EFF/CON/MLG	(Ravi Bhushan) DY.CLL/CON/HQ/MLG

(B.K.Maliya) CLL/CON/NFR

25.4.7 **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.

25.4.8 **Breaking & Making Capacity**

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 symmetrical at 11000 volts three phase.

25.4.9 **Busbar**

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.

25.4.10 **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.

25.4.11 **Cable Termination**

Each Cable compartment shall be provided with three bushings of adequate sizes to terminate the incoming and outgoing 11 KV 3 Core cables. There shall be enough height (Minimum 450 mm) from the base to 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.

25.4.12 **Locking Arrangement**

Suitable padlocking arrangements shall be provided as stated below:

a) CB manual operating handle in the "OFF" positon.

b) Each feeder panel operation handles in 'Closed', 'Open' or 'Earth' position.

c) Each isolator operating handle in 'Closed', 'Open' or 'Earth' position.

(Manju Yadav) JE/TECH/CON/HQ	(P.K.Das) AEE/CON/FL/MLG	(E.C.Das) LLE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(M.K.Alok)
CEE/CON/HQ

25.4.13 Ratings

		Extensible radial compact switchgear with VCB
	Switchgear Data	
(a)	Service	Outdoor but inside Enclosure
(b)	Type	Metal Enclosed
(c)	Number of phases	3
(d)	Voltage	11000 V
(e)	Rated Frequency	50 Hz
(f)	Rated Current	630 Amp (isolator)
(g)	Short Circuit rating	
	(I) Breaking	21 KA rms for Breaker
	(II) Short time withstand for 3 Sec	21 KA
	(III) Rated S/C making	52.5 KA peak for Breaker
(h)	Short duration power freq.	28 Kv
(i)	Insulation Level	75 Kv peak
(j)	System earthing	Solidly earthed at substation
	Breaker	**For load**
(a)	Type VCB in SF6 tank	
(b)	Rated voltage	11 KV
(c)	Breaking current	
	(I) Load breaking	21 KA rms.
(d)	Making current	52.5 KA peak
(e)	Rated current	630 Amps.
(f)	No. of poles	3
(g)	Operating mechanism	Trip free & free handle type with mechanically operated indication & pad locking
	Isolators	Loop-in & Loop out.
(a)	Type	Load breaking and fault making in SF6 tank
(b)	Rated current	630 Amps.
(c)	Rated breaking capacity	630 Amps.
(d)	Fault making capacity	52.5 KA peak
(e)	No. of poles	3
(f)	Operating mechanism	Operating handle with ON, OFF, Earth positions with arrangement for padlocking in each position.
	Bus bars	
(a)	Material	Copper
(b)	Type	SF6 insulated
(c)	Rated Current	630 Amps

(Manju Yadav) JE/TECH/CON/HQ	(B.K.Das) AEE/CON/PE/MIG	(S.C.Das) EEE/CON/WLG	(Ravi Bhushan) DY.GEE/CON/HQ/MIG

(R.K.Mishra) CM/CON/MIG

25.4.14 **Testing**

Each type of 11 KV 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

25.4.15 **Routine Test**

The tests shall include but not necessarily limited to the 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.

25.5 **Transformers**

11Kv/433 V distribution transformer shall be cast resin dry type transformer as per technical specification no. NER/ELECT/CON/GS/21/TRANSFORMERS.

25.6 All equipments and materials of compact sub-station shall be designed, manufactured and tested in accordance with latest applicable Indian Standards.

(Manju Yadav) JE/TECH/CON/HQ	(D.K Das) ALE/CON/PL/MLG	(Kartik) EEE/CON/MLG	(Ravi Bhushan) DY.CLE/CON/HQ/MLG

(T.K.Mahanta) CE/CLE/CON/HQ

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(CONSTRUCTION ORGANISATION)

APPENDIX A

SAFETY PROCEDURE

A.1 While the Indian Electricity Rules 1956, as amended upto date, are to be followed in their entirety, particular attention is drawn to the various clauses indicated in Appendix 'C'. Any installation or portion of installation, which does not comply with these rules, should be got rectified immediately.

A.2 The detailed instructions on safety procedures given in B.I.S. Code No. 5216 : 1982 "Code of Safety Procedures and Practices in Electrical Works" shall be strictly followed.

A.3 **(a) Schematic Diagram**

It shall be responsibility of the JE (E)/AE (E) to ensure that for each building, a comprehensive schematic diagram is prepared starting from the main board upto the final DBs. All such boards are to be duly marked and numbered.

Similarly, for each campus consisting of sub-station/ sub-stations and a number of buildings, a comprehensive power distribution schematic diagram for the entire campus shall be prepared.

Based on additions/ alterations such diagrams should be updated from time to time.

(b) **Keep Premises Clean**

Premises like sub-stations, switch rooms, pump house, generating rooms etc. shall be kept clean. Such premises should not be used to store broken furniture, dismantled materials, waste material, packing boxes etc.

(c) **Keep all Electrical Shafts Clean and Locked**

Such shafts should not be used for dumping floor malba etc.

(d) **Protected Premises**

All premises like sub-station, pump house etc. to be maintained as protected area, admission allowed to authorized persons only.

(e) Also, the frontage of such areas shall be kept free and parking etc. in front shall not be allowed.

A.4 No inflammable materials shall be stored in places other than the rooms specially constructed for this purpose in accordance with the provisions of Indian Explosives Act.

A.5 Rubber or insulating mats should be provided in front of the main switchboards or any other control equipments of medium voltage and above.

[Manju Yonzon] JE/ELO/CON/HQ	[S.R.Das] AEE/CON/PL/MLG	[B.Das] EEE/CON/MLG	[Ravi Bhushan] 13/4/16 DY.CEE/CON/HQ/MLG

[R.K.Aoliya] CEE/CON/NFR

A.6 Protective and safety equipments such as rubber gauntlets or gloves, earthing rods, lineman's belt, portable artificial respiration apparatus etc. should be provided in each sub-station, service center/enquiry office and important installations. Where electric welding or such other nature of work is undertaken, goggles shall also be provided.

A.7 Necessary number of caution boards such as "Man on Line. Don't switch on" should be readily available in each sub-station, enquiry office and important installations.

A.8 Standard first aid boxes containing materials as prescribed by the St. John Ambulance Brigade or Indian Red Cross should be provided in each sub-station, enquiry office and important installations and should be readily available.

A.9 Periodical examination of the first aid facilities and protective and safety equipments provided at the various installations shall be undertaken for their adequacy and effectiveness and a proper record shall be maintained.

A.10 Charts (one in English and another one in the regional language) displaying methods of giving artificial respiration to a recipient of electrical shock should be prominently displayed at appropriate places.

A.11 A chart containing the names, addresses and telephone numbers of nearest authorized medical practitioners, hospitals, fire brigade and also of the officers in executive charge shall be displayed prominently along with the First Aid Box.

A.12 Executive Engineers should take immediate steps to train supervisory and authorized persons of the Engineering staff viz. A.Es, J.Es, Head Electricians, Foremen, Electricians and Wiremen in the First Aid Practices, including various methods of artificial respiration with the help of local authorities such as Fire Brigade, St. John Ambulance Brigade, Indian Red Cross or other recognized institutions equipped to impart such training, as prompt rendering of artificial respiration can save life at times of electric shock.

A.13 All new recruits should be given such First Aid Training immediately after appointment.

A.14 All supervisory and authorized persons of the Engineering staff should be deputed for refresher course in First Aid Training after every two years.

A.15 All preventive maintenance works shall be pre- planned as far as possible and names of persons who are assigned to this work should be entered in a logbook.

A.16 Electrical wiring and control switches should be periodically inspected and any defective wiring, broken parts of switches which will expose live parts, should be replaced immediately to make the installations safe for the user.

A.17 Reports indicating details of preventive maintenance works done should be kept in a register by each Junior Engineer (E) and should bear signatures of Assistant Engineer and Executive Engineer by way of checks.

(Manju Yaro...) JE/TECH/CON/...	(R.K.Das) AEE/CON/PL/M.C	(S.Das) LLL/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Adhikary) CEE/CON/NFR

A.18 No work shall be undertaken on live installations, or on installations, which could be energized unless another person is present to immediately isolate the electric supply in case of any accident and to render first aid, if necessary.

A.19 No work of live L.T. switch board in the sub-stations should be handled by a person below the rank of a Wireman and such a work should preferably be done in the presence of the Junior Engineer (E) in charge of the work.

A.20 When working on or near live installations, suitably insulated tools should be used, and special care should be taken to see that those tools accidentally do not drop on live terminals causing shock or dead short.

A.21 The electrical switchgears and distribution boards should be clearly marked to indicate the areas being controlled by them.

A.22 Before starting any work on the existing installation, it should be ensured that the electric supply to that portion in which the work is undertaken is preferably cut off. Precautions like displaying "Men at Work" caution boards on the controlling switches, removing fuse carrier from these switches, and these fuse carriers being kept with the person working on the installation, etc. should be taken against accidental energisation. "Permit to Work" should be obtained from the Junior Engineer-in-charge. No work on H.T. main should be undertaken unless it is made dead and discharged to earth with an earthing lead of appropriate size. The discharge operation shall be repeated several times and the installation connected to earth positively before any work is started.

A.23 Before energizing on an installation after the work is completed, it should be ensured that all tools have been removed and accounted, no person is present inside any enclosure of the switch board etc., any earthing connection made for doing the work has been removed, "Permit to Work" is received back duly signed by the person to whom it was issued in token of having completed the work and the installation being ready for re-energising and "Men at Work" caution boards removed.

A.24 In case of electrical accidents and shock, the electrical installation on which the accident occurred should be switched off immediately and the affected person should be immediately removed from the live installation by pulling him with the help of his coat, shirt, wooden rod, broom handle or with any other dry cloth or paper. He should be removed from the place of accident to a nearby safe place and artificial respiration continuously given as contained in B.I.S. Code and Standard prescribed by St. John Ambulance Brigade or Fire Brigade.

A.25 While artificial respiration on the affected person is started immediately, help of Fire Brigade and Medical Practitioner should be called for and artificial respiration should be continued uninterrupted until such help arrives.

A.26 These instructions should be explained in Hindi/local language to those staff that does not understand English.

A.27 Executive Engineers should take particular care to ensure that these instructions are imparted to the existing staff and as well as to the new entrants.

[Manju Yadav] JE/TECH/CON/HQ	[B.B.Das] AEE/CON/PL/MLG	[B.C.Das] LLL/CON/MLG	[Ravi Bhushan] 15/6/16 DY.CEE/CON/HQ/MLG

[P.K.Sinha] CEE/CON/HQ/MLG

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APPENDIX B

SAFETY REQUIREMENTS

B.1 SCOPE

This section covers the requirements of items to be provided in the sub-station for compliance with statutory regulations, safety and operational needs.

B.2 REQUIREMENTS

In particular following items shall be provided:

a) Insulation Mats

Insulation mats conforming to IS 15652: 2006 shall be provided in front of main switch boards as well as other control equipments as specified.

b) First Aid Charts and First Aid Box

Charts (one in English, one in Hindi, one in Regional language), displaying methods of giving artificial respiration to a recipien. of electrical shock shall be prominently provided at appropriate place. Standard first aid boxes containing materials as prescribed by St. John Ambulance brigade or Indian Red Cross should be provided in each sub-station.

c) Danger Plate

Danger Plates shall be provided on HV and MV equipments. MV danger notice plate shall be 200 mm x 150 mm made of mild steel at least 2 mm thick vitreous enameled white on both sides and with the descriptions in signal red colour on front side as required. Notice plates of other suitable materials such as stainless steel, brass or such other permanent nature material shall also be accepted with the description engraved in signal red colour.

d) Fire Extinguishers

Portable CO_2 conforming to IS 2878: 1976/ chemical conforming to IS 2171: 1976 extinguishers, HCFC Blend A (P-IV) shall be installed in the sub-station at suitable places. Other extinguishers recommended for electric fires may also be used.

e) Fire Buckets

Fire buckets conforming to IS 2546: 1974 shall be installed with the suitable stand for storage of water and sand.

(Manju Yonzone) JE/TECH/CON/MLG	(B.Das) AEE/CON/TL/MLG	(B.Das) EEE/CON/MLG	(Ravi Bhushan) DY CEE/CON/HQ/MLG

(R.K.Mallick)
CEE/CON/NFR

f) Tool Box

A Standard tool box containing necessary tools required for operation and maintenance shall be provided in the sub-station.

g) Caution Board

Necessary number of caution boards such as "Man on Line" 'Don't Switch on' etc. shall be available in the sub-station.

h) Key Board

A keyboard of required size shall be provided at a proper place containing castle keys, and all other keys of sub-station and allied areas

(Manju Vansdia) JE/TECH/CON/HQ	(D.K.Das) AEE/CON/PL/MLG	(D.K.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(N.C.Acalinga)
CEE/CON/NFR

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APPENDIX C

FIRE HAZARDS

C.1 The main pre-requisites of a fire hazard free building are: -

(a) Installation based on sound design and use of quality materials and equipments.

(b) Good house keeping.

(c) Proper maintenance based on skilled personnel, proper supervision and preventive maintenance.

(d) Periodic inspection from fire hazard point of view by a qualified engineer.

C.2 Following instructions should be followed. Besides, based on the requirement of a particular building, other instructions may be issued for avoidance of possible fire hazard.

(i) No over loading of main board, DB, submain, wiring.

(ii) No loose wiring.

(iii) One socket outlet to feed one appliance only and do not use multiple outlets.

(iv) The AE (E) in charge will have an annual inspection of the building and list out deficiencies and report to the EE who will take necessary remedial action.

(v) Only MCB type DBs to be provided, so that overload, short circuit currents are interrupted immediately. Rewirable type fuses not to be used.

(vi) Change old/ outlived wiring, switchboard, and appliance.

(vii) Extension to wiring/ EI only after proper design and capacity of augmentation of the existing installation.

(viii) **Record Room** – No power outlet / switches should be provided inside the room. Use flameproof electrical fittings. In case it is a must to provide switches / outlets in a record room, they should be flameproof.

(ix) **Fire Protection**

(a) The building should have a comprehensive fire protection system in conformity with CFO's requirement, backed by proper manning and maintenance.

(Manju Yantome) JE/TLEH/CON/HQ	(B. S. Das) ALL/CON/PL/MLG	(R.Gilas) EFF/CON/MLG	15/6/16 (Ravi Bhushan) DY.CEE/CON/TIC/VLG

(R.K.Atrallya) CFF/CON/NFR

(b) Important building will have a fire control room, for monitoring and control of fire safety of the building.

(c) Local fire extinguishers for various electrical Switchgears Locations, Lift Machine Room, Electrical Sub-station, Generating Rooms, Pump Houses etc.

(d) Get CFO's annual inspection of the building done.

(e) Organize fire drill periodically, at least once in six months.

(x) **Maintenance**

Maintenance by qualified/ licensed (as applicable) personnel. When maintenance is done by contract system, only properly prequalified and skilled contractors to be deployed. Such contract should have preventive maintenance items.

(xi) Only quality and genuine material should be used.

(xii) When repairs are needed, act immediately, don't postpone repairs.

(xiii) Keep telephone/ address details of Fire Station/ Police/ Hospital/ Departmental Officials/Client Department Officials, both Office and Residence (in case of emergency).

(xiv) All switch rooms/ electrical shafts to be kept clean and duly locked. All locks will have common key, with keys available to all authorized personnel.

(xv) Keep appliances 'OFF' after office hours. Instruction to be issued, so that all switches and appliances are 'OFF' after office hours.

(Manju Vondrol) IF/TECH/CON/HQ	(U.B.Das) AEE/CON/PL/MLG	(B.Das) FEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Choliya) EEE/CON/AAR

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APPENDIX D

FIRE PROTECTION

D.1 Class of Fire

Class A : Fires involving Paper, Wood, Textile, Packing materials and the like.

Class B : Fires involving Oil, Petrol, Solvent, Grease, Paints, Celluloid and the like.

Class C : Fires involving Electrical Hazards, Motor Vehicle Gaseous substances under pressure.

Class D : Fires involving Chemicals, Metal and active like.

Class E : Fires involving Electrical equipment, Delicate machinery and the like.

D.2 Mode of Fire Protection

1. Sand/ Water buckets
2. Dry/ Wet Hydrant risers
3. Heat/ Smoke Detectors
4. Automatic/ Manual Fire Alarm
5. Sprinklers
6. Lightning Conductors
7. Fire Dampers in AC Ducts
8. Fire Doors with fusible link
9. Pressurization Plant
10. Public Address System
11. Fire Escapes/ External Stairs

D.3 Coverage (Floor) Area

1.	Water/ Sand Bucket	100 sq.mt.	4.	Sprinklers	6 sq.mt.
2	Extinguishers (9 lts)	600 sq.mt.	5.	Heat Detectors	16 sq.mt.
3	Hydrant Riser (Outlet 100 mm dia with landing valve and first aid hose reel)	100 sq.mt. 930 sq.mt.	6.	Smoke Detectors (For a ceiling height of 3 mts. and clean environment)	50 sq.mt.

D.4 Choice of Extinguishers

Type of Extinguishers	Suitable for Class of Fire
1. Soda Acid Type	Class - A
2. Foam Type	Class - B
3. Dry Chemical Powder Type	Class - B, C, D & E
4. Carbon-di-oxide Type	Class - B, C & E

(Manju Yonzone) JE/TECH/CON/HQ	(R.K.Das) SEE/CON/PL/MLG	(Pal Das) EEE/CON/MLG	15/6/16 (Hari Bhushan) DY.CLE/CON/HQ/MLG

(R.K.Ahuja)
CFE/CON/NFR

5. Water Carbon-di-oxide Type — Class - A
6. Carbo-Tetra-Chloride Type — Class - C

D.5 Water Requirement for the Fire Fighting

$Q = 3000\ P$ — Q = Fire demand in Liters/Minutes

P = Population in Thousands

Note: The above rate must be maintained at a minimum pressure of 1 to 1.5 kg / cm^2 for at least four hours.

[Manju Yondhe] JE/TECH/CON/HQ	[T.K.Das] AEE/CON/PL/MLG	[B.C.Das] EEE/CON/MLG	15/6/16 [Ravi Bhushan] DY.CFE/CON/HQ/MLG

[R.K.Mishra] CsE/CON/NFR

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APPENDIX E

SPACING OF OVERHEAD CONDUCTORS ON OVRHEAD LINES

E.1 Relevant pages of the following IS specification are enclosed.

E.1.1 Consideration of conductor spacing for 11 KV electrical overhead lines, [IS: 5613 (Part1/Sec1)-1985 page no 10 and page no .11 enclosed].

E.1.2 Consideration of conductor spacing for 33 KV to 220 KV electrical overhead lines. [IS: 5613 (Part2/Sec1)-1985 page no. 22 enclosed].

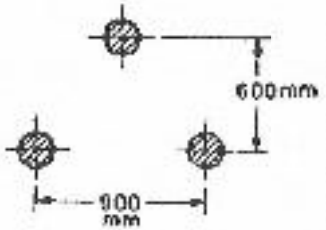
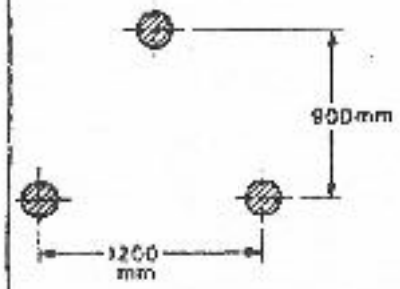
E.1.3 Consideration of span for 33 KV to 220 KV electrical overhead lines. [IS: 5613 (Part2/Sec1)-1985 page no. 7 enclosed].

[Name illegible] JE/TECH/CON/HQ	[B.K.Das] AEE/CON/PL/MLG	[R.Das] EEE/CON/ML/G	[Ravi Bhushan] DY.CEE/CON/HQ/MLG

[R.K.Abolish]
CEE/CON/NFR

TABLE 2 kW-km FOR 11 kV LINES WITH 12·5 PERCENT VOLTAGE REGULATION
(CONDUCTOR MATERIAL — ACSR AND COPPER)

(*Clause* 6.5.3)

Size of Conductor	kW-km at 80 Percent Power Factor for Various Configurations						kW-km at 100 Percent Power Factor		
									
	Equivalent Spacing 810 mm			Equivalent Spacing 1 145 mm					
	54·4°C	60°C	65·6°C	54·4°C	60°C	65·6°C	54·4°C	60°C	65·6°C
ACSR 15 mm²	8 216	8 082	7 952	8 155	8 023	7 894	9 662	9 477	9 300
ACSR 16 mm²	9 967	9 809	9 659	9 879	9 719	9 571	12 128	11 896	11 674
ACSR 20 mm²	11 618	11 436	11 269	11 491	11 312	11 148	14 592	14 309	14 045
ACSR 25 mm²	14 684	14 426	14 193	14 420	14 231	13 989	19 520	19 151	18 795
ACSR 30 mm²	17 336	17 093	16 867	17 054	16 810	16 600	24 438	23 957	23 517
Copper 4·25 mm dia	8 193	8 068	7 937	8 150	8 002	7 878	9 756	9 571	9 394
Copper 4·75 mm dia	11 109	10 939	10 773	10 982	10 821	10 660	14 061	13 798	13 538
Copper 16 mm²	9 944	9 780	9 642	9 851	9 698	9 553	12 250	12 014	11 793
Copper 35 mm²	17 062	16 827	16 608	16 780	16 552	16 341	25 512	24 029	23 586

where

U = voltage drop per km in volts,

I = line current in amperes,

R = ac resistance per km per conductor of the line in ohms,

ϕ = angle of lag/lead in degrees, and

X = reactance per km per conductor of the line in ohms.

6.4 Spacing of Conductors

6.4.0 The configuration of conductors is a matter of choice and no definite recommendations can be given in this code.

6.4.1 To have proper insulation clearance, in order to avoid trouble due to birds and to avoid conductors clashing due to wind, it is very essential that conductors in an overhead power line are adequately spaced.

6.4.2 There are no fixed rules for spacing arrangement of overhead line conductors. However, the following formula gives an economical spacing of conductors:

$$D = 500 + 10\,U + \frac{L^2}{50}$$

where

D = spacing in mm,

U = phase-to-phase voltage in kV, and

L = span length in m.

7. SAG-TENSION

7.1 In practice, for overhead line design, the general theory for sag-tension is based on the fact that if a flexible wire of uniform weight is suspended at two points at the same level, it sags and assumes the shape of a catenary curve. For short spans normally adopted for transmission and distribution lines the catenary is very nearly a parabola and hence the sag is calculated by the following formula:

$$S = \frac{wl^2}{8T}$$

where

S = sag in m,

w = weight of loaded conductor in kg per metre run,

l = span length in metres, and

T = maximum working tension in conductor in kg.

etc. The following values are representative of minimum spacings adopted currently:

Line kV	*No. of Circuits*	*Minimum Electrical Clearance Between Conductors, Metres*	
		Vertical	Horizontal
33	1 (on poles)	1·5	1·5
33	1 or 2	1·5	1·5
66	1 or 2	2·0	3·5
110	1 or 2	3·2	5·5
132	1 or 2	3·9	6·8
220	1 (horizontal formation)	—	6·0
220	1 or 2	4·9	8·4

NOTE — The standard empirical formula for determining conductor spacing is under consideration.

7.3.2.1 The values of minimum electrical clearances given in 7.3.2 do not take into account the effect of galloping or dancing of conductors. The galloping or dancing of conductors may be caused because of the following:

a) When a flock of birds perching together on a conductor suddenly takes off, leaving the conductor jumping in loops;

b) When ice on a portion of an ice-covered conductor melts and suddenly drops off; and

c) Under light drift wind conditions on ice covered conductor in valley.

7.3.2.2 There is no mechanical device available at present for effectively damping a galloping or dancing conductor. In any case, it is necessary that the conductors do not contact each other and for this purpose arrangements given below may be resorted to:

a) *Single circuit lines*

1) The conductors shall preferably be placed in horizontal formation on 'H-type' or 'Corset' type structures.

2) In case triangular formation has to be adopted, the conductor lying below an upper one shall be staggered out by a distance of

$$X = \frac{V}{150}$$

6.3 In case of hot-dip galvanized structures galvanizing shall conform to IS : 2633-1972*, IS : 4759-1979† and IS : 1367 (Part 13)-1983‡. For spring washers, bolts and nuts of 12·7 mm diameter or below, electrogalvanizing in accordance with IS : 1573-1970§ shall be acceptable.

6.4 **Choice of Spans** -- Besides others, the following factors influence the choice of span:

a) Ease of construction and cost of the line,

b) Ease of maintenance and maintenance cost of the line,

c) Terrain conditions, and

d) Availability and cost of relevant equipment.

6.4.1 The following span lengths may be considered for adoption:

Nominal System Voltage kV (rms)	*Number of Circuits*	*Span Range* m
33 (over poles)	1	90-135
33	1	180-305
	2	180-305
66	1	204-305
	2	240-320
110	1	305-335
	2	305-335
132	1	305-365
	2	305-380
220	1	320-380
	2	320-380

6.4.2 *Ruling (Equivalent) Span* -- For erecting an overhead line all the spans cannot be kept equal because of the profile of the land and proper clearance considerations. If this was done then adjustments of tensions would be necessary in adjacent spans since any alteration in temperature and loading would result in unequal tension in the various spans. This is

*Methods of testing uniformity of coating on zinc coated articles (*first revision*).

†Specification for hot-dip zinc coatings on structural steel and other allied products (*first revision*).

‡Technical supply conditions for threaded steel fasteners; Part 13 Hot-dip galvanized coatings on threaded fasteners (*second revision*).

§Electroplated coatings for zinc on iron and steel (*first revision*).

NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

APPENDIX F

CONVENTIONAL SIGNS & SYMBOLS FOR ELECTRICAL INSTALLATION

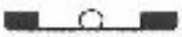
General wiring

Wiring on the surface

Wiring under the surface

WIRING IN CONDUIT

Conduit on surface



Concealed Conduit

Wiring going upwards

Wiring going downwards

Wiring passing vertically

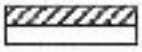
FUSE BOARDS

LIGHTING CIRCUIT FUSE BOARDS

Main fuse-board without switches

Main fuse-board with switches

Distribution fuse-board without switches



Distribution fuse-board without switches

(Manju Yonzone) JE/TECH/CON/HQ	(D.Das) AEE/CON/PL/MLG	(D.C.Das) EEE/CON/VLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(B.K.Moliya)
CEE/CON/NER

POWER CIRCUITS FUSE BOARDS

Main fuse without switches

Main fuse board with switches

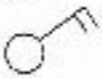
Distribution fuse-board without switches

Distribution fuse-board without switches

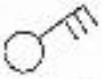
SWITCHES AND SWITCH OUTLETS

ONE WAY SWITCH

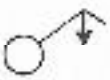
Single pole



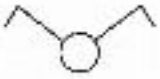
Double pole



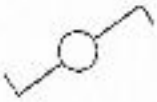
Three pole



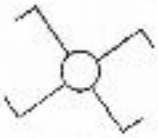
Single pole pull switch



Multi position switch (for different degrees of lighting)



Two way switch

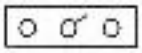


Intermediate switch

Period limiting switch

(Manju Yonzone) Jr/ SCH/CON/HQ	(B.K.Das) AEE/CON/PL/MIS	(B.C.Das) FFF/CON/MLC	(Ravi Bhushan) DY.CEE/CON/HQ/MLS

(R.K.Atoliya)
CEE/CON/A&R



Time switch

Pendant switch

Push button

Luminous push button

Restricted access push button

SOCKET OUTLETS

Socket outlet, 5A

Socket outlet, 15A

Combined switch & socket outlet, 5A

Combined switch & socket outlet, 15A

Interlocking switch & socket outlet, 5A

Interlocking switch & socket outlet, 15A

(Manju Yonzone) JE/TECH/CON/HQ	(Dilip Das) AEE/CON/FL/MLG	(Ajit Das) SEE/CON/MLG	13/6/16 (Ravi Bhushan) DY.CFF/CON/HQ/MLC

(R.K.Abbi)
CEE/CON/NF3

LAMPS AND LIGHTING APPARATUS


Lamp or outlet for lamp

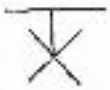
Group of three 40W lamps


Lamp mounted on a wall


Lamp mounted on a ceiling


Counter weight lamp fixture


Chain lamp fixture


Road lamp fixture


Lamp fixture with built-in-switch


Lamp fed from variable voltage supply


Emergency lamp

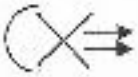

Panic lamp


Bulk head lamp

Water tight light fitting

Batten lamp holder

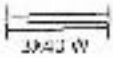
Projector



Spot light

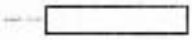
Flood light

Fluorescent lamp



Group of three 40W fluorescent lamps

ELECTRICAL APPLIANCES



General

BELL, BUZZERS

Bell push

Bell

Buzzer

(Manju Yonzone) JE/TECH/CON/TVC	(S.K.Das) ALE/CON/PUDMG	(B.C.Das) ELE/CON/MLG	(Ravi Bhushan) DY.CE/CON/HQ/MLG

(R.K.Mallick)
CEE/CON/NFR

FIRE ALARM

Fire alarm push

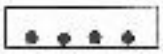
Automatic contact

Bell connected to fire alarm

Fire alarm indicator (At 'N' insert number of ways)

PUBLIC ADDRESS SYSTEM

Amplifier

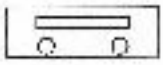


Control board

Microphone outlet

Loudspeaker outlet

RADIO RECEPTION OUTLETS



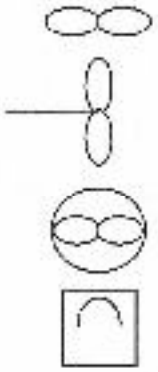
Receiver outlet

Aerial

(Manju Yonzone) IE/TECH/CON/HQ	(D.K.Das) ALL/CON/PL/MLG	(D.C.Das) CLL/CON/MLG	(Ravi Dhusiya) DY CLE/CON/TID/MLG

(D.K.Gupta)
CLE/CON/NFR

FIXED APPARATUS OUTLETS



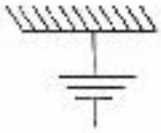
Ceiling fan

Bracket fan

Exhaust fan

Fan regulator

EARTHING



Earth Point

(Manju Yonzone) JE/TLCI/CON/HQ	(B.K.Das) AEE/CON/PI/MLG	(B.C.Das) EEE/CON/P.I.C.G	15/6/16 (Ravi Bhushan) DY.CEE/CON/HQ/MLG

(B.K.Mallick)
CEE/CON/NFR

NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

APPENDIX G

IMPORTANT INDIAN STANDARDS

S.No	IS Number	Standard Title
1	IS/10000/Part 1/1980	Method of tests for internal combustion engines: Part 1 Glossary of terms relating to Test
2.	IS10000/Part10/1980	Methods of test for internal combustion engines: Part 10 Tests for Smoke Levels, Limits and Corrections for Smoke Levels for Variable Speed Compression Ignition Engines.
3	IS10000/Part 11/1980	Methods of tests for internal combustion engines: Part 11 Information to be supplied by the purchaser to the manufacturer and information to be supplied by the manufacturer along with the engine
4	IS10000/Part 13/1980	Methods of tests for internal combustion engines- Part 13: Recommendations on Nature of Tests Required for Functional changes in Critical Components
5	IS10000/Part2/1980	Methods of tests internal combustion engines; Part 2 Standard for reference conditions
6	IS10000/Part3/1980	Methods of tests for internal combustion engines: Part 3 Measurements for testing units and limits for accuracy
7	IS10000/Part5/1980	Methods of tests for internal combustion engines: Part 5 preparation for tests and measurements for wear
8	IS10000/Part6/1980	Methods of tests for internal combustion engines: Part 6 Recording of test results
9	IS10000/Part7/1980	Methods of tests for internal combustion engines: Part 7 Governing tests for constant speed engines and selection of engines for use with electrical generators
10	IS10000/Part8/1980	Methods of tests for internal combustion engines: Part 8 Performance tests
11	IS10000/Part9/1980	Methods of tests for internal combustion engines: Part 9 Endurance tests
12	IS10000/Part IV/1980	Methods of tests for internal combustion Engines Part IV: Declaration of Power, Efficiency, Fuel Consumption and Lubricating Oil
13	IS10000/PartXII/1980	Methods of tests for internal combustion Engines- Part XII: Specimen Test Certificates
14	IS10001/1981	Specification for performance requirements for constant speed compression ignition (diesel) engines for general purposes(up to 20
15	IS 10027/2000	Composite units of Air-break Switches and Rewritable Type Fuses for Voltages Not Exceeding 650 V Ac- Specification

16	IS 10118/Part 2/1982	Code of practice for selection, installation and maintenance of Switchgear and control gear: Part 2 Selection
17	IS10118/Part 3/1982	Code of practice for selection installation and maintenance of Switchgear and control gear. Part 3 Installation.
18	IS10118/Part 4/1982	Code of practice for selection installation and maintenance of Switchgear and control gear. Part 4 Maintenance
19	IS 10118/Part I/1982	Code of practice for selection installation and maintenance of Switchgear and control gear: Part 1 : General
20	IS 10322/Part1/ 1982	Luminaries. Part 1 General requirements
21	IS10322/Part 2/1982	Specification for Luminaries- Part 2. Constructional Requirements
22	IS 10322/Part	Specification for Luminaries- Part 3: Screw and Screw less Terminals
23	IS 10322/Part4/	Specification for Luminaries – Part 4: Methods of Tests
24	IS10322/Part 5/Sec1/1985	Luminaries: Part 5 Particular requirements, sec 1 General purpose luminaries
25	IS 10322/Part	Specification for Luminaries Part 5: Particular Requirements- Section 2: Recessed Luminaries
26	IS10322/Part 5/Sec	Luminaries: Part 5 Particular requirements, Section 3 Luminaries for road and street lighting (superseding IS: 2149)
27	IS 10322/Part 5	Luminaries Part 5 Particular requirements, Section 4 portable general purpose luminaries.
28	IS 10322/Part	Luminaries Part 5 particular requirements, Section 5 Flood light (superseding IS: 1947)
28A	IS:15111	T-5 Fluorescent tubelight
29	IS 10617/Part 1/ 1983	Specific for Hermetic Compressors- Part 1: High Temperature Application Group
30	IS/10617/Part 2/1983	Specification for Hermetic Compressors – Part 2. Medium Temperature Application group
31	IS 10617/Part	Specification for Hermetic Compressors- Part 3: Low Temperature Application group
32	IS 11037/1984	Electronic type fan regulators
33	IS 11338/1985	Specification for Thermostats for Use in Refrigerators, Air Conditioners, Water Coolers and Beverage Coolers
34	IS 12021/1987	Specification for Control Transformers for Switchgear and Control gear for Voltages not exceeding 1000V ac.
35	IS12155/1987	General and safety requirements for fans and regulators for household and similar purposes

36	IS1239/Part 1/2004	Steel tubes, tubular and other wrought steel fittings- specification-part 1: Steel Tubes
37	IS 1239/Part 2/1992	Mild steel tubes, tubular and other wrought steel fittings, part 2 mild steel tubular and other wrought steel pipe fittings
38	IS 1248/Part 1/2003	Direct Acting indicating analogue electrical measuring instruments and their accessories- specification – part:1 Definitions and General Requirements
39	IS 1248/Part 2/2003	Direct Acting indicating analogue electrical measuring instruments and their accessories-Part 2: Special Requirements for Ammeters and Voltmeters
40	IS 1248/Part 3/2003	Direct Acting indicating analogue electrical measuring instruments and their accessories- Part 3: Special Requirements for Watt meters and Varmeters
41	IS 1248/Part 4/2003	Direct Acting indicating analogue electrical measuring instruments and their accessories- Part4: Special Requirements for Frequency Meters
42	IS 1248/Part 5/2003	Direct Acting indicating analogue electrical measuring instruments and their accessories- Pat 5: Special Requirements for Phase Meters, Power Factors Meters and Synchroscopes
43	IS 1248/Part 6/2003	Direct Acting indicating analogue electrical measuring instruments and their accessories- Part6: Special Requirements for Ohmmeters (Impedance Meters) and Conductance Meters
44	IS 1248/Part 7/2003	Direct Acting indicating analogue electrical measuring instruments and their accessories- Part 7: Special Requirements for Multi- Function instruments
45	IS 1248/Part 8/2003	Direct Acting indicating analogue electrical measuring instruments and their accessories- Part 8: Special Requirements for Accessories
46	IS 1248/Part 9/2003	Direct Acting indicating analogue electrical measuring instruments and their accessories- Part 9: Test Methods
47	IS 1255/1983	Code of practice for installation and maintenance of power cables up to and including 33 kV rating
48	IS 1258/2005	Bayonet Lamp holders
49	IS12640/Part 1/2000	Residual Current Operated Circuit- Breaking for Household and Similar Uses- Part 1 Circuit- Breakers with Integral Over current Protection (RCCBs)
50	IS 12640/Part 2/2001	Residual Current Operated Circuit- Breaking for Household and Similar Uses- Part 2 Circuit- Breakers with Integral Over current Protection (RCVOs)
51	IS 1271/1985	Thermal evaluation and classification of electrical insulation

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(R.K.Mishra)
CLL/CON/HQ

52	IS 1293/2005	Plugs and Socket- Outlets of Rated Voltage Up to and including 250 Volt and Rated Current Up to and including 16 Amperes- Specification
53	IS 13010/2002	AC Watt Hour Meters, Class 0.5, 1 and 2 – Specification
54	IS 13032/2002	Ac Miniature Circuit- Breaker Boards for Voltages not exceeding 1000V- Specification
55	IS 13118/1991	Specification for High – Voltage Alternating – Current Circuit-Breakers
56	IS 13340/1993	Power Capacitors of self-healing Type for Ac Power Systems having Rated Voltage up to 650 V – Specification.
57	IS 13779/1999	AC Static Watt- hour Meters, Class 1 and 2- Specification
58	IS 13925/Part 1/19 98	Shunt capacitors for Ac power systems having a rated voltage above 1000 V Part 1 : General performance, testing and rating safety requirements- Guide for installation and operation
59	IS 13925/Part	Shunt Capacitors for Ac Power Systems Having a Rated Voltage Above 1000 V – Part 2: Endurance Testing
60	IS 13925/Part 3/2002	Shunt Capacitors for Ac Power Systems Having a Rated Voltage Above 1000 V- Part 3: Protection of Shunt Capacitors and Shunt Capacitor Banks
61	IS 13947/Part 1/1993	Specification for Low Voltage Switchgear and Control gear – Part 1: General Rules.
62	IS 13947/Part 2/1993	Specification for Low- Voltage Switchgear and Control gear- part 2: Circuit Breakers
63	IS 13947/ Part 3/1993	Specification for Low Voltage Switchgear and Control gear-Part 3: Switches, Disconnectors, Switch Disconnectors and Fuse Combination Units.
64	IS 13947/Part 4/Sec 1/1993	Specification for. Low-Voltage Switchgear and Control gear- Part 4: Contractors and Motor-starters- Section 1: Electromechanical Contractors and Motor Starters
65	IS 13947/ Part Part 5/Sec 1/2004	Low Voltage Switchgear and Control gear- specification- Part 5: Control Circuit Devices and Switching Elements- Section 1: Electromechanical Control Circuit Devices
66	IS 13947/Part 5/Sec 2/2004	Low Voltage Switchgear and Control gear- specification- Part 5: Control Circuit Devices and Switching Elements- Section 2: Proximity Switches.
67	IS 1445/1977	Porcelain insulators for overhead power lines with a nominal voltage upto and including 1000 V
68	IS 1460/2005	Automotive Diesel Fuels- Specification

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(R.K.Arolia)
CEE/CON/NER

69	IS 14697/1999	AC Static Transformer Operated Watt-hour and VAR Hour Meters, class 0.2 and 0.5 S- Specification
70	IS 1475/1978	Specification for Self-contained Drinking Water Coolers
71	IS 1475/Part 1/2001	Self-Contained Drinking Water Coolers- Specification – Part 1: Energy Consumption and Performance
72	IS 1897/1983	Copper Strip for electrical purposes
73	IS 14772/2000	General Requirements for Enclosures for Accessories for Household and Similar Fixed Electrical Installations- Specification
74	IS 14930/Part 1/2001	Conduit Systems for Electrical Installations- Part 1: General Requirements
75	IS 14930/Part 2/2001	Conduit Systems for Electrical Installations- Part 2: Particular Requirements- Conduit Systems Buried Underground
76	IS 15111/part 1/2002	Self Ballasted Lamps for General Lighting Services- Part1: Safety Requirements
77	IS 15111/Part 2/2002	Self Ballasted Lamps for General Lighting Services- Part 2: Performance Requirements
78	IS 1678/1998	Specification for prestressed concrete poles for overhead power, traction and telecommunication lines
79	IS 1777/1978	Industrial luminaries with metal reflectors
80	IS 1897/1983	Copper strip for electrical purposes
81	IS 1944/Part 5/1981	Code of practice for lighting of public thoroughfare: Part 5 Lighting for grade separated junctions, bridges and elevated roads (Group D)
82	IS 1944/Part 6/1981	Code of practice for lighting of public thoroughfare: Part 6 Lighting for towns and city centres and areas of civic importance (Group E)
83	IS 1944/Part 7 /1981	Code of practice for lighting of public thoroughfare Part 7 lighting for roads with special requirement (Group F)
84	IS 1944/Parts I and II/1970	Code of practice for Lighting of public Throughfares
85	IS 2026/Part 1/1977	Power transformers; Part 1 General
86	IS 2026/Part 2/1977	Power transformers: Part 2 Temperature-rise
87	IS 2026/Part 3/1981	Power transformers: Part 3 Insulation level and dielectric tests
88	IS 2026/Part 4/1977	Power transformers: Part 4 Terminal marking, tappings and connections

89	IS 2026/Part 5/1994	Power Transformer: Part 5 Transformer/Reactor bushings minimum external clearance in air specification
90	IS 2036/1995	Phenolic Laminated Sheets- Specification
91	IS 2082/1993	Stationary storage type electric water heaters
92	IS 2086/1993	Carriers and bases used in rewirable type electric fuses for voltages up to 650 V
93	IS2121/Part 1/1981	Conductors and earth wire accessories for overhead power lines: Part 1 Armour rods, binding wires and tapes for conductors
94	IS 2121/Part 2/1981	Conductors and earth wire accessories for overhead power lines: Part 2 Mid span joints and repair sleeves for conductors
95	IS 2121/Part3/ 1992	Conductors and earthwire accessories for overhead power lines: part 3 Accessories for earthwire
96	IS 2121/Part 4/1991	Conductors and earth wire accessories for overhead power lines: part 4 non tension joints
97	IS 2141/2000	Hot Dip Galvanized Stay Strand- Specification
98	IS 2206/Part 2/1976	Flameproof electric lighting fittings: Part 1 Well-glass and bulkhead types
99	IS 2206/Part 3/1976	Flameproof electric lighting fittings: Part 2 Fittings using glass tubes
100	IS 2206/Part 3/1989	Flameproof electric lighting fittings: Part 3 Fittings Using Fluorescent Lamps and Plastic Covers
101	IS 2206/Part 4/1987	Specification for Flameproof Electric Lighting Fittings- Part 4: Portable Flame-proof Hand lamps and Approved Flexible Cables.
102	IS 2268/1994	Electric call bells and buzzers for indoor use
103	IS 2312/1967	Propeller type ac ventilating fans
104	IS2418/Part I/1977	Specification for Tubular Fluorescent Lamps for General Lighting Service- Part I: Requirements and Tests
105	IS2448/Part 1/1963	Adhesive insulating tapes for electrical purposes: Part 1 Tapes with cotton textile substrates
106	IS2516/Part 1/Sec 1/1985	Circuit breakers: Part 1 &2 Requirements and tests: sec 1 Voltages not exceeding 1000 V AC or 1200 V DC (Withdrawn)
107	IS2516/Part 1/Sec 2/1980	Circuit-breakers: Part 1 General and definitions, sec 2 For voltages above 1000 V AC (Withdrawn)
108	IS 2516/Part 1/Sec 3/1972	Circuit breakers: Part 1 General and definitions, section3 Voltages above 11 kV (Withdrawn)
109	IS2516/Part 2/Sec 2/1980	Circuit Breakers: Part 2 rating, sec 2 for voltages above 1000 V AC (Withdrawn)
110	IS2516/Part 3/Sec 2/1980	Circuit breakers: Part 3 Design and construction, sec 2 for Voltages above 1000 V AC (Withdrawn)

(Manju Pohekar) JE/TECH/CON/HQ	(R.C.Das) AEE/CON/PL/MUG	(R.C.Das) EEE/CON/MUG	15/6/16 (Ravi Bhushan) DY CEE/CON/HQ/MUG

(R.K.Atolia)
CEE/CON/HQ

111	IS2516/Part 4/Sec 2/1980	Circuit Breakers: Part 4 Type Tests and Routine Tests: sec 2 For Voltages above 1000 V AC (Withdrawn)
112	IS2516/Part 5/Sec 2/1980	Circuit Breakers: Part 5 Information to be given with enquiries Tenders and Orders and Rules of Transport Erection and Maintenance : sec 2 for Voltages above 1000 V AC (Withdrawn)
113	IS 2551/1982	Danger Notice plates
114	IS 2629/1985	Recommended Practice for Hot-Dip Galvanizing of Iron and Steel
115	IS 2667/1988	Fittings for rigid steel conduits for electrical wiring
116	IS 2675/1983	Enclosed distribution fuse boards and cutouts for voltages not exceeding 1000 V Ac and 1200 V DC
117	IS 269/1989	Specification for 33 grade ordinary Portland cement
118	IS 2705/Part 1/1992	Current transformers: Part 1 General requirements
119	IS 2705/Part 2/1992	Current transformers: Part 2 Measuring current transformers
120	IS 2705/Part 3/1992	Current transformers: Part 3 Protective current transformers
121	IS 2705/Part 4/1992	Current transformers: Part 4 Protective current transformers for special purpose applications
122	IS 2713/Parts 1 to 3/1980	Specification for Tubular Steel Poles for Overhead Power Lines
123	IS 278/1978	Specification for Galvanized Steel Barbed Wire for Fencing
124	IS 2905/1989	Methods of test for concrete poles for overhead power and telecommunication lines
125	IS 2997 /1964	Air circulator type electric fans and regulators
126	IS 302/Part 1/1979	General and Safety Requirements for Household and Similar Electrical Appliances
127	IS 302/Part 2/sec 201/1992	Safety of household and similar electrical appliances: Part 2 Particular requirements, Section 201 Electric immersion water heater
128	IS 302/Part 2/sec 203/1994	Safety of Household and similar Electrical Appliances- Part 2: Particular Requirements- Section 203 Electric Call Bells and Buzzers for Indoor Use
129	IS 302/Part 2/sec 204/1994	Safety of household and similar electrical appliances: Part 2 Particular requirements: Section 204 Electric water boilers
130	IS 302/Part 2/sec 21/1992	Safety of household and similar electrical appliances Part 2 Particular requirements. Section 21 Stationary storage type electric water heater
131	IS 302/Part 2/sec 35/1993	Safety of Household and Similar Electrical Appliances – Part 2: Particular Requirements- Section 35: Electric Instantaneous Water Heaters

(Manju Yadav) JE/TECH/CON/HQ	(Dey Das) AEE/CON/PL/MLG	(K.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Atoliya)
CPE/CON/SER

132	IS 302/Part 2 sec 59/1999	Safety of Household and Similar Electrical Appliances- Part 2: Particular Requirements- Section 59: Insect Killers
133	IS 302/Part 2/sec 80/2003	Safety of Household and Similar Electrical Appliances- Part 2 Particular Requirements- Section: 80 Fans
134	IS 304/1981	Specification for High Tensile Brass ingots and Castings
135	IS 3043/1987	Code of Practice for earthing
136	IS 3156/Part 1/1992	Voltage transformers: Part 1 General General requirements
137	IS 3156/Part 2/1992	Voltage transformers: Part 2 Measuring voltage transformers
138	IS 3156/Part 3/1992	Voltage transformers: part 3 Protective voltage transformers
139	IS 3156/Part 4/1992	Voltage Transformers: Part 4 Capacitor voltage transformers
140	IS 3231/Part 0/1986	Electrical relays for power systems protection: Part 0 General introduction and list of parts
141	IS 3231/Part 1/Sec 1/1986	Specification for Electrical Relays for Power System Protection part 1 : General Requirements Section 1: Contact Performance
142	IS 3231/Part 1/Sec 2/1986	Electrical relays for power system protection: Part 1 General requirements, section 2 Insulation tests
143	IS 3231/Part 1/Sec 3/1986	Electrical relays for power system protection: Part 1 General requirements, section 3 High frequency disturbance test for static relays
144	IS 3231/Part 2/Sec 1/1987	Specification for Electrical Relays for Power System Protection- Part 2 - Requirements for Principal Families- Section 1 : All -or- Nothing Relays
145	IS 3231/Part 2/Sec 2/1987	Specification for Electrical Relays for Power System Protection- Part 2: Requirements for Principal Families- Section 2: General Requirements for Measuring Relays
146	IS 3231/Part 2/Sec 3/1987	Electrical relays for power system protection: Part 2 requirements for principal families, section 3 General requirements for thermal relays
147	IS 3231/Part 3/Sec 1/1987	Specification for Electrical Relays for Power System Protection- Part 3: Requirements for Particular Group of Relays- Section 1: Non-specified Time or Independent Specified Time Measuring Relays.
148	IS 3231/Part 3/Sec 2/1987	Specification for Electrical Relays for Power System Protection- Part 3: Requirements for Particular Group of Relays- Section 2: dependent Specified Time Measuring Relays.
149	IS 3231/Part 2/Sec 3/1987	Specification for Electrical Relays for Power System Protection- Part 3: Requirements for Particular Group of Relays- Section 3. Biased (percentage) Differential Relays.

(Manju Yadav) EE/TECH/CON/HQ	(Sanjay Das) AEE/CON/PL/MUG	(Sachin) EEE/CON/MUG	(Ravi Bhushan) DY.CLL/CON/HQ/MUG

(R.K.Arolia)
CEE/CON/NHP

150	IS 3231/Part 3/Sec 4/1987	Specification for Electrical Relays for Power System Protection- Part 3: Requirements for Particular Group of Relays- Section 4: Directional Relays and Power Relays.
151	IS 3231/Part 3/Sec 5/1987	Electrical relays for power system Protection; Part 3 Requirements for particular group of relays, section 5 Impedance measuring relays
152	IS 325/ 996	Three phase induction motors
153	IS 12463/ 1998	New insulating oils
154	IS 3412/1994	Electric water boilers
155	IS 3419/1988	Fittings for rigid non-metallic conduits
156	IS 3427/1997	AC Metal Enclosed Switchgear and Control gear for Rated Voltages Above 1 kV and Up to and including 52 kV
157	IS 3528/1966	Waterproof electric lighting fittings
158	IS 3553/1966	Specification for Watertight Electric Lighting Fittings
159	IS 371/1999	Ceiling Roses- Specification
160	IS 374/1979	Electric Ceiling type fans and regulators
161	IS 3764/1992	Code of safety for excavation work
162	IS 3842/Part 12/1976	Application guide for electrical relays for Ac systems: Part 12 Differential relays for transformers
163	IS 3842/Part IV/1966	Application Guide for Electrical Relays for AC Systems- Part IV: Thermal Relays
164	IS 3854/1997	Switches for domestic and similar purposes
165	IS 3895/1966	Mono crystalline semi-conductor rectifier cells and stacks
166	IS 398/Part 1/1996	Aluminium conductors for overhead transmission purposes: Part 1 Aluminium stranded conductors
167	IS 398/Part 2/1996	Aluminium conductors for overhead transmission purposes. Part 2 Aluminium conductors, galvanized steel reinforced.
168	IS 398/Part 3/1976	Aluminium conductors for overhead transmission purposes: Part 3 Aluminium conductors, aluminized steel reinforced.
169	IS 398/Part 4/1994	Aluminium conductors for overhead transmission purposes; Part 4 Aluminium alloy stranded conductors (aluminium magnesium silicon type)
170	IS 398/Part 5/1992	Aluminium conductors for overhead transmission purposes; Part 5 Aluminium conductors, galvanized steel reinforced for extra high voltage (400 kV and above).
171	IS4064/Part 1/1978	Air break switches, air-break disconnectors, air break switch disconnectors and fuse-combination units for voltages not exceeding 1000 V ac or 1200 V dc: Part 1 General requirements

172	IS 4064/Part 2/1978	Air break switches, air-break disconnectors, air break switch disconnectors and fuse-combination units for voltages not exceeding 1000 V AC or 1200 V dc: Part 2 Specific requirements for the direct switching of individual motors
173	IS 4160/2005	Interlocking Switch Socket Outlets- Specification
174	IS 418/2004	Tungesten Filament Lamp for Domestic and Similar General Lighting Purposes
175	IS 4289/Part 1/1984	Specification for Flexible Cables for Lifts and Other Flexible Connections- Part 1: Elastomer Insulated Cables
176	IS 4289/Part / 2/2000	Flexible Cables for Lifts and Other Flexible Connections- Specification- Part 2. PVC Insulated Circular Cables
177	IS 4347/1967	Code of practice for hospital lighting
178	IS 4540/1968	Monocrystalline semiconductor rectifier assemblies and equipment
179	IS 4615/1968	Switch socket outlets (non-interlocking type)
180	IS 4648/1968	Guide for Electrical Layout in Residential Buildings
183	IS 4722/2001	Rotating Electrical Machines- specification
181	IS 4770/1991	Rubber Gloves- electrical Purposes- Specification
182	IS 4794/Part 1/1968	Push button switches: Part 1 General requirements and tests
183	IS 4794/Part 2/1986	Push buttons switches: Part 2 push button switches, type 1
184	IS 4984/1995	Specification for high density polyethylene pipes for potable water supplies.
185	IS 5039/1983	Distribution pillars for voltages not exceeding 1000 V Ac and 1200 V DC
186	IS 5082/1998	Wrought aluminium and aluminium alloy bars, rods, tubes and sections for electrical purposes
187	IS 5216/Part I/1982	Recommendations on safety procedures and practices in Electrical Work- Part I: General
188	IS 5216/Part II/1982	Recommendation on Safety procedures and practices in Electrical Work- Part II: Life Saving Techniques
189	IS 5300/1969	Specification for Porcelain Guy Strain Insulators
190	IS 5578/1984	Guide for marking of insulated conductors
191	IS 5613/Part 1/Sec 1/1985	Code of practice for Design, installation and Maintenance of Overhead power Lines- Part 1: Lines Up to and Including 11 kV- section 1: Design
192	IS 5613/Part 1/Sec 2/1985	Code of practice for Design, installation and Maintenance of Overhead power Lines- Part 1: Lines Up to and Including 11 kV- section 2: Installation and Maintenance

[Manju Yonzone] JE/ LC I/CON/TIC	[D.K.Das] AEE/CON/PL/MLG	[D.K.Das] ELL/CON/MLG	[Ravi Bhushan] DY.ELL/CON/TIC/MLG

[R.K.Ahuja] CEE/CON/MTR

193	IS 5613/Part 2/Sec 1/1985	Code of practice for Design, installation and Maintenance of Overhead power Lines- Part 2: Lines above 11 kV Up to and Including 220 kV- section 1: Design
194	IS 5613/Part 2/Sec 2/1985	Code of practice for Design, installation and Maintenance of Overhead power Lines- Part 2: Lines above 11 kV and Up to and Including 220 k V. - section 2: Installation and maintenance.
195	IS 5613/Part 3/Sec 1/1989	Code of practice for Design, installation and Maintenance of Overhead power Lines- Part 3: 400 kV Lines section 1: Design
196	IS 5613/Part 3/Sec 2/1989	Code of practice for Design, installation and Maintenance of Overhead power Lines- Part 3:400 kV Lines –Section 2 Installation and Maintenance
197	IS 6236/1971	Direct Recording electrical measuring instruments
198	IS 694/1990	PVC insulated cables for working voltages up to and including 1100 V
199	IS 6949/1973	Summation current transformers
200	IS 6792/1992	Method for Determination of Electric Strength of Insulating Oils
201	IS 7098/Part 1/1988	Cross linked polyethylene insulated PVC sheathed cables: Part 1 For working voltage up to and including 1 100 V
202	IS 7098/Part 2/1985	Cross linked polyethylene insulated PVC sheathed cables: Part 2 for working voltages from 3.3 kV up to and including 33 kV
203	IS 7098/Part 3/1993	Cross –linked polythelene insulated thermoplastic sheathed cables: part 3 for Working voltages from 66 kV upto and including 220 kV
204	IS 731/1971	Porcelain insulators for overhead power lines with a nominal voltage up to and including 1000 V
205	IS 732/1989	Code of Practice for Electrical Wiring Installations.
206	IS 7321/1974	Code of practice for selection, handling and erection of concrete poles for overhead power and telecommunication lines
207	IS 7935/1975	Insulator fittings for overhead power lines with a nominal voltage up to and including 1000 V
208	IS 800/1984	Code of practice for general construction in steel
209	IS 802/Part 1 Sec 1/1995	Code of practice for use of structural steel in overhead transmission line towers, Part 1 Materials and Loads and permissible stresses Section 1 Materials and Loads
210	IS 802/Part 1 /Sec 2/1992	Code of practice for use of structural steel in overhead transmission line towers part 1 Material, loads and permissible stress section 2 Permissible stress.

211	IS 802/Part 2/1978	Code of Practice for use of structural steel in overhead transmission line towers- Part II- Fabrication, Galvanizing, Inspection and Packing
212	IS 802/Part 3/1978	Code of practice for use of structural steel in overhead transmission line towers, part 3 Testing
213	IS 8034/2002	Submersible Pumpsets-specification
214	IS 8041/1990	Specification for rapid hardening Portland cement
215	IS 8061/1976	Code of practice for design, installation and maintenance of service lines upto and including 650 V
216	IS8183/1993	Bonded mineral wool
217	IS 8530/1977	Maximum demand indicators (class 1)
218	IS 8623 Part 1/1993	Specification for Low- Voltage Switchgear and Controlgear Assemblies- Part 1: Requirements for Type-Tested and partially type- Tested Assemblies
219	IS 8623/Part 2/1993	Specification for Low- Voltage Switchgear and Controlgear Assemblies- Part 2: Particular Requirements for Busbar Trunking Systems (Busway)
220	IS 8623/Part 3/1993	Specification for Low- Voltage Switchgear and Controlgear Assemblies- Part 3: Particular Requirements for Equipment where unskilled persons have Access for their use.
221	IS 875/Part 1/1987	Code of practice for design loads (other than earthquake) for buildings and structures Part 1 Dead loads- Unit weights of building material and stored materials (Incorporating IS1911:1967)
222	IS 875/Part 2/1987	Code of practice for design loads (other than earthquake) for buildings and structures Part 2: imposed loads
223	IS 875/Part 3 1987	Code of practice for design loads (other than earthquake) for buildings and structures Part 3: Wind loads
224	IS 875/Part 4/1987	Code of practice for design loads (other than earthquake) for buildings and structures Part 4 Snow loads
225	IS 875/Part 5/1987	Code of practice for design loads (other than earthquake) for buildings and structures Part 5 Special loads and load combinations
226	IS 8828/1996	Electrical Accessories- Circuit Breakers for Over Current Protection for Household and Similar Installations
227	IS 8884/1978	Code of practice for the installation of electric bells and call system
228	IS 9224/Part 1/1979	Low voltage fuses: Part 1 General requirements (Withdrawn)

(Manju Yonzone) IE/TECH/CON/HQ	(D. Das) AEE/CON/PC/MLG	(D. Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(B.C.Acaliya)
CEE/CON/NER

229	IS 9224/Part 2/1979	Low voltage fuses: Part 2 Supplementary requirements for fuses for industrial applications (Withdrawn)
230	IS 9224/Part 4/1980	Low voltage fuses: Part 4 Supplementary requirements for fuse-links for the protection of semiconductor devices (Withdrawn)
231	IS 9537/Part 1/1980	Conduits for electrical installations: Part 1 General requirements
232	IS 9537 /Part 2/1981	Conduits for electrical installations : Part 2 Rigid steel conduits (superseding IS :1653)
233	IS 9537/Part 3/1983	Conduits for electrical installations: Part 3 Rigid plain conduits of insulating materials (superseding IS: 2509)
234	IS 9537/Part 4/1983	Specification for Conduits for Electrical Installations – Part 4: Pliable Self- recovering Conduits of Insulating Materials
235	IS 9537/Part 5/2000	Conduits for Electrical Installations- Part 5: Pliable conduits of Insulating Material
236	IS 9537/Part 6/2000	Conduits for Electrical Installations- Specification- Part 6: Pliable Conduits of Metal or Composite Materials.
237	IS 9537/Part 8/2003	Conduits for Electrical Installations- Specification- Part 8: Rigid Non- Threadable Conduits of Aluminium Alloy
238	IS 9583/1981	Emergency lighting units
239	IS 9900/Part 1/1981	High pressure mercury vapour lamps. Part 1 Requirements and test
240	IS 9974/Part 1/1981	High pressure sodium vapour lamps: Part 1 General requirements and tests
241	IS 13573: 1992	Joints and Terminations of Polymeric Cables for Working Voltages from 6.6 kV up to and including 33 kV – Performance Requirements and Type Tests
242	IS. 1391 Pt.II/1992(Amdnt. I	Split type Air Conditioner.
243	IS:1391 Pt.I/1992(Amendment 1&2	Window type Air Conditioner
244	IS 456:2000	PLAIN AND REINFORCED CONCRETE CODE OF PRACTICE

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APPENDIX H

GUIDELINES FOR SELECTION AND APPLICATION OF RCCBs (RCDs)

H.1 General

H.1.1 IS 732 : 1989 recognizes two forms of shock hazard, 'Indirect contact' and 'Direct contact'. The objective is to achieve safety to personnel and property through the best possible means in the most economic manner.

H.1.2 The most commonly used protective measure against indirect contact is termed "main equi-potential bonding and automatic disconnection of supply". Irrespective of the type of protective device used, the aim is to prevent dangerous 'touch voltages' persisting on accessible conductive parts which become live under earth fault conditions. Use of RCCBs is only one of the means that would provide automatic disconnection of supply in the event of shock hazard. The use of RCCB is not considered, as a sole means of protection and it does not obviate the need to apply other protective measures. Some broad guidelines are provided in this Appendix on these issues.

H.2 Residual Current Operated Circuit Breaker (RCCB)

H.2.1 In general, every circuit is provided with a means of over current protection. If the earth fault loop impedance is low enough to cause these devices to operate within the specified times, such devices can be relied upon to give the requisite automatic disconnection of supply. Where the earth fault loop impedance is too large, efforts are required to make it low enough. Guidelines are available in IS 3043 : 1987. When protection against indirect contact is decided to be provided by RCCB, IS 732 : 1989 prescribes that the product of its rated residual current (rated tripping current) in amperes and the earth loop impedance in ohms should not exceed the value 50

H.2.2 Fault voltage operated circuit breakers voltage operated ELCB are not preferred devices against shock protection. This Appendix covers only truly current-operated devices. These are of different types. The following are the two main types:

a) Residual current devices not dependent on line voltage, and
b) Residual current devices dependent on line voltage.

H.3 Choice of RCCBs

H.3.1 Where RCCBs are required to be used for affording shock protection; there are several broad parameters that are required to be carefully chosen. These are described in the following clauses.

H.3.2 Location

RCCB can be used as a protective measure to the entire installation, or part, or to an item of equipment. This is determined by the security of supply desired in certain parts of the same installation when RCCB operates. Where only one RCCB is being employed to protect

(Manju Vel Tirkey) JE/TECH/CON/HQ	(S.R.Das) AEE/CON/PL/MLG	(S.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Rudigar)
CEE/CON/NFR

the entire installation, it is necessary that it is located at the main distribution board, at the origin of the installation.

H.3.3 Type of RCCB

RCCBs are suitable in general for various applications. However, devices suitable for household applications are to be verified for additional requirements as given in this Appendix. RCCB that has its automatic opening intentionally delayed may be preferred under certain circumstances. Portable RCCBs may be necessary especially in situations where portable/mobile equipment pose a shock hazard against which other suitable means of protection are not available. Portable RCCBs are required to be tested (using the test button) each time they are used.

H.3.4 Rated Current

The IS restricts the rated current of the device to an order of magnitude of 125 A. Use of RCCB in circuits of higher rated currents is not envisaged for the time being.

H.3.5 Rated Tripping Current

(i) The preferred rated currents of RCCBs are 10, 30, 100 and 300 mA. RCCBs having minimum operating currents of 30 mA are intended to give protection against 'indirect contact'. RCCB having minimum operating currents of 30 mA and below are generally referred to as having 'high sensitivity' and can give protection against 'direct contact' in case of failure of other protective measures. It is essential that an RCCB is not used as a sole means for protection against direct contact.

(ii) It is emphasized that the value of leakage current that can flow before the RCCB has operated can be higher than the rated tripping current, the actual value being determined by the impedance of the circuit on which the fault occurs. The rated tripping current is a value assigned by the manufacturer at which the RCCB opens under specified conditions. While the speed of operation will not be significantly affected by the value of leakage current, RCCB can open at any value between 50 to 100 percent of the rated tripping current.

(iii) The RCCB should be so chosen as to have the lowest suitable tripping current. Lower the tripping current, the greater is the degree of protection afforded. Nevertheless, it would introduce the possibility of nuisance tripping and may also become unnecessarily expensive. The minimum operating current will, therefore, have to be above any standing leakage that may be unavoidable in the installation

H.3.5.1 Discrimination

When more than one RCCB is required to be used by grading the sensitivities, it is possible to achieve discrimination amongst RCCB in the same circuit. Discrimination may also be achieved by selectively employing devices having their tripping times intentionally delayed.

(Manju Verghese) IF/TECH/CON/HQ	(R.K.Das) APF/CON/PL/MLG	(B.C.Das) LLL/CON/MLC	(Ravi Bhushan) DY.CFE/CON/HQ/MLG

(R.K.Mallya)
CEE/CON/NFR

H.3.5.2 Type of System Earthing

The choice of right sensitivity of RCCB would also be determined by the type of earthing system adopted in the installation. The vectoral sum of leakage currents of equipment supplied by an installation or part of an installation by an RCCB shall be less than one half of the rated residual operating current of the device and it may be necessary to sub-divide the earthing arrangement for this reason. Reference is also invited to IS 3043 : 1987 "Code of practice for earthing", which gives guidelines on the use of RCCB for different types of system earthing.

H.3.6 Breaking Capacity

(i) When using RCCBs, it is necessary to assess the prospective current value in the location where it is likely to be installed and ensure that where higher withstanding or breaking capacities are desirable, suitable back-up protection is available in the system. This could be by means of a fuse or another circuit breaker (MCB), which is in series with the RCCB. The over current/ short circuit protective device is then said to provide back-up protection for the RCCB. Alternately, RCCBs with integral over current/short circuit protection could be employed.

(ii) In practice, the functions of RCCB and that of the over current/ short circuit protective device in series may tend to overlap and under certain conditions both may attempt to clear the fault. This may occur, for example, when a severe earth fault produces a current of similar magnitude to that under short circuit conditions, or when an earth fault and short circuit occur simultaneously. Another possible cause is the inherent out of balance in the primary windings of the balance transformer causing the RCCB to trip. Care is, therefore, necessary to be exercised in ensuring that RCCB is coordinated with over current devices.

H.3.7 Neutral Grounding or Failure

Use of RCCBs assumes adequate care in wiring and earthing design. Use of RCCB is not a sole means of affording shock protection. Attention should be given to bonding and choosing the right cross-sectional area of the conductors, specially the protective conductor. Different types of RCCBs in different circuits may react differently to the presence of a neutral to earth fault on the load side. Such a fault together with the earthing of the supply at the neutral point will constitute a shunt across the neutral winding on the RCCB transformer. Consequently a part of the neutral load current will be shunted away and this may result in the device tripping. On the other hand, the shunting may result in reduced sensitivity and prevent its tripping in general. Therefore, care should be taken to avoid neutral to ground fault when RCCBs are in use. In the event of the neutral failure on the supply side, the RCCB should either open automatically, or is of such a design that it remains functional.

H.4 Guidelines for Specific Occupancies or Locations

H.4.1 Household and Similar Installations

The rated tripping current of RCCBs for use in household and similar installation shall not exceed 30 mA. Use of devices with intentional time delay is not recommended.

(Manju Yadav) JE/TECH /CON/HQ	(S.K. Das) AEE/CON/PL/MLG	(S.C.Das) EEE/CON/MLG	(Pavi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Atalia)
CEE/CON/NFR

H.4.2 Locations containing Bath Tub/Shower Basin and Swimming Pools

Where socket outlets and other appliances are to be protected by RCCB, the rated tripping current shall not exceed 30 mA.

H.4.3 Where individual socket outlets are required to be protected by RCCB, the rated tripping current shall not exceed 30 mA.

H.4.4 Industrial Installations

For industrial installations, use of RCCB would be dependent upon already available devices capable of offering protection against harmful earth leakages. For example, use of a separate RCCB may not be necessary for installations equipped with protective devices with inbuilt releases initiating trip signals due to harmful earth leakages. Similarly, individual or group of motors otherwise adequately protected need not be provided additional protection through RCCBs.

H.4.5 Data Processing Installations/ Industrial Control/ Telecommunication Equipment

Radio frequency interference suppression filters fitted to these equipments may produce high earth leakages. Failure of the protective earth connection may cause a dangerous touch voltage. Use of RCCBs under such circumstances should be carefully considered owing to their frequent tripping, besides capacitor charging currents at switching on shall have to be considered. Under such circumstances, where leakages exceed 10 mA, one of the three measures given below may be necessary:

(a) Use of high integrity protective earth circuits by robust or duplicate conductors,

(b) Earth continuity monitoring, or provision for automatic disconnection when earth continuity fails, or

(c) Use of double wound transformers to enable localization of path of leakage and minimize the possibility of breakages.

H.4.6 The presence of generating sets within an installation may change the conditions of application of RCCB. The contribution to the prospective short circuit current by the generating set should be taken into account.

H.4.7 Medical Establishment and Electrical Installations in Hazardous Locations

The use of RCCB and their selection in such installations has to be carefully considered. Reference is invited to SP 30:1985, "National Electrical Code".

(Manju Ranjan) JL/TECH/CON/HQ	(B.Das) AEE/CON/PL/MIG	(L.Das) LLL/CON/MJG	(Ravi Bhushan) DY CEE/CON/HQ/MLC

(R.K.Arolia) CEE/CON/NER

NORTHEAST FRONTIER RAILWAY
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APPENDIX I

ESTIMATED VOLTAGE DROPS IN PVC/XLPE ALUMINIUM CABLES FOR A.C.SYSTEM

Nominal area of conductor (sq.mm)	(Voltage drop- Volts/Km/Amps)			
	PVC Cables		XLPE Cables	
	Single Phase	Three Phase	Single Phase	Three Phase
1.5	43.44	37.62	46.34	40.13
2.5	29.04	25.15	30.98	26.83
4	17.78	15.40	18.98	16.44
6	11.06	9.58	11.80	10.22
10	7.40	6.41	7.88	6.82
16	4.58	3.97	4.9	4.24
25	2.89	2.50	3.08	2.67
35	2.10	1.80	2.23	1.94
50	1.55	1.30	1.65	1.44
70	1.10	0.94	1.15	1.00
95	0.79	0.68	0.83	0.70
120	0.63	0.55	0.66	0.56
150	0.52	0.46	0.55	0.48
185	0.42	0.37	0.44	0.40
240	0.34	0.30	0.35	0.30
300	0.28	0.26	0.30	0.26
400	0.24	0.22	0.24	0.22
500	0.23	0.20	0.23	0.20
630	0.20	0.18	0.21	0.18
800	0.19	-	0.20	-
1000	0.18	-	0.18	-

** Above voltage drops (volts/km/amps/) shall be multiplied with rated current & length of Cable in K.M. to calculate total voltage drop in particular length and size of cables.

(Manju Yadav) JE/TCC/CON/HQ	(B.B.Das) AFE/CON/FI/MLG	(S.C.Das) FFE/CON/MLG	15/6/16 (Ravi Bhushan) DY.CEE/CON/HQ/MLG

(S.K.Malviya)
CEC/CON/NFR

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APPENDIX J

Current Rating (in Ground) for XLPE Insulated 1.1 KV Grade Cables

Nominal Area of the Conductor	Aluminium Conductor				Copper Conductor			
	Single Core		Multi Core		Single Core		Multi Core Unity	
mm^2	PVC	XLPE	PVC	XLPE	PVC	XLPE	PVC	XLPE
10	51	55	46	50	65	71	60	65
16	66	74	60	68	85	95	77	87
25	86	98	76	90	110	125	99	115
35	100	118	92	108	130	150	120	138
50	120	137	110	126	155	175	145	161
70	140	172	135	158	190	220	175	202
95	175	204	165	187	220	260	210	239
120	195	234	185	215	250	301	240	276
150	220	262	210	240	280	336	270	308
185	240	298	235	272	305	381	300	350
240	270	344	275	316	345	441	345	405
300	295	387	305	355	375	496	385	455
400	325	458	335	420	400	586	425	538
500	345	495	-	-	425	635	-	-
630	390	555	-	-	470	710	-	-
800	440	625	-	-	-	-	-	
1000	490	685	-	-	-	-	-	-

RATING FACTORS FOR VARIATION IN AMBIENT AIR TEMPERATURE			
Air Temperature (^{o}C)	40	45	50
Rating Factor (XLPE)	1.00	0.94	0.88
Rating Factor (PVC)	1.00	0.90	0.81

(Manju Yadav) JE/TECH/CON/HQ	(S.K.Das) ALO/CON/PL/MLG	(R.C.Rai) FEE/CON/MLG	(Ravi Bhushan) Dy.CEE/CON/HQ/MLG

(R.K.Shukla) CEE/CON/MLG

NORTHEAST FRONTIER RAILWAY
(CONSTRUCTION ORGANISATION)

APPENDIX K

Permissible Maximum Short Circuit Current Ratings for XLPE Cables

Conductor Area	*Short Circuit Ratings for One Second Duration*	
	Copper Conductors	*Aluminium Conductors*
Sq.mm.	*A*	*B*
16	2570	1730
25	3970	2670
35	5500	3690
50	7800	5220
70	10850	7400
95	14600	9740
120	18400	12200
150	23000	15200
185	28200	18700
240	36400	24200
300	45300	30100
400	60200	39800
500	74800	49800
630	92700	62000
800	–	78800
1000	–	97600

Initial Conductor Temperature 90 Deg C

Final Conductor Temperature 250 Deg. C

For durations other than one second the short circuit current may be calculated from the following formula:

$$Isc = \frac{\sqrt{1}}{t}$$

Where, Isc – Short circuit current during time t, amperes.
I – Short circuit current during the time one second as given in above table.
T – Short circuit current duration, seconds.

Note : For large currents the force between the conductors must be considered especially when single core cable are used.

[Manju Tongcent] JE/TECH/CON/FIG	[R.Das] AEE/CON/PL/MLG	[S.Das] EEE/CON/MLG	[Ravi Bhushan] DY.CEE/CON/HQ/MLG

[R K Audiya] CEE/CON/NFR

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APPENDIX L

TRIPPING CHARACTERISTICS OF MCBS

Based on the tripping characteristics, MCBs are available in 'B' and 'C' curve to suit different types of applications.

'B' Curve: For protection of electric circuits with equipment that does not cause surge current (lighting and socket outlet circuits)

Short circuit release is set to 3 - 5 I_n

'C' Curve: For protection of electric circuits with equipment that cause surge current (inductive and motor circuits)

Short circuit release is set to 5 - 10 I_n

'D' Curve: For protection of electric circuits which cause high in rush current when they are switched ON, typically 15 times the normal running current (Transformers, Heavy Start Motors, 2 Pole Motors)

Short circuit release is set to 10 - 20 I_n

(Manju Verma) JE/TECH/CON/MG	(S.K.Das) ACE/CON/PL/MLG	(S.K.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.C.Adolya)
CEE/CON/N-R

NORTHEAST FRONTIER RAILWAY
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APPENDIX M

DUTY CATEGORY OF SWITCHES

Utilization Category	Typical Applications
AC20/DC20	Connecting and disconnecting under no-load. Assumes all switching operations are carried out by other applicable devices before this device is operated.
AC21/DC21	Switching of resistive loads including moderate overloads. Suitable for purely resistive type loads Device can switch 150% of its rated current under fault conditions.
AC22/DC22	Switching of mixed resistive/ inductive loads, including moderate overloads Suitable for mixed resistive/inductive loads. Device can switch 300% of its rated current under fault conditions.
AC23/DC23	Switching of highly inductive loads. Devices complying with AC23/DC23 are provided mainly as backup to other means of switching Eg. Contacts. In the event of failure of functional devices, an AC23/DC23 type device can safely interrupt a stalled motor current. Where devices are the only means of controlling individual motors, they should comply with the requirements of Appendix A of the standard.

(Manoj Agarwal) JE/TECH/CON/HQ	(B.B.Das) AFE/CON/P /MLG	(D.C.Das) CEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(B.K.Aadiyal)
CE/CON/NFR

NORTHEAST FRONTIER RAILWAY
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APPENDIX N

CLASS OF INSULATION (FOR ELECTRIC MOTORS)

Type	Max. Operating Temp.	Materials Used
Y	90°C	Cotton, silk, paper, and similar organic material and combination of such material which are not (impregnated) nor immersed in oil.
A	105°C	Above materials impregnated with Varnish or enamel or oil immersed.
E	120°C	Comprise inorganic materials such as mica, glass fiber asbestos or combination of these materials in built up form with binding cement.
B	130°C	
F	155°C	Class B materials when built up with suitable cement or binder.
H	180°C	Consists of materials or combination of materials such as mica, glass fiber Silicon elastomer with suitable winding, impregnating or coating substances as silicon resins.
C	Above 180°C	Materials such as mica Porcelain, glass quartz and asbestos with or without an inorganic binder

(Manju Nirwan) JE/TECH/CON/HQ	(B.K.Das) AEE/CON/FI/MLG	(B.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CLE/CON/II/MLG 15/6/16

(R.K.Ahuja)
CFE/CON/NFR

NORTHEAST FRONTIER RAILWAY
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APPENDIX O

DEGREES OF PROTECTION (IP**)

Degrees of Protection to DIN 40 050 and to IEC 144

The degree of protection is specified in accordance with DIN 40 050 and with Publications of the International Electro-technical Commission (IEC) by means of the letters IP (International Protection) and two characteristic numerals		The first numeral indicates the degree of protection against contact with live parts and the ingress of foreign bodies, the second numeral indicates the degree of protection against water.	
First characteristic numeral Degree of protection against contact with live parts and the ingress of foreign bodies		**Second characteristic numeral** Degree of protection against water	
First Characteristic Numeral	**Degree of Protection**	**Second Characteristic Numeral**	**Degree of Protection**
0	No protection of persons against contact with live or moving parts inside the enclosure. No protection of equipment against ingress of solid foreign bodies.	0	No protection
1	Protection against accidental inadvertant contact with live moving parts inside the enclosure body large surface of the human body as, for example, a hand, but no protection against deliberate access to such parts. Protection against ingress of large solid foreign bodies of diameters greater than 50 mm.	1	Protection against drops condensate. Drops of condensate falling vertically on the enclosure shall have no harmful effect.

(Manik Yenpure) IF/TECH/CON/HQ	(B.C.Das) AFE/ZOO/PL/MIG	(R.C.Das) EEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Arolya)
CEE/CON/NFR

First Characteristic Numeral	Degree of Protection	Second Characteristic Numeral	Degree of Protection
2	Protection against contact with live or moving parts inside the enclosure by fingers. Protection against ingress of medium size solid foreign bodies of diameters greater than 12 mm.	2	Protection against drops of other liquids. Drops of falling liquid shall have no harmful effect when the enclosure is tilted at any angle up to 15° from the vertical.
3	Protection against contact with live or moving parts inside the enclosure by tools, wires or such objects of thickness greater than 2.5 mm. Protection against ingress of small solid foreign bodies of diameters greater than 2.5 mm.	3	Protection against rain: Water falling as rain at an angle equal to or less than 60° with respect to the vertical shall have no harmful effect.
4	Protection against contact with live or moving parts inside the enclosure by tools, wires or such objects of thickness greater than 1 mm. Protection against ingress of small solid foreign bodies of diameters greater than 1 mm.	4	Protection against splashing liquid: Liquid splashed from any direction shall have no harmful effect
5	Complete protection against contact with live or moving parts inside the enclosure. Protection against harmful deposits of dust. The ingress of dust is not totally prevented, but dust cannot enter in an amount sufficient to interfere with the operation of the equipment enclosed.	5	Protection against water-jets: Water projected by a nozzle from any direction under stated conditions shall have no harmful effect.
6	Complete protection against contact with live or moving parts inside the enclosure. Protection against ingress of dust.	6	Protection against conditions on ships decks (deck water equipment): Water due to heavy seas shall not enter the enclosures under prescribed conditions[1].

First Characteristic Numeral	Degree of Protection	Second Characteristic Numeral	Degree of Protection
		7	Protection against immersion in water: It must not be possible for water to enter the enclosure under stated conditions of pressure and time[1].
		8	Protection against indefinite immersion in water under specified pressure: It must not be possible for water to enter the enclosure[1].

1. For certain types of equipment there must be no ingress of water. Where required this is stated in a supplementary page for the equipment concerned.

NOTE:

Degrees of Protection - First Digit:

The first digit of the IP code indicates the degree that persons are protected against contact with moving parts (other than smooth rotating shafts, etc.) and the degree that equipment is protected against solid foreign bodies intruding into an enclosure.

Degrees of Protection - Second Digit:

The second digit indicates the degree of protection of the equipment inside the enclosure against the harmful entry of various forms of moisture (e.g. dripping, spraying, submersion, etc.)

Example:

Sl.No.	IP Number	First Digit- SOLIDS	Second Digit-LIQUIDS
1.	IP54	Complete protection against contact with live or moving parts inside the enclosure. Protection against harmful deposits of dust. The ingress of dust is not totally prevented, but dust cannot enter in an amount sufficient to interfere with the operation of the equipment enclosed.	Protection against splashing liquid. Liquid splashed from any direction shall have no harmful effect.
2	IP67	Complete protection against contact with live or moving parts inside the enclosure. Protection against ingress of dust.	Protection against indefinite immersion in water under specified pressure: It must not be possible for water to enter the enclosure[1].

(Manju Vempare) JE/ELEC/CON/HQ	(B.B.Das) AFE/CON/PL/MLG	(R.C.Das) FEE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(B.K.Mohanty) CEE/CON/NFR

NORTHEAST FRONTIER RAILWAY
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APPENDIX P

GUIDELINE FOR SELECTION OF ILLUMINATION LEVEL

P.1.1 Necessary guideline for selection of illumination level has been laid down in different specifications.

However, selection of illumination level for a particular application, if not found in those specifications, IS 3646 (Part I): 1992 may be referred to.

P.1.2 Recommended illumination level of IS 3646 (Part I): 1992 (page no. 6 to page no .22) is enclosed.

(Manik Tantubai) IF/TEC-I/CON/HQ	(R.K.Das) APE/CON/PI/MLG	(S.C. Das) EE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(R.K.Malviya)
CEE/CON/NFR

Table 1 Recommended Illumination

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
1 AGRICULTURE AND HORTICULTURE			
1.1 Inspection of Farm Produce Where Colour is Important	300-500-750	1	Local lighting may be appropriate
Other Important Tasks	200-300-500	2	Local lighting may be appropriate
1.2 Farm Workshops			
1.2.1 General	50-100-150	3	
1.2.2 Workbench or machine	200-300-500	2	Local or portable lighting may be appropriate
1.3 Milk Premises	50-100-150	3	
1.4 Sick Animal Pets, Calf Nurseries	30-50-100	3	
1.5 Other Farm and Horticultural Buildings	20-30-50	3	
2 COAL MINING (SURFACE BUILDINGS)			
2.1 Coal Preparation Plant			
2.1.1 Walkways, floors under conveyors	30-50-100	3	
2.1.2 Wagon loading, bunkers	30-50-100	3	
2.1.3 Elevators, chute transfer pits, washbox area	50-100-150	3	
2.1.4 Drum filters, screen, rotating shafts	100-150-200	3	
2.1.5 Picking belts	150-200-300	3	Directional and colour properties of lighting may be important for easy recognition of coal and rock
2.2 Lamp Rooms			
2.2.1 Repair section	200-300-500	2	
2.2.2 Other areas	100-150-200	3	
2.3 Weight Cabins, Fan Houses	100-150-200	3	
2.4 Winding Houses	100-150-200	3	
3 ELECTRICITY GENERATION, TRANSMISSION AND DISTRIBUTION			
3.1 General Plant			
3.1.1 Turbine houses (operating floor)	150-200-300	2	
3.1.2 Boiler and turbine house basements	50-100-150	3	
3.1.3 Boiler houses, platforms, areas around burners	50-100-150	3	
3.1.4 Switch rooms, meter rooms, oil plant rooms, HV substations (indoor)	100-150-200	2	
3.1.5 Control rooms	200-300-500	1	Localized lighting of control display and the control desks may be appropriate
3.1.6 Relay and telecommunication rooms	200-300-500	2	
3.1.7 Diesel generator rooms, compressor rooms	100-150-200	3	
3.1.8 Pump houses, water treatment plant houses	100-150-200	3	
3.1.9 Battery rooms, chargers, rectifiers	50-100-150	3	
3.1.10 Precipitator chambers, platforms, etc	50-100-150	3	
3.1.11 Cable tunnels and basements, circulating water culverts and screen chambers, storage tanks (indoor), operating areas and filling points at outdoor tanks	30-50-100	3	

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
3.2 Coal Plant			
3.2.1 Conveyors, gantries, function towers, unloading hoppers, ash handling plants, settling pits, dust hoppers outlets	50-100-150	3	
3.2.2 Other areas where operators may be in attendance	100-150-200	3	
3.3 Nuclear Plants			
Gas circulation bays, reactor area, boiler platform, reactor charges and discharge face	100-150-200	2	
4 METAL MANUFACTURE			
4.1 Iron Making			
4.1.1 Sinter plant:			
Plant floor	150-200-300	3	
Mixer drum, fan house, screen houses, coolers, transfer stations	100-150-200	3	
4.1.2 Furnaces, cupola:			
General	100-150-200	3	
Control platforms	200-300-500	2	Local lighting may be appropriate
Conveyor galleries, walkways	30-50-100	3	
4.2 Steel Making			
4.2.1 Electric melting shops	150-200-300	3	
4.2.2 Basic oxygen steel making plants			
4.2.2.1 General	100-150-200	3	
4.2.2.2 Convertor floor, teeming bay	150-200-300	3	
4.2.2.3 Control platforms	200-300-500	2	Local lighting may be appropriate
4.2.2.4 Scrap bays	100-150-200	3	
4.3 Metal forming and treatment			
4.3.1 Ingot stripping, soaking pits, annealing and heat treatment bays, acid recovery plant	150-200-300	3	
Pickling and cleaning bays, roughing mills, cold mills, finishing mills, tinning and galvanizing lines, cut up and rewind lines			
4.3.2 General	100-150-200	3	
4.3.3 Control platforms	200-300-500	2	Local lighting may be appropriate
4.3.4 Wire mills, product finishing, steel inspection and treatment	200-300-500	3	
4.3.5 Plate/strip inspection	300-500-700	2	
4.3.6 Inspection of tin plate, stainless steel, etc	—	—	Special lighting to reveal faults in the specular surface of the material will be required
4.4 Foundries			
4.4.1 Automatic plant			
4.4.1.1 Without manual operation	30-50-100	3	
4.4.1.2 With occasional manual operation	100-150-200	3	
4.4.1.3 With continuous manual operation	150-200-300	3	
4.4.1.4 Control room	200-300-500	1	Localized lighting of the control display and the control desks may be appropriate
4.4.1.5 Control platforms	200-300-500	2	

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
4.4.2 Non-automatic plants			
4.4.2.1 Charging floor, pouring, shaking out, cleaning, grinding fettling	200-300-500	3	
4.4.2.2 Rough moulding, rough core making	200-300-500	3	
4.4.2.3 Fine moulding, fine core making	300-500-750	2	
4.4.2.4 Inspection	300-500-750	2	
4.5 Forges (Severe vibration is likely to occur)			
4.5.1 General	200-300-500	2	
4.5.2 Inspection	300-500-750	2	
5 CERAMICS			
5.1 Concrete products			
Mixing, casting, cleaning	150-200-300	3	
5.2 Potteries			
5.2.1 Grinding, moulding, pressing, cleaning, trimming, glazing, firing	200-300-500	3	
5.2.2 Enamelling, colouring	500-750-1 000	1	
5.3 Glass Works			
5.3.1 Furnace rooms, bending, annealing	100-150-200	3	
5.3.2 Mixing rooms, forming, cutting, grinding, polishing, toughening	200-300-500	3	
5.3.3 Bevelling, decorative cutting, etching, silvering	300-500-750	2	
5.3.4 Inspection	300-500-750	2	
6 CHEMICALS			
6.1 Petroleum, Chemical and Petrochemical Works			
6.1.1 Exterior walkways, platforms, stairs and ladders	30-50-100	3	
6.1.2 Exterior pump and valve areas	50-100-150	3	
6.1.3 Pump and compressor houses	100-150-200	3	
6.1.4 Process plant with remote control	30-50-100	3	
6.1.5 Process plant requiring occasional manual intervention	50-100-150	3	
6.1.6 Permanently occupied work stations in process plant	150-200-300	3	
6.1.7 Control rooms for process plant	200-300-500	1	
6.2 Pharmaceutical Manufacturer and Fine Chemicals Manufacturer			
6.2.1 Pharmaceutical manufacturer			
Grinding, granulating, mixing, drying, tableting, sterilizing, washing, preparation of solutions, filling, capping, wrapping, hardening	300-500-750	2	
6.2.2 Fine chemical manufacture			
6.2.2.1 Exterior walkways, platforms, stairs and ladders	30-50-100	3	
6.2.2.2 Process plant	50-100-150	3	
6.2.2.3 Fine chemical finishing	300-500-750	2	
6.2.2.4 Inspection	300-500-750	1	Local lighting may be appropriate
6.3 Soap Manufacture			
6.3.1 General area	200-300-500	2	
6.3.2 Automatic processes	100-200-300	2	
6.3.3 Control panels	200-300-500	1	Local lighting may be appropriate
6.3.4 Machines	200-300-500	2	

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
6.4 Paint Works			
6.4.1 General	200-300-500	2	
6.4.2 Automatic processes	150-200-300	2	
6.4.3 Control panels	200-300-500	2	
6.4.4 Special batch mixing	500-750-1 000	2	
6.4.5 Colour matching	750-1 000-1 500	1	
7 MECHANICAL ENGINEERING			
7.1 Structural Steel Fabrication			
7.1.1 General	200-300-500	3	
7.1.2 Marking off	300-500-750	3	Local lighting may be appropriate
7.2 Sheet Metal Works			
7.2.1 Pressing, punching shearing, stamping, spinning, folding	300-500-750	2	
7.2.2 Benchwork, scribing, inspection	500-750-1 000	2	
7.3 Machine and Tool Shops			
7.3.1 Rough bench and machine work	200-300-500	3	
7.3.2 Medium bench and machine work	300-500-750	2	
7.3.3 Fine bench and machine work	500-750-1 000	2	
7.3.4 Gauge rooms	750-1 000-1 500	1	Optical aids may be required
7.4 Die Sinking Shops			
7.4.1 General	300-500-750	2	
7.4.2 Fine work	1 000-1 500-2 000	1	Flexible local lighting is desirable
7.5 Welding and Soldering Shops			
7.5.1 Gas and arc welding, rough spot welding	200-300-500	3	
7.5.2 Medium soldering, brazing, spot welding	300-500-750	3	
7.5.3 Fine soldering, fine spot welding	750-1 000-1 500	2	Local lighting is desirable
7.6 Assembly Shops			
7.6.1 Rough work for example, frame and heavy machine assembly	200-300-500	3	The lighting of vertical surface may be important
7.6.2 Medium work, for example, engine assembly, vehicle body assembly	300-500-750	2	
7.6.3 Fine work, for example, office machinery assembly	500-750-1 000	1	Localized lighting may be useful
7.6.4 Very fine work, for example, instrument assembly	750-1 000-1 500	1	Local lighting and optical aids are desirable
7.6.5 Minute work, for example, watch making	1 000-1 500-2 000	1	Local lighting and optical aids are desirable
7.7 Inspection and Testing Shops			
7.7.1 Coarse work, for example, using go/no go gauges, inspection of large sub-assemblies	300-500-750	2	Local or localized lighting may be appropriate
7.7.2 Medium work, for example, inspection of painted surfaces	500-750-1 000	1	Local or localized lighting may be appropriate
7.7.3 Fine work, for example, using calibrated scales, inspection of precision mechanisms	750-1 000-1 500	1	Local or localized lighting may be appropriate
7.7.4 Very fine work, for example, inspection of small intricate parts	1 000-1 500-2 000	1	Local lighting and optical aids are desirable
7.7.5 Minute work, for example, inspection of very small instruments	2 000	1	Local lighting and optical aids are desirable

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
7.8 Paints Shops and Spray Booths			
7.8.1 Dipping, rough spraying	200-300-500	3	
7.8.2 Preparation, ordinary painting, spraying and finishing	200-500-750	2	
7.8.3 Fine painting, spraying and finishing	500-750-1 000	2	
7.8.4 Inspection, retouching and matching	750-1 000-1 500	2	
7.9 Plating Shops			
7.9.1 Vats and baths	200-300-500	3	
7.9.2 Buffing, polishing burnishing	300-500-750	2	
7.9.3 Final buffing and polishing	500-750-1 000	2	
7.9.4 Inspection	—	—	Special light to reveal fault in the surface of the material will be required
8 ELECTRICAL AND ELECTRONIC ENGINEERING			
8.1 Electrical Equipment Manufacture			
8.1.1 Manufacture of cables and insulated wires, winding, varnishing and immersion of coils, assembly of large machines, simple assembly work	200-300-500	3	
8.1.2 Medium assembly, for example, telephones, small motors	300-500-750	3	Local lighting may be appropriate
8.1.3 Assembly of precision components, for example, telecommunication equipment, adjustment, inspection and calibration	750-1 000-1 500	1	Local lighting is desirable. Optical aids may be useful
8.1.4 Assembly of high precision parts	1 000-1 500-2 000	1	Local lighting is desirable. Optical aids may be useful
8.2 Electronic Equipment Manufacture			
8.2.1 Printed circuit board			
8.2.1.1 Silk screening	300-500-750	1	Local lighting may be appropriate
8.2.1.2 Hand insertion of components, soldering	500-750-1 000	1	Local lighting may be appropriate.
8.2.1.3 Inspection	750-1 000-1 500	1	A large, low luminance luminaire overhead ensures specular reflection conditions which are helpful for inspection of printed circuits
8.2.1.4 Assembly of wiring harness, cleating harness, testing and calibration	500-750-1 000	1	Local lighting may be appropriated
8.2.1.5 Chassis assembly	750-1 000-1 500	1	Local lighting may be appropriated
8.2.2 Inspection and testing:			
8.2.2.1 Soak test	150-200-300	2	
8.2.2.2 Safety and functional tests	200-300-500	2	
9 FOOD, DRINK AND TOBACCO			
9.1 Slaughter Houses			
9.1.1 General	200-300-500	3	
9.1.2 Inspection	300-500-750	2	
9.2 Canning, Preserving and Freezing			
9.2.1 Grading and sorting of raw materials	500-750-1 000	2	Lamps of colour rendering group 1A or 1B will be required, if colour judgment is required

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
9.2.2 Preparation	300-500-750	3	
9.2.3 Canned and bottled goods			
9.2.3.1 Retorts	200-300-500	3	
9.2.3.2 Automatic processes	150-200-300	3	
9.2.3.3 Labelling and packaging	200-300-500	3	
9.2.4 Frozen foods			
9.2.4.1 Process area	200-300-500	3	
9.2.4.2 Packaging and storage	200-300-500	3	
9.3 Bottling, Brewing and Distilling			
9.3.1 Keg washing and handling, bottle washing	150-200-300	3	
9.3.2 Keg inspection	200-300-500	3	
9.3.3 Bottle inspection	—	—	Special lighting will be required
9.3.4 Process areas	200-300-500	3	
9.3.5 Bottle filling	500-750-1 000	3	
9.4 Edible Oils and Fats Processing			
9.4.1 Refining and blending	200-300-500	3	
9.4.2 Production	300-500-750	2	
9.5 Mills-Milling, Filtering and Packing	200-300-500	3	
9.6 Bakeries			
9.6.1 General	200-300-500	2	
9.6.2 Hand decorating, icing	300-500-750	2	
9.7 Chocolate and Confectionery Manufacture			
9.7.1 General	200-300-500	3	
9.7.2 Automatic processes	150-200-300	3	
9.7.3 Hand decoration, inspection, wrapping and packing	300 500-750	2	If accurate colour judgements are required, lamps of colour rendering group 1A or 1B are used
9.8 Tobacco Processing			
9.8.1 Material preparation, making and packing	300-500-750	2	
9.8.2 Hand processes	500-750-1 000	2	
10 TEXTILES			
10.1 Fibre Preparation			
10.1.1 Bale breaking, washing	200-300-500	3	
10.1.2 Stock dyeing, tinting	200-300-500	3	
10.2 Yarn Manufacture			
10.2.1 Spinning, roving, winding, etc	300-500-750	2	
10.2.2 Healding (drawing in)	750-1 000-750	2	
10.3 Fabric Production			
10.3.1 Knitting	300-500-750	2	
10.3.2 Weaving			
10.3.2.1 Jute and hemp	200-300-500	2	
10.3.2.2 Heavy woollens	300-500-750	1	
10.3.2.3 Medium worsteds, fine woollens, cottons	500-750-1 000	1	
10.3.2.4 Fine worsteds, fine linens, synthetics	750-1 000-1 500	1	
10.3.2.5 Mending	1 000-1 500-2 000	1	
10.3.2.6 Inspection	1 000-1 500-2 000	1	

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
10.4 Fabric Finishing			
10.4.1 Dyeing	200-300-500	3	
10.4.2 Calendering, chemical treatment, etc	300-500-750	2	
10.4.3 Inspection			
10.4.3.1 'Grey' cloth	750-1 000-1 500	1	
10.4.3.2 Final	1 000-1 500-2 000	1	
10.5 Carpet Manufacture			
10.5.1 Winding, beaming	200-300-500	3	
10.5.2 Setting pattern, tufting cropping, trimming, fringing, latexing and latex drying	300-500-750	2	
10.5.3 Designing, weaving, mending	500-750-1 000	2	
10.5.4 Inspection			
10.5.4.1 General	750-1 000-1 500	1	Local lighting may be appropriate
10.5.4.2 Piece dyeing	500-750-1 000	1	Local lighting may be appropriate
11 LEATHER INDUSTRY			
11.1 Leather Manufacture			
11.1.1 Cleaning, tanning and stretching, vats, cutting, fleshing, stuffing	200-300-500	3	
11.1.2 Finishing, scarfing	300-500-750	2	
11.2 Leather Working			
11.2.1 General	200-300-500	3	
11.2.2 Pressing, glazing	300-500-750	2	
11.2.3 Cutting, splitting, scarfing, sewing	500-750-1 000	2	Directional lighting may be useful
11.2.4 Grading, matching		2	Local lighting may be appropriate
12 CLOTHING AND FOOTWEAR			
12.1 Clothing Manufacture			
12.1.1 Preparation of cloth	200-300-500	2	
12.1.2 Cutting	500-750-1 000	1	
12.1.3 Matching	500-750-1 000	1	
12.1.4 Sewing	750-1 000-1 500	1	
12.1.5 Pressing	300-500-750	2	
12.1.6 Inspection	1 000-1 500-2 000	1	Local lighting may by appropriate
12.1.7 Hand tailoring	1 000-1 500-2 000	1	Local lighting may be appropriate
12.2 Hosiery and Knitwear Manufacture			
12.2.1 Flat bed knitting machines	300-500-750	2	
12.2.2 Circular knitting machines	500-750-1 000	2	
12.2.3 Lockstitch and overlocking machine	750-1 000-1 500	1	
12.2.4 Linking or running on	750-1 000-1 500	1	
12.2.5 Mending, handfinishing	1 000-1 500-3 000	—	Local lighting may by appropriate
12.2.6 Inspection	1 000-1 500-2 000	2	Local lighting may be appropriate
12.3 Glove Manufacture			
12.3.1 Sorting and grading	500-750-1 000	1	
12.3.2 Pressing, knitting, cutting	300-500-750	2	
12.3.3 Sewing	500-750-1 000	2	
12.3.4 Inspection	1 000-1 500-2 000	—	Local lighting may be appropriate

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
12.4 Hat Manufacture			
12.4.1 Stiffening, braiding, refining, forming, sizing, pounding, ironing	200-300-500	2	
12.4.2 Cleaning, flanging, finishing	300-500-750	2	
12.4.3 Sewing	500-750-1 000	2	
12.4.4 Inspection	1 000-1 500-2 000	—	Local lighting may be appropriate
12.5 Boot and Shoe Manufacture			
12.5.1 Leather and Synthetics			
12.5.2 Sorting and grading	750-1 000-1 500	1	
12.5.3 Clicking, closing	750-1 000-1 500	2	Local or localized lighting may be appropriate
12.5.4 Preparatory operations	750-1 000-1 500	2	Local or localized lighting may be appropriate
12.5.5 Cutting tables and pressure	1 000-1 500-2 000	1	Local or localized lighting may be appropriate
12.5.6 Bottom stock preparation, lasting, bottoming finishing, shoe rooms	750-1 000-1 500	1	Local or localized lighting may be appropriate
12.5.7 Rubber			
12.5.7.1 Washing, compounding, coating, drying, varnishing, vulcanizing, calendering, cutting	200-300-500	3	
12.5.7.2 Lining, making and finishing	300-500-750	2	
13 TIMBER AND FURNITURE			
13.1 Sawmills			
13.1.1 General	150-200-300	3	
13.1.2 Head saw	300-500-750	2	Local lighting may be appropriate
13.1.3 Grading	500-750-1 000	2	Directional lighting may be useful
13.2 Woodwork Shops			
13.2.1 Rough sawing, bench work	200-300-500	2	
13.2.2 Sizing, planning, sanding, medium machining and bench work	300-500-750	2	
13.2.3 Fine bench and machine work, fine sanding, finishing	500-750-1 000	2	Localized lighting may be appropriate
13.3 Furniture Manufacture			
13.3.1 Raw material stores	50-100-150	3	
13.3.2 Finished goods stores	100-150-200	3	
13.3.3 Wood matching and assembly, rough sawing, cutting	200-300-500	2	
13.3.4 Machining, sanding and assembly, polishing	300-500-750	2	Localized lighting may be appropriate
13.3.5 Tool rooms	300-500-750	2	
13.3.6 Spray booths			
13.3.6.1 Colour finishing	300-500-750	2	
13.3.6.2 Clear finishing	200-300-500	2	
13.3.7 Cabinet making			
13.3.7.1 Veneer sorting and grading	750-1 000-1 500	1	
13.3.7.2 Marquetry, presaing, patching and fitting	300-500-750	2	
13.3.7.3 Final inspection	500-750-1 000	1	Special lighting will be required

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
13.4 Upholstry Manufacture			
13.4.1 Cloth inspection	1 000-1 500- 2 000	1	Social lighting will be required
13.4.2 Filling, covering	300-500-750	2	
13.4.3 Slipping, cutting, sewing	500-750-1 000	2	
13.4.4 Mattress making			
13.4.5 Assembly	300-500-750	2	
13.4.6 Tape edging	750-1 000-1 500	2	Local lighting may be appropriate
14 PAPER AND PRINTING			
14.1 Paper Mills			
14.1.1 Pulp mills, preparation plants	200-300-500	3	
14.1.2 Paper and board making			
14.1.2.1 General	200-300-500	3	
14.1.2.2 Automatic process	150-200-300	3	Supplementary lighting may be necessary for maintenance work
14.1.2.3 Inspection, sorting	300-500-750	1	
14.1.3 Paper converting processes			
14.1.3.1 General	200-300-500	3	
14.1.3.2 Associated printing	300-500-750	2	
14.2 Printing Works			
14.2.1 Type foundries			
14.2.1.1 Matrix making, dressing type, hand and machine casting	200-300-500	3	
14.2.1.2 Front assembly, sorting	500-750-1 000	2	
14.2.2 Composing rooms			
14.2.2.1 Hand composing, imposition and distribution	500-750-1 000	1	
14.2.2.2 Hot metal keyboard	500-750-1 000	1	
14.2.2.3 Hot metal casting	200-300-500	2	
14.2.2.4 Photo composing keyboard or setters	300-500-750	1	
14.2.2.5 Paste up	500-750-1 000	1	
14.2.2.6 Illuminated tables — general lighting	200-300-500	—	Dimming may be required
14.2.2.7 Proof presses	300-500-750	2	
14.2.2.8 Proof reading	500-750-1 000	1	
14.2.3 Graphic Reproduction			
14.2.3.1 General	300-500-750	2	
14.2.3.2 Precision proofing, retouching, etching	750-1 000-1 500	1	Local lighting may be appropriate
14.2.3.3 Colour reproduction and inspection	750-1 000-1 500	1	
14.2.4 Printing machine room			
14.2.4.1 Presses	300-500-750	2	
14.2.4.2 Frenmake ready	300-500-750	2	
14.2.4.3 Printed sheet inspection	750-1 000-1 500	1	
14.2.5 Binding			
14.2.5.1 Folding, pasting, punching and stitching	300-500-750	2	
14.2.5.2 Cutting, assembling, embossing	500-750-1 000	2	

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
15 PLASTICS AND RUBBER			
15.1 Plastic Products			
15.1.1 Automatic plant			
15.1.1.1 Without manual control	30-50-100	3	
15.1.1.2 With occasional manual control	50-100-150	3	
15.1.1.3 With continuous manual control	200-300-500	3	
15.1.1.4 Control rooms	200-300-500	1	
15.1.1.5 Control platforms	200-300-500	2	Local lighting may be appropriate
15.1.2 Non-automatic plant			
15.1.2.1 Mixing, calendering, extrusion, injection, compression and blow moulding, sheet fabrication	200-300-500	3	
15.1.2.2 Trimming, cutting, polishing, cementing	300-500-750	2	
15.1.2.3 Printing, inspection	750-1 000-1 500	1	
15.2 Rubber Products			
15.2.1 Stock preparation — plasticizing, milling	150-200-300	3	
15.2.2 Calendering, fabric preparation, stock-cutting	300-500-750	3	
15.2.3 Extruding, moulding	300-500-750	2	
15.2.4 Inspection	750-1 000-1 500	—	
16 DISTRIBUTION AND STORAGE			
16.1 Work Stores	100-150-200	3	Avoid glare to drivers of vehicles approaching the loading bay
16.1.1 Unpacking, sorting	150-200-300	3	Avoid glare to drivers of vehicles approaching the loading bay
16.1.2 Large item storage	50-100-150	3	Avoid glare to drivers of vehicles approaching the loading bay
16.1.3 Small item rack storage	200-300-500	3	Avoid glare to drivers of vehicles approaching the loading bay
16.1.4 Issue counter, records, storeman's desk	300-500-750	2	Local or localized lighting may be appropriate
16.2 Warehouses and Bulk Stores			
16.2.1 Storage of goods where identification requires only limited preparation of detail	50-100-150	3	
16.2.2 Storage of goods where identification requires perception of detail	100-150-200	3	
16.2.3 Automatic high bay rack stores			
16.2.3.1 Gangway	20	—	
16.2.3.2 Control station	150-200-300	3	
16.2.3.3 Packing and despatch	200-300-500	3	
16.2.3.4 Loading bays	100-150-200	3	Avoid glare to drivers of vehicles approaching the loading bay
16.3 Cold Stores			
16.3.1 General	200-300-500	3	
16.3.2 Breakdown, make-up and despatch	200-300-500	3	
16.3.3 Loading bays	100-150-200	3	Avoid glare to drivers of vehicles approaching bay

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
17 COMMERCE			
17.1 Offices			
17.1.1 General offices	300-500-750	1	
17.1.2 Deep plan general offices	500-750-1 000	1	
17.1.3 Computer work stations	300-500-750	1	
17.1.4 Conference rooms, executive offices	300-500-750	1	
17.1.5 Computer and data preparation rooms	300-500-750	1	
17.1.6 Filing rooms	200-300-500	1	
17.2 Drawing Offices			
17.2.1 General	300-500-750	1	
17.2.2 Drawing boards	500-750-1 000	1	
17.2.3 Computer aided design and drafting	—	—	Special lighting is required
17.2.4 Print rooms	200-300-500	1	
17.3 Banks and Building Societies			
17.3.1 Counter, office area	300-500-750	1	
17.3.2 Public area	200-300-500	1	
18 SERVICES			
18.1 Garages			
18.1.1 Interior parking areas	20-30-50	3	
18.1.2 General repairs, servicing, washing, polishing	200-300-500	2	
18.1.3 Workbench	300-500-750	1	Local or localized lighting may be appropriate
18.1.4 Spray booths	300-500-750	1	
18.1.5 External apron			
18.1.5.1 General	30-50-100	—	Care should be taken to avoid glare to drivers and neighbouring residents
18.1.5.2 Pump area (retail sales)	200-300-500	—	*See* 'Retailing'
18.2 Appliance servicing			
18.2.1 Workshop			
18.2.1.1 General	200-300-500	2	
18.2.1.2 Workbench	300-500-750	2	Localized lighting may be appropriate
18.2.1.3 Counter	200-300-500	2	Localized lighting may be appropriate
18.2.1.4 Stores	200-300-500	3	
18.3 Laundries			
18.3.1 Commercial laundries			
18.3.2 Receiving, sorting, washing, drying, ironing, despath, dry-cleaning, bulk machine work	200-300-500	3	
18.3.3 Hand ironing, pressing, mending, spotting, inspection	300-500-750	3	
18.3.4 Launderettes	200-300-500	3	
18.4 Sewage Treatment Works			
18.4.1 Walkways	30-50-100	3	
18.4.2 Process areas	50-100-150	3	

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
19 RETAILING			
19.1 Small Shops with Counters	300-500-750	1	The service illuminance should be provided on the horizontal plane of the counter. Where wall displays are used, a similar illuminance on the walls is desirable.
19.2 Small Self-Service Shops with Island Displays	300-500-750	1	
19.3 Supper Markets, Hyper-Markets			
19.3.1 General	300-500-750	2	
19.3.2 Checkout	300-500-750	2	
19.3.3 Showroom for large objects, for example, cars, furnitures	300-500-750	1	
19.3.4 Shopping precincts and arcades	100-150-200	2	
20 PLACES OF PUBLIC ASSEMBLY			
20.1 Public Rooms, Village Halls, Worship Halls	200-300-500	1	
20.2 Concert Halls, Cinemas and Theatres			
20.2.1 Foyer	150-200-300	—	
20.2.2 Booking office	200-300-500	—	Local or localized lighting may be appropriate
20.2.3 Auditorium	50-100-150	—	Dimming facilities will be necessary. Special lighting of the aisles is desirable
20.2.4 Dressing rooms	200-300-500	—	Special mirror lighting for make-up may be required
20.2.5 Projection room	100-150-200	—	
20.3 Churches			
20.3.1 Body of church	100-150-200	2	
20.3.2 Pulpit, lectern	200-300-500	2	Use local lighting
20.3.3 Choir stalls	200-300-500	2	Local lighting may be appropriate
20.3.4 Alter, communion table, chancel	100-150-200	2	Additional lighting to provide emphasis is desirable
20.3.5 Vestries	100-150-200	2	
20.3.6 Organ	200-300-500	—	
20.4 Hospitals			
20.4.1 Anaesthatic rooms			
20.4.1.1 General	200-300-500	—	
20.4.1.2 Local	750-1 000-1 500	—	
20.4.2 Consulting areas			
20.4.2.1 General	200-300-500	—	
20.4.2.2 Examination	750-1 000-1 500	—	
20.4.3 Corridors			
20.4.3.1 General	100-150-200	—	
20.4.4 Ward corridors			
20.4.4.1 Day, screened from bays	150-200-300	—	
20.4.4.2 Day, open to natural light	150-200-300 (total)	— —	
20.4.4.3 Morning/evening	100-150-200	—	
20.4.4.4 Night	5-10	—	

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
20.4.5 Cubicles			
20.4.5.1 General	200-300-500	—	
20.4.5.2 Treatment	750-1 000-1 500	—	
20.4.6 Examination			
20.4.6.1 General	200-300-500	—	
20.4.6.2 Local inspection	750-1 000-1 500	—	
20.4.7 Intensive therapy			
20.4.7.1 Bad head	30-50	—	
20.4.7.2 Circulation between bed ends	50-100-150	—	
20.4.7.3 Observation	200-300-500	—	
20.4.7.4 Local observation	750-1 000-1 500	—	
20.4.7.5 Staff base (day)	200-300-500	—	
20.4.7.6 Staff base (night)	30	—	
20.4.8 Laboratories			
20.4.8.1 General	200-300-500	—	
20.4.8.2 Examination	300-500-750	—	
20.4.9 Nurses' stations			
20.4.9.1 Morning/day/evening	200-300-500	—	
20.4.9.2 Night desks	30	—	
20.4.9.3 Night, medical trolleys	50-100-150	—	
20.4.10 Operating theatres			
20.4.10.1 General	300-500-750	—	
20.4.10.2 Local	10 000 to 50 000	—	Special operating lights are used
20.4.11 Pathology departments			
20.4.11.1 General	200-300-500	—	
20.4.11.2 Examination	300-500-750	—	
20.4.11.3 Pharmacies	200-300-500	—	
20.4.11.4 Reception/enquiry	200-300-500	—	
20.4.11.5 Recovery rooms	200-300-500	—	
20.4.12 Ward-circulation			
20.4.12.1 Day	50-100-150	—	
20.4.12.2 Morning/evening	50-100-150	—	
20.4.12.3 Night	3-5	—	
20.4.13 Ward-bed head			
20.4.13.1 Morning/evening	30-50		
20.4.13.2 Reading	100-150-200		
20.4.14 Night			
20.4.14.1 Adult	0·1-1		
20.4.14.2 Paediatric	1		
20.4.14.3 Psychiatric	1-5		
20.4.14.4 Watch	5		
20.4.15 X-Ray areas			
20.4.15.1 General	150-200-300		
20.4.15.2 Diagnostic	150-200-300		
20.4.15.3 Operative	200-300-500		
20.4.15.4 Process dark room	50		
20.4.16 Surgeries			
20.4.16.1 General	200-300-500	—	
20.4.16.2 Waiting rooms	100-150-200	—	
20.4.17 Dental surgeries			
20.4.17.1 Chair	Special lighting		
20.4.17.2 Laboratories	300-500-750	—	
20.4.18 Consulting rooms			
20.4.18.1 General	200-300-500	—	
20.4.18.2 Desk	300-500-750	—	
20.4.18.3 Examination couch	300-500-750	—	
20.4.18.4 Ophthalmic wall and near-vision charts	300-500-750	—	

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
20.5 Hotels			
20.5.1 Entrance halls	50-100-150		
20.5.2 Reception, cashier's and porters' desks	200-300-500		Localized lighting may be appropriate
20.5.3 Bars, coffee bars, dining rooms, grill rooms, restaurants, lounges	50-200		The lighting should be designed to create an appropriate atmosphere
20.5.4 Cloak rooms, baggage rooms	50-100-150	3	
20.5.5 Bed rooms	30-50-100	—	Supplementary local lighting at the bed head, writing table should be provided
20.5.6 Bathroom	50-100-150		Supplementary local lighting near the mirror is desirable
20.5.7 Food preparation and stores, cellars, lifts and corridors	—	—	*See* 'General Building Areas'
20.6 Libraries			
20.6.1 Lending library			
20.6.1.1 General	200-300-500	1	
20.6.1.2 Counters	300-500-750	1	Localized lighting may be appropriate
20.6.1.3 Bookshelves	100-150-200	2	The service illuminance should be provided on the vertical face at the bottom of the bookstack
20.6.1.4 Reading rooms	200-300-500	1	
20.6.1.5 Reading tables	200-300-500	1	Localized lighting may be appropriate
20.6.2 Catalogues			
20.6.2.1 Card	100-150-200	2	
20.6.2.2 Microfiche/Visual display units	100-150-200	2	
20.6.3 Reference libraries			
20.6.3.1 General	200-300-500	1	
20.6.3.2 Counters	300-500-750	1	Localized lighting may be appropriate
20.6.3.3 Bookshelves	100-150-200	2	The service illuminance should be provided on a vertical surface at the foot of the bookshelves
20.6.3.4 Study tables, carrels	300-500-750	1	
20.6.3.5 Map room	200-300-500	1	
20.6.4 Display and exhibition areas			
20.6.4.1 Exhibits insensitive to light	200-300-500	—	
20.6.4.2 Exhibit sensitive to light, for example, pictures, prints, rare books in archives	50 to 150	—	
20.6.5 Library workrooms			
20.6.5.1 Book repair and binding	300-500-750	2	
20.6.5.2 Cataloguing and sorting	300-500-750	2	
20.6.5.3 Remote book stores	100-150-200	3	
20.7 Museums and Art Galleries			
20.7.1 Exhibits insensitive to light	200-300-500	—	

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
20.7.2 Light sensitive exhibits, for example, oil and temper paints, undyed leather, bone, ivory, wood, etc	150	—	This is a maximum illuminance to be provided on the principal plane of the exhibit
20.7.3 Extremely light sensitive exhibits, for example, textiles, water colours, prints and drawings, skins, botanical specimens, etc	50	—	This is the maximum illuminance to be provided on the principal plane of the object
20.7.4 Conservation studies and workshops	300-500-750	1	
20.8 Sports Facilities			
Multi-purpose sports halls	300-750	—	This lighting system should be sufficiently flexible to provide lighting suitable for the variety of sports and activities that take place in sports halls. Higher illuminance of 1 000-2 000 lux would be required for television coverage
21 EDUCATION			
21.1 Assembly Halls			
21.1.1 General	200-300-500	3	
22.1.2 Platform and stage	—	—	Special lighting to provide emphasis and to facilitate the use of the platform/ stage is desirable
21.2 Teaching Spaces			
General	200-300-500	1	
21.3 Lecture Theatres			
21.3.1 General	200-300-500	1	
21.3.2 Demonstration benches	300-500-750	1	Localized lighting may be appropriate
21.4 Seminar Rooms	300-500-750	1	
21.5 Art Rooms	300-500-750	1	
21.6 Needlework Rooms	300-500-750	1	
21.7 Laboratories	300-500-750	1	
21.8 Libraries	200-300-500	1	
21.9 Music Rooms	200-300-500	1	
21.10 Sports Halls	200-300-500	1	
21.11 Workshops	200-300-500	1	
22 TRANSPORT			
22.1 Airports			
22.1.1 Ticket counters, checking desks, and information desks	300-500-750	2	Localized lighting may be appropriate
22.1.2 Departure lounges, other waiting areas	150-200-300	2	
22.1.3 Baggage reclaim	150-200-300	2	
22.1.4 Baggage handling	50-100-150	2	
22.1.5 Customs and immigration halls	300-500-750	2	
22.1.6 Concourse	150-200-300	2	
22.2 Railway Stations			
22.2.1 Ticket office	300-500-750	2	Localized lighting over the counter may be appropriate
22.2.2 Information office	300-500-750	2	Localized lighting over the counter may be appropriate

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illumination in Lux	Quality Class of Direct Glare Limitation	Remarks
22.2.3 Parcels office, left			
22.2.4 Luggage office			
22.3.4.1 General	50-100-150	2	
22.2.4.2 Counter	150-200-300	2	
22.2.5 Waiting rooms	150-200-300	2	
22.2.6 Concourse	150-200-300	2	
22.2.7 Time table	150-200-300	2	Localized lighting may be appropriate
22.2.8 Ticket barriers	150-200-300	2	Localized lighting may be appropriate
22.2.9 Platforms (covered)	30-50-100	2	Care should be taken to light and mark the edge of the platform clearly
22.2.10 Platforms (open)	20	—	Care should be taken to light and mark the edge of the platform clearly
22.3 Coach Stations			
22.3.1 Ticket offices	300-500-750	2	Localized lighting over the counter may be appropriate
22.3.2 Information offices	300-500-750	2	Localized lighting over the counter may be appropriate
22.3.3 Left luggage office			
22.3.3.1 General	50-100-150	3	
22.3.3.2 Counter	150-200-300	3	Localized lighting is appropriate
22.3.4 Waiting rooms	150-200-300	2	
22.3.5 Concourse	150-200-300	2	
22.3.6 Time tables	150-200-300	2	Local lighting is appropriate
22.3.7 Loading areas	100-150-200	3	
23 GENERAL BUILDING AREAS			
23.1 Entrance			
23.1.1 Entrance halls, lobbies, waiting rooms	150-200-300	2	
23.1.2 Enquiry desks	300-500-750	2	Localized lighting may be appropriate
23.1.3 Gatehouses	150-200-300	2	
23.2 Circulation Areas			
23.2.1 Lifts	50-100-150	—	
23.2.2 Corridors, passageways, stairs	50-100-150	2	
23.2.3 Escalators, travellators	100-150-200	—	
23.3 Medical and First Aid Centres			
23.3.1 Consulting rooms, treatment rooms	300-500-750	1	
23.3.2 Rest rooms	100-150-200	1	
23.3.3 Medical stores	100-150-200	2	
23.4 Staff Rooms			
23.4.1 Changing, locker and cleaners rooms, cloakrooms, lavatories	50-100-150	—	
23.4.2 Rest rooms	100-150-200	1	
23.5 Staff Restaurants			
23.5.1 Canteens, cafeterias, dining rooms, mess rooms	150-200-300	2	
23.5.2 Servery, vegetable preparation, washing-up area	200-300-500	2	

Table 1 (*concluded*)

Type of Interior or Activity	Range of Service Illumination in Lux	Quality Class of Direct Glare Limitation	Remarks
23.5.3 Food preparation and cooking	300-500-750	2	
23.5.4 Food stores, cellars	100-150-200	2	
23.6 Communications			
23.6.1 Switchboard rooms	200-300-500	2	
23.6.2 Telephone apparatus rooms	100-150-200	2	
23.6.3 Telex room, post room	300-500-750	2	
23.6.4 Reprographic room	200-300-500	2	
23.7 Building Services			
23.7.1 Boiler houses			
23.7.1.1 General	50-100-150	3	
23.7.1.2 Boiler front	100-150-200	3	
23.7.1.3 Boiler control room	200-300-500	2	Localized lighting of the control display and the control desk may be appropriate
23.7.1.4 Control rooms	200-300-500	2	Localized lighting of the control display and the control desk may be appropriate
23.7.1.5 Mechanical plant room	100-150-200	2	
23.7.1.6 Electrical power supply and distribution rooms	100-150-200	2	
23.7.1.7 Store rooms	50-100-150	3	
23.8 Car Parks			
23.8.1 Covered car parks			
23.8.1.1 Floors	5-20	—	
23.8.1.2 Ramps and corners	30	—	
23.8.1.3 Entrances and exits	50-100-150	—	
23.8.1.4 Control booths	150-200-300	—	
23.8.1.5 Outdoor car parks	5-20	—	

4.4.2.2 *Shielding angle*

For luminaires whose lamps or parts thereof are visible when viewed at angles from the vertical 45° and greater, not only should the average luminance of luminaire be limited according to the limiting curves of the diagrams (*see* Fig. 2), but in addition the lamps should be sufficiently shielded depending on the luminance of the lamp and the selected quality class. The required shielding angles (*see* Fig. 3) are given in Table 2.

If the shielding angle is less than the tabulated value, the lamp luminance must be used in Diagram II for checking the glare limitation.

4.4.2.3 *Procedure for the use of the luminance limiting curves*

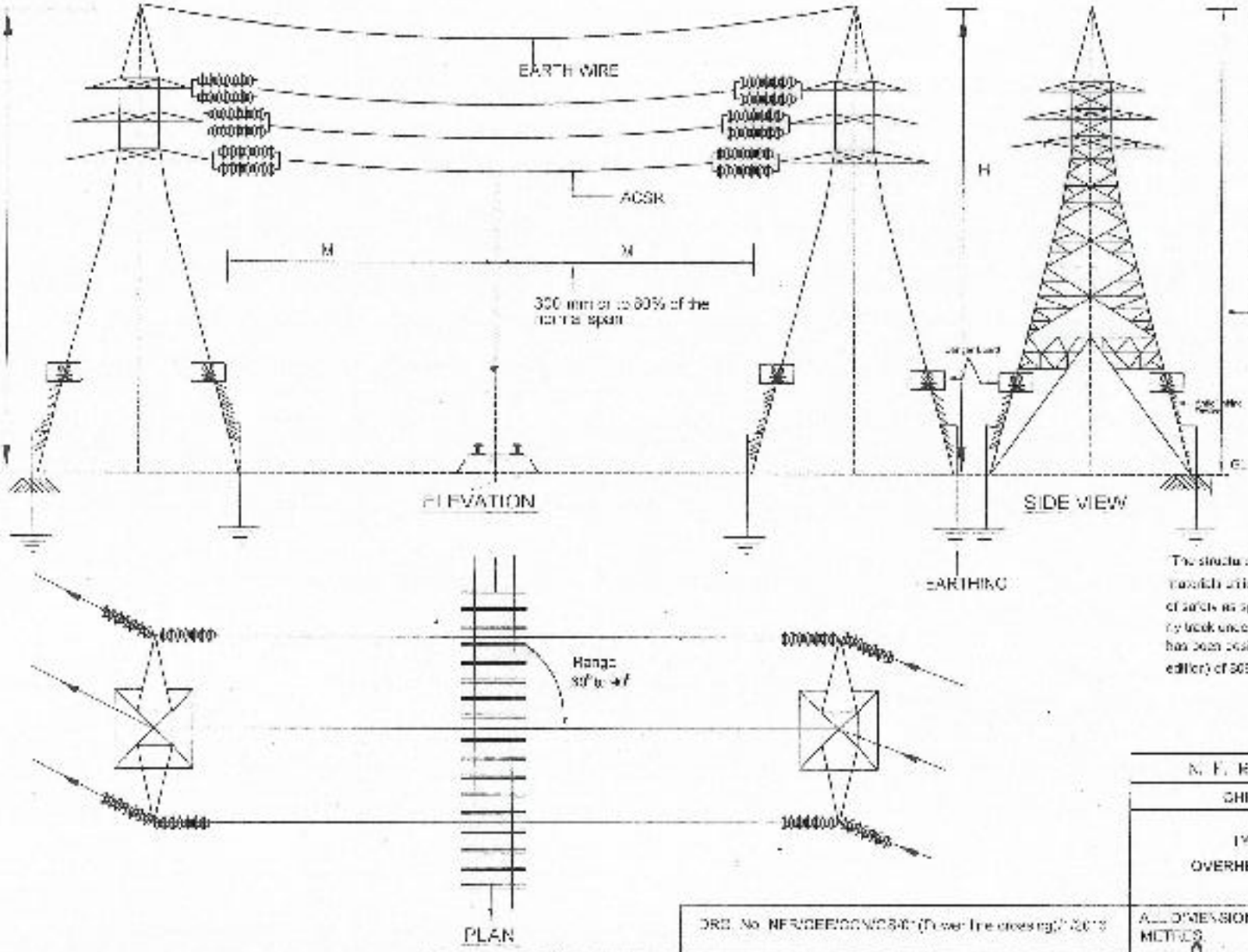
a) Luminaire manufacturers should provide in the photometric data sheet of the luminaire the average luminance distribution in the C_0 and C_{90} planes, either in the form of luminance values (*see* Table 3) or in the form of luminance curves (*see* Fig. 5); and

b) Compare plots of these luminance values on the correct scale against the reference curves:

   i) For all types of luminaires seen lengthwise and for those luminaires seen crosswise and having only horizontal light emitting surfaces, Diagram I; and

   ii) For those luminaires seen crosswise and having luminous side panels, Diagram II.

c) Determine the value of $\frac{a}{h_s}$ up to which, according to Fig. 1, has to be considered.



LIST OF MATERIALS	
[illegible]	[illegible]
GALVANISED LATTICE STEEL	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
ACSR	
[illegible]	[illegible]

NOTE:

[illegible]

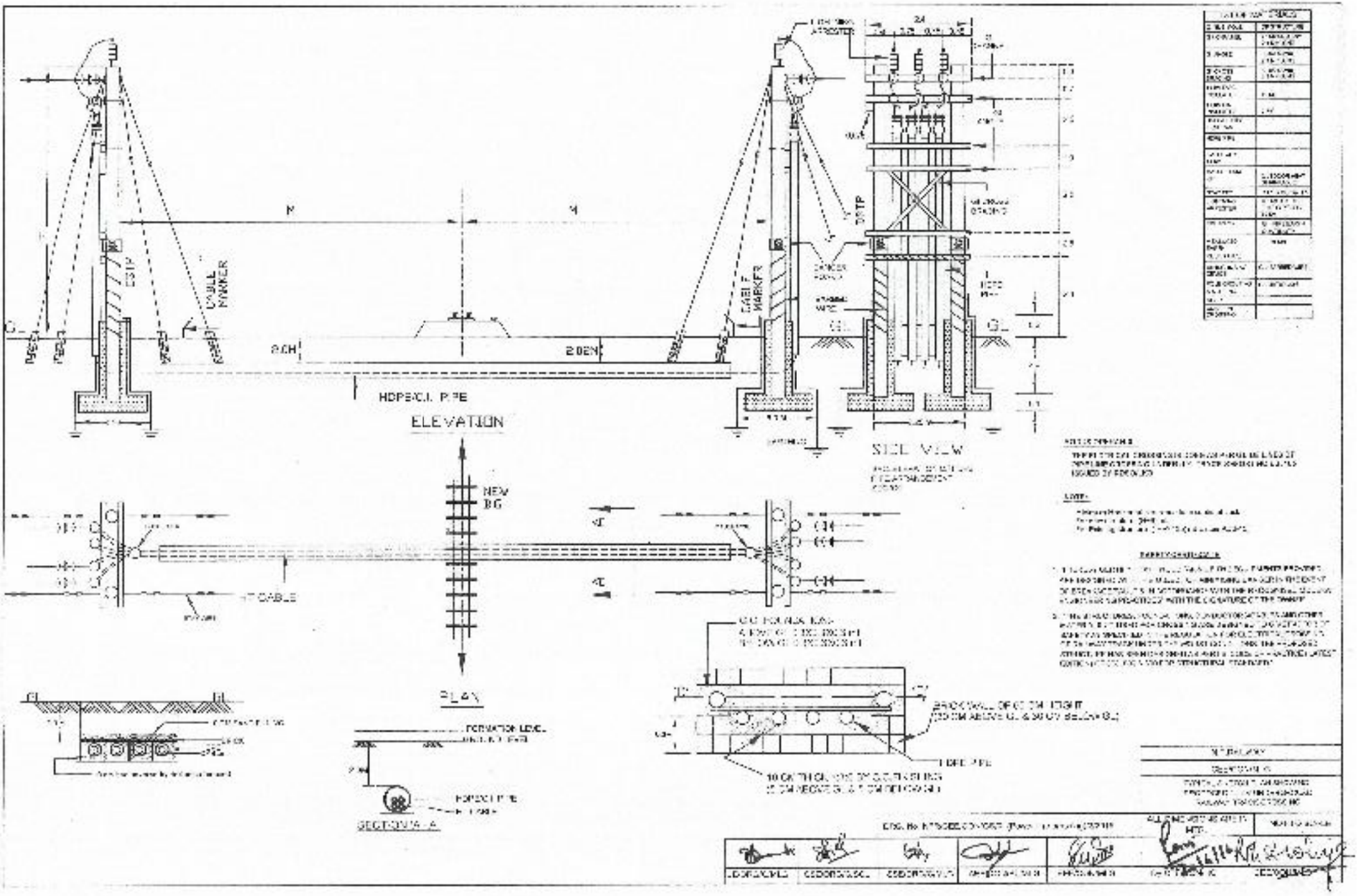
The structure foundation, earthing details and other constructional details for crossing span shall be as per latest drawings as specified in the respective tender specification for tower under worst condition. The proposed structure has been designed as per IS Code of practice (latest edition) of 802.632 and 800 for structural standard.

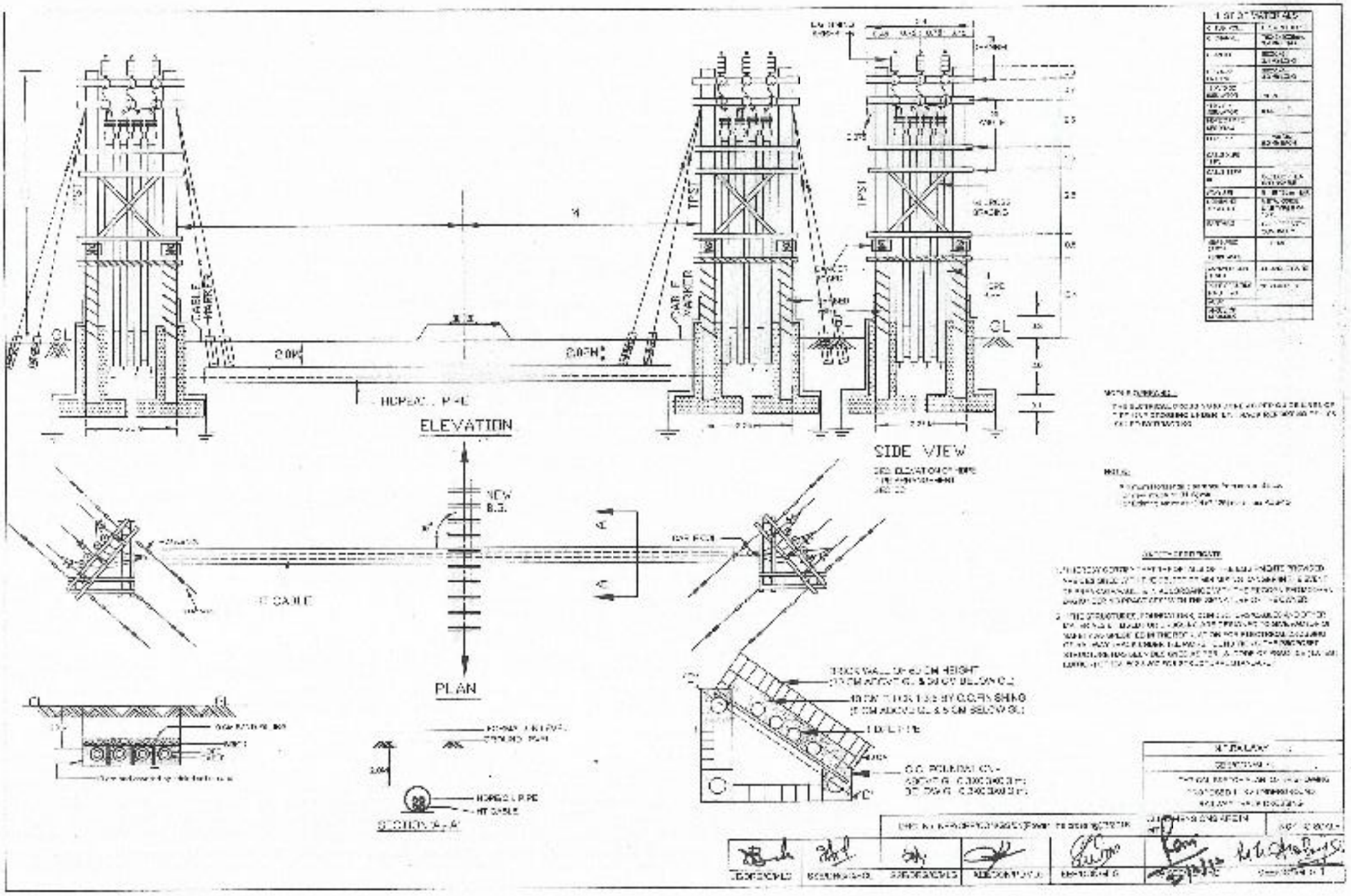
		DRG. No. NFR/CEE/CON/OHE/[illegible] (Power line crossing)/2019	ALL DIMENSIONS ARE IN METRES.	NOT TO SCALE
JE/ERS/CON/MLG	SSE/ERS/CON/MLG	SSE/ERS/CON/MLG ASE/CON/PLW/MLG	DY.CEE/CON/HQ	CEE/CON/MLG

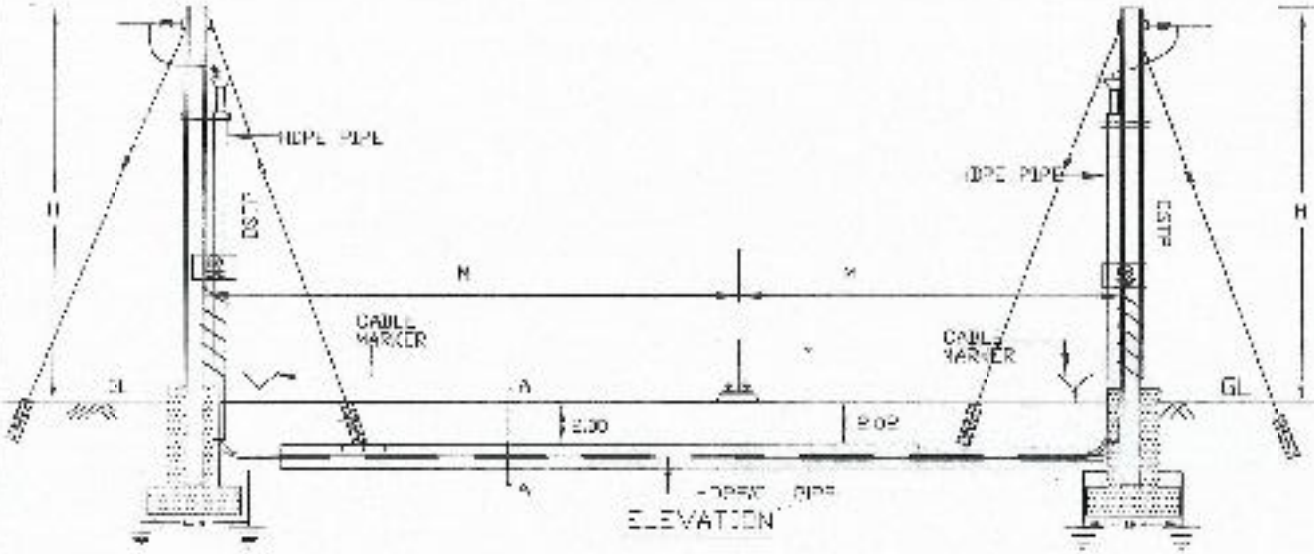
N. F. RAILWAY CONSTRUCTION

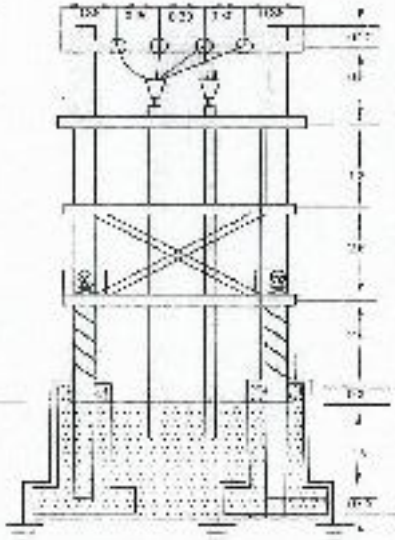
CHIEF ELECTRICAL ENGINEER

TYPICAL DRAWING OF OVERHEAD TOWER CROSSING


ELEVATION
SIDE VIEW
PLAN
SECTION A-A
HDPE/C.I. PIPE
CABLE MARKER
NEW BG
CABLE
FORMATION LEVEL


ELEVATION
SIDE VIEW
PLAN
SECTION A-A
CABLE MARKER
CL
NEW B.S.
HDPE PIPE
HT CABLE

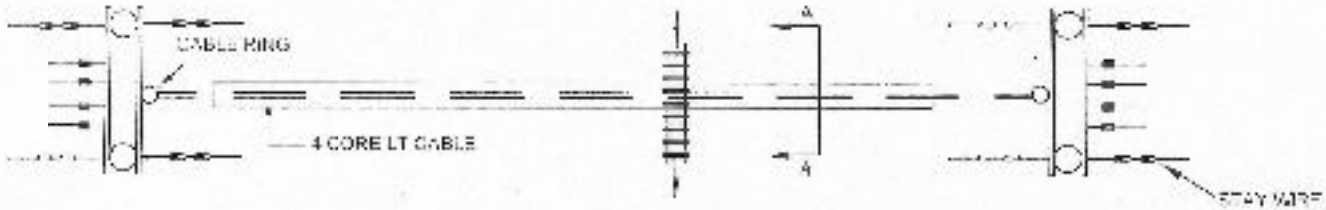




LIST OF MATERIALS FOR LT

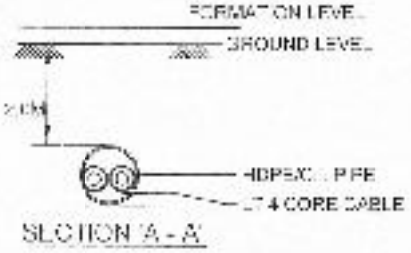
C.T.C. POLE	ST STRUCTURE
G.I. CABLE	[illegible]
G.I. CROSS BRACING	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
G. PIPE	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
LT CABLE TO LV KIT	[illegible]
STAY SET	[illegible]
EARTHING	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

"I hereby certify that the equipment provided are designed with the object of minimizing the danger in the event of breakage/defect and in accordance with accepted modern engineering practice"



NOTE:-

[illegible]



NOTE:-

ALL THE STRUCTURE SHOULD BE HOT DIP GALVANISED AND THE CONSTRUCTION OF EARTHING IS NOT SHOWN IN THE DRG BUT DONE CONFORMING TO IS:3043

MODUS OPERANDI:-

THE ELECTRICAL CROSSING IS DONE AS PER GUIDE LINES OF PIPE LINE CROSSING UNDER R.Y. TRACK REPORT NO RS: 105 ISSUED BY RDSO/LKO

N. F. RAILWAY CONSTRUCTION

CHIEF ELECTRICAL ENGINEER

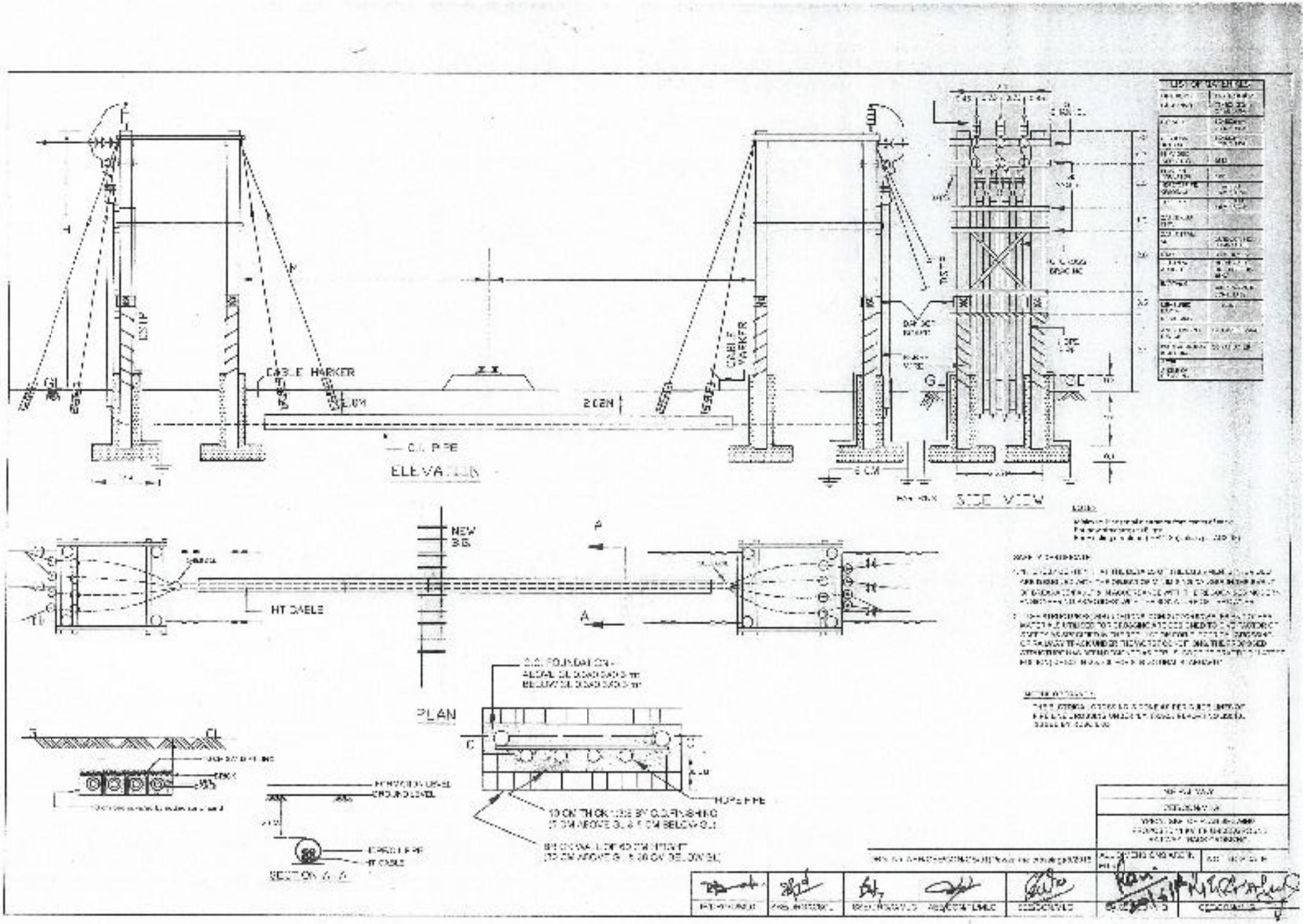
TYPICAL DRAWING OF OVERHEAD 415 LT FEEDER INTO UNDER GROUND CABLE TRACK CROSSING

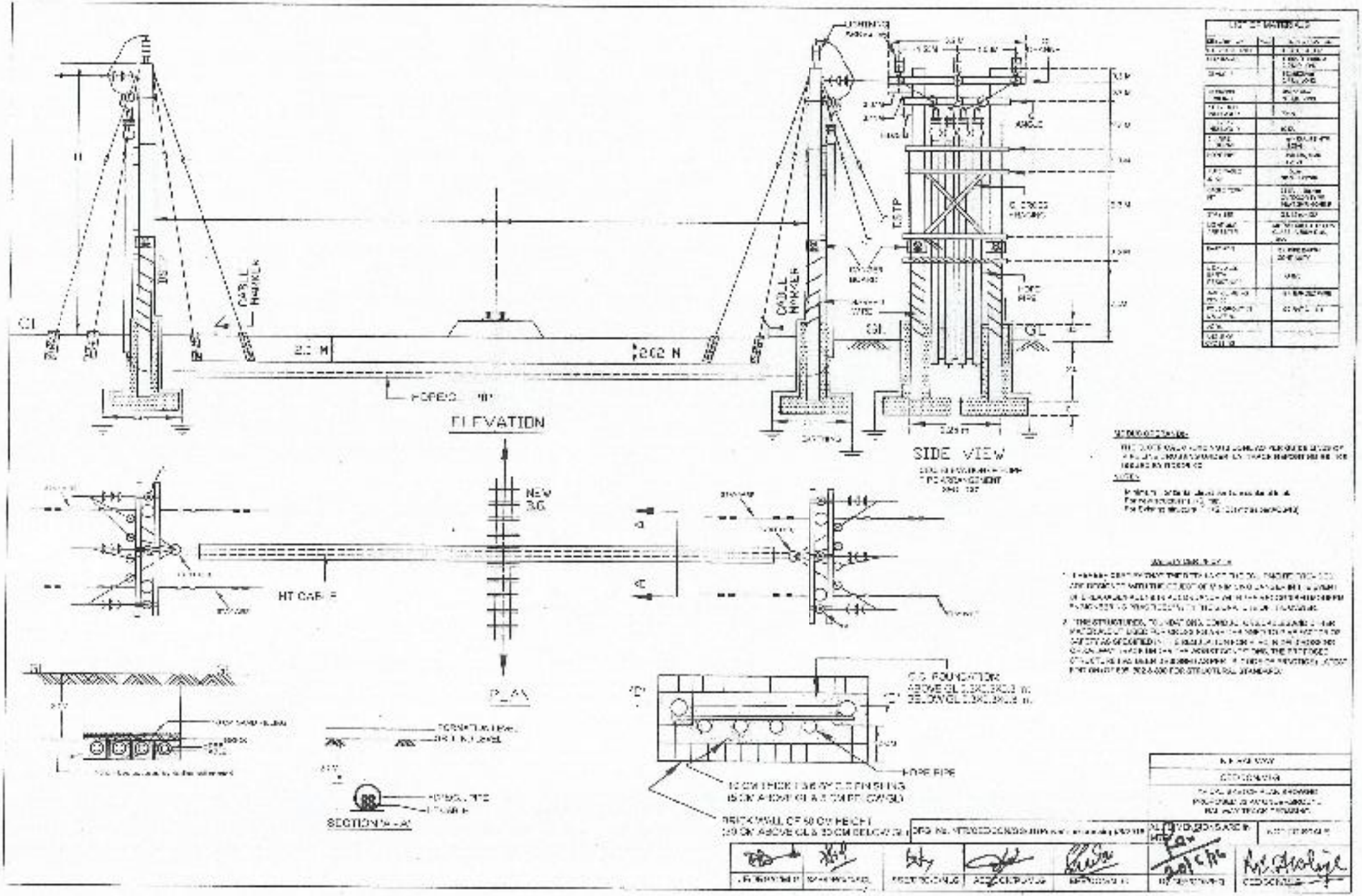
DSO No. [illegible]

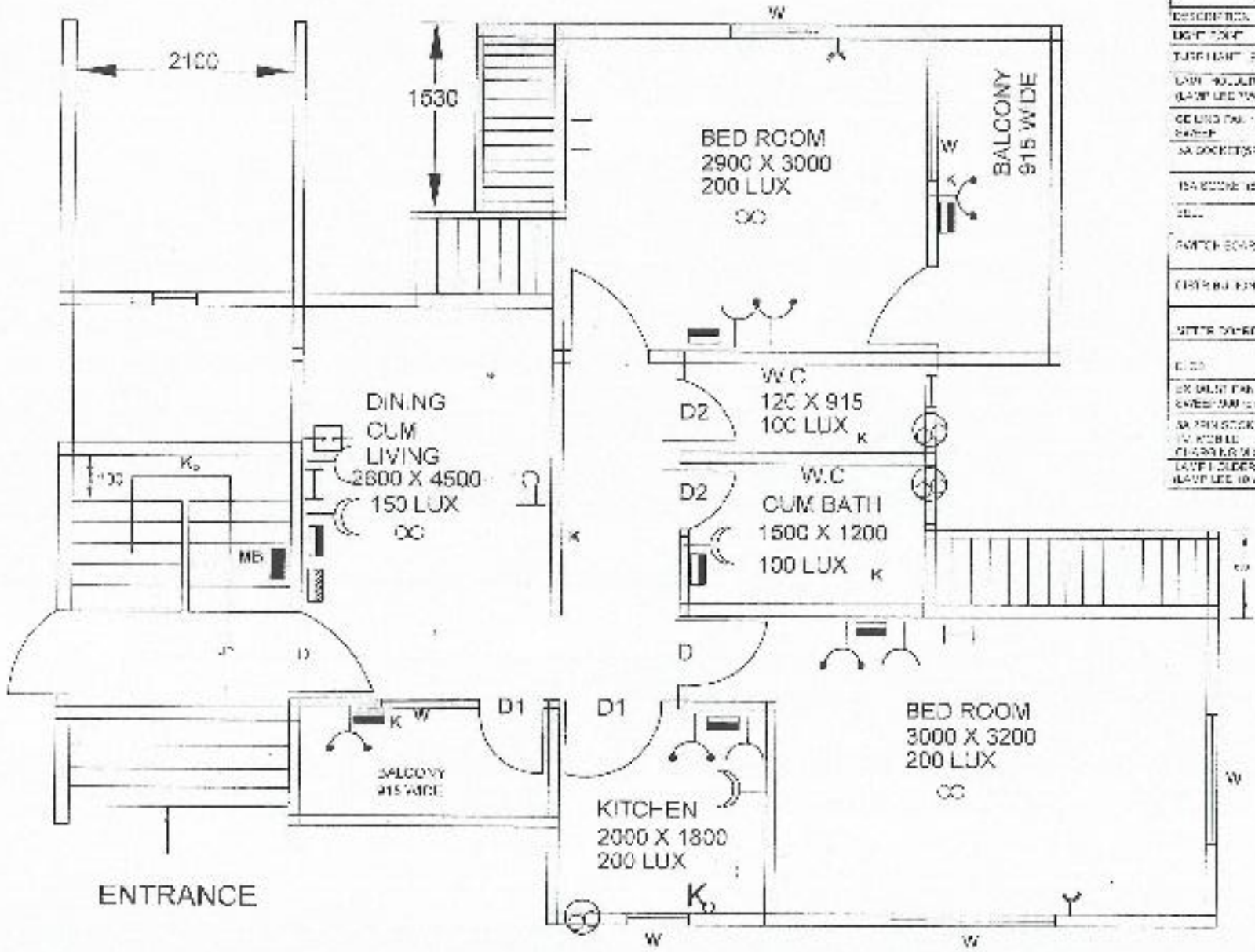
ALL DIMENSIONS ARE IN MM

NOT TO SCALE

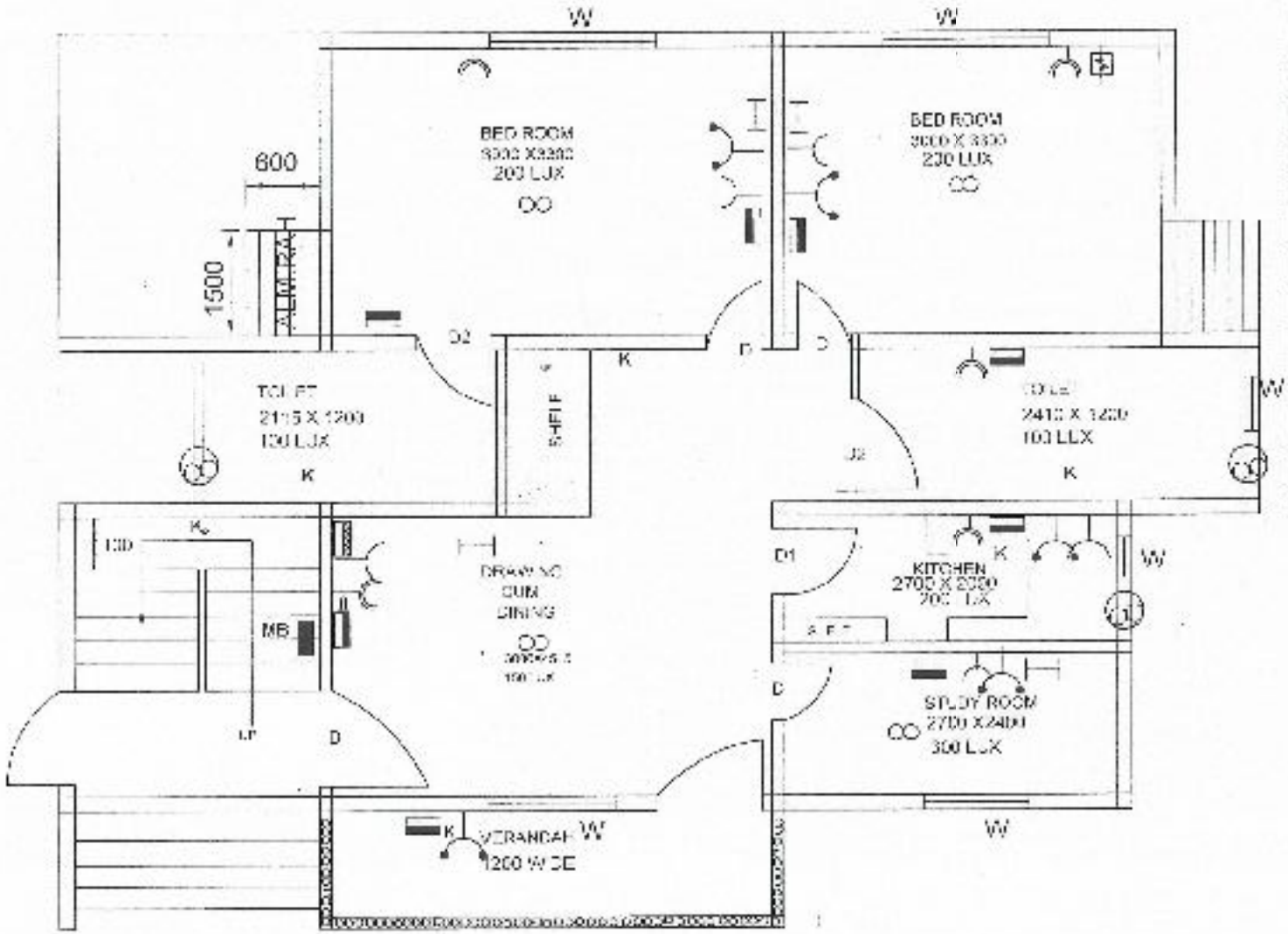
DESIGNED/ML'S	SSE/DRG/WSCL	SSE/DRG/WLG	AEE/CON-PL/WLG	EE/CON/WLG	DY.EE/CON/HQ	CEE/CON/MLG
					30/6/11	


CABLE MARKER
C.L. PIPE
ELEVATION
SIDE VIEW
NEW S.S.
HT CABLE
PLAN
SECTION A-A


ELEVATION
SIDE VIEW
PLAN
SECTION A-A
NEW 3.0
HT CABLE
CABLE MARKER
GL
FOUNDATION
REINFORCEMENT
HOPE PIPE
BRICKWALL OF 50 CM HEIGHT



LIST OF MATERIALS				
DESCRIPTION	SYMBOL	NOS	NOS	NOS
LIGHT POINT				
TUBE LIGHT POINT				
LAMP HOLDER (LAMP LED TYP)	K			
CEILING FAN POINT WITH REGULATOR	CD			
5A SOCKET OUTLET				
15A SOCKET OUTLET				
BELL				
PATCH BOARD				
CONCEALED EXHAUST FAN				
SPARE POINT				
EARTHING				
EXHAUST FAN POINT WITH REGULATOR				
5A PIN SOCKET FOR TV OUTLET (LAMP LED TYP)				
LAMP HOLDER (LAMP LED TYP)				

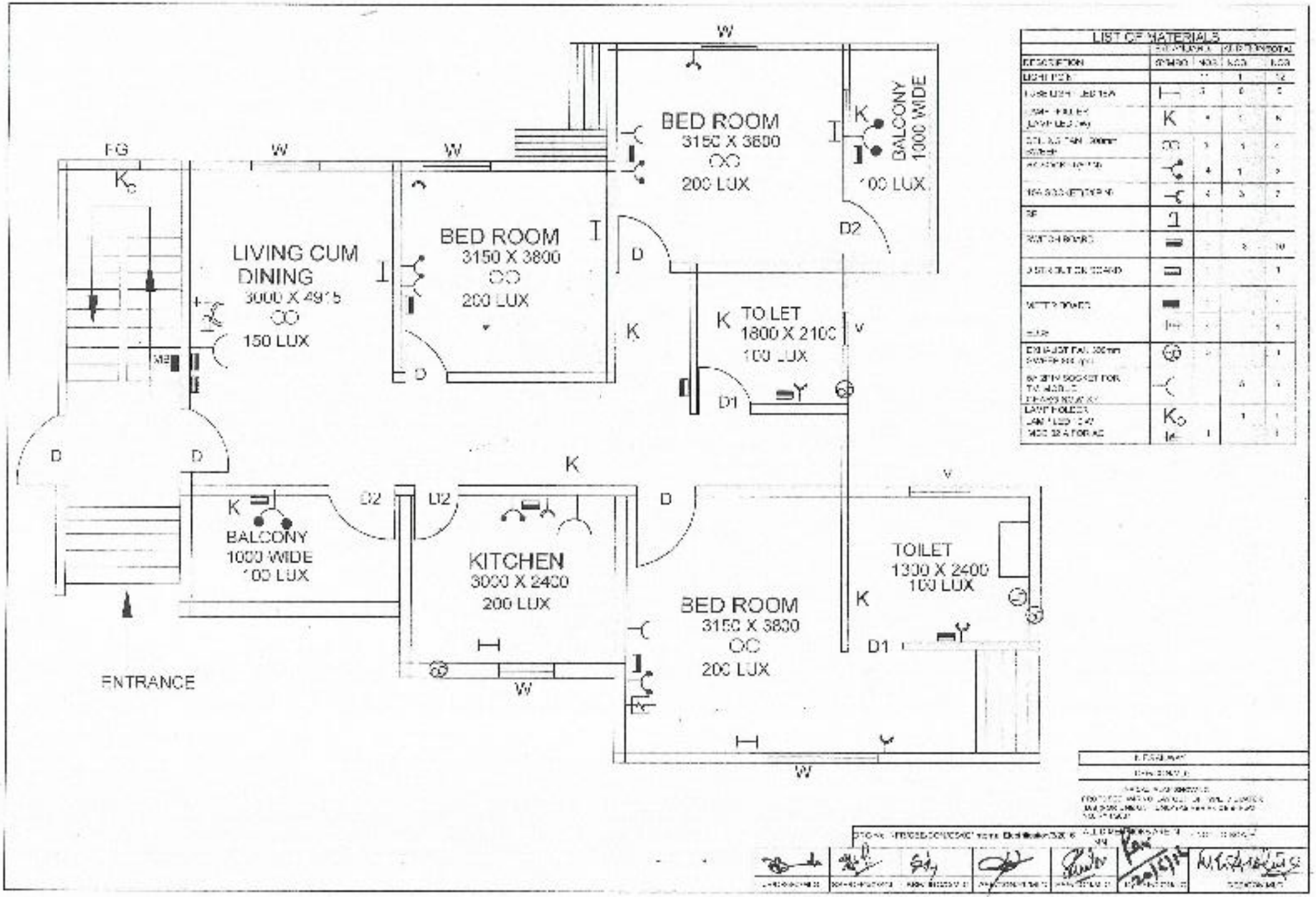


ENTRANCE

LIST OF MATERIALS				
	SYMBOLS		ADDED	TOTAL
DESCRIPTION	SYMBOL	[illegible]	[illegible]	[illegible]
LIGHT POINT		7	3	10
TUBE LIGHT LED 18W	⊢	3	1	4
FAN REGULATOR (UNIT 1200 MM)	K	4	1	5
EXHAUST FAN 450mm SWEEP	EXH	3	1	4
[illegible]		3	2	5
[illegible]		2	3	5
[illegible]		1		1
[illegible]		3	2	5
DISTRIBUTION BOARD		1		1
METER BOARD		1		
BELL		1		1
EXHAUST FAN 300mm WATER PROOF			2	2
[illegible]			3	3
[illegible]				1
[illegible]				1

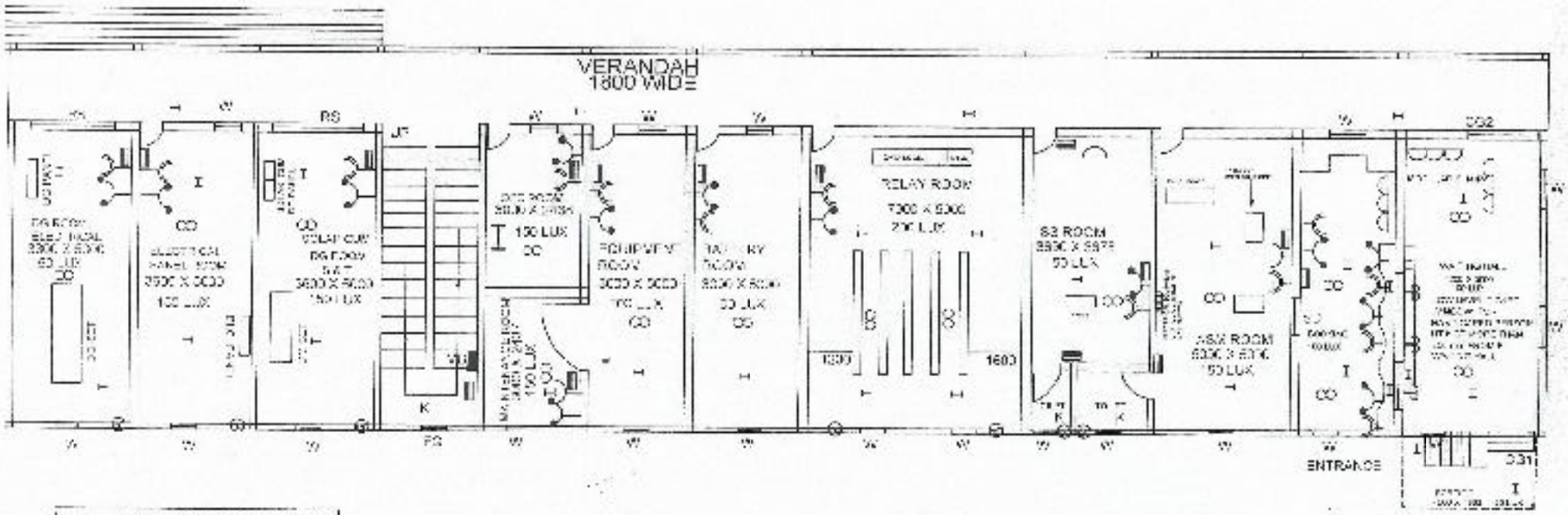
JEN/DRAWING	SOLID/DRAWING	[illegible]	[illegible]	[illegible]	30/6/16	[illegible]

ERG No. [illegible] Formal Check Date 30/6/2016 | ALL DIMENSIONS ARE IN MM | NOT TO SCALE



LIST OF MATERIALS				
DESCRIPTION				

PLATFORM SIDE



LIST OF MATERIALS

DESCRIPTION	SYMBOL
LIGHT	
TUBE LIGHT LED 1X4'	H
CEILING FAN 1400mm SWEEP	CD
5A SOCKET(3 PIN)	
15A SOCKET(3PIN)	
5A 3PIN SOCKET FOR MOBILE CHARGING	
PATROL BOARD	
DISTRIBUTION BOARD	
METER BOARD	
FLOR	
EXHAUST FAN 300mm SWEEP 600 rpm	
BRACKET FAN 300 mm SWEEP	
LADY FOLDER LAMP LED 4W	K

DESIGNED	CHECKED	DRAWN	APPROVED	CHECKED		

TYPICAL SCHEMATIC DIAGRAM FOR POWER DISTRIBUTION FROM SUB-STATION

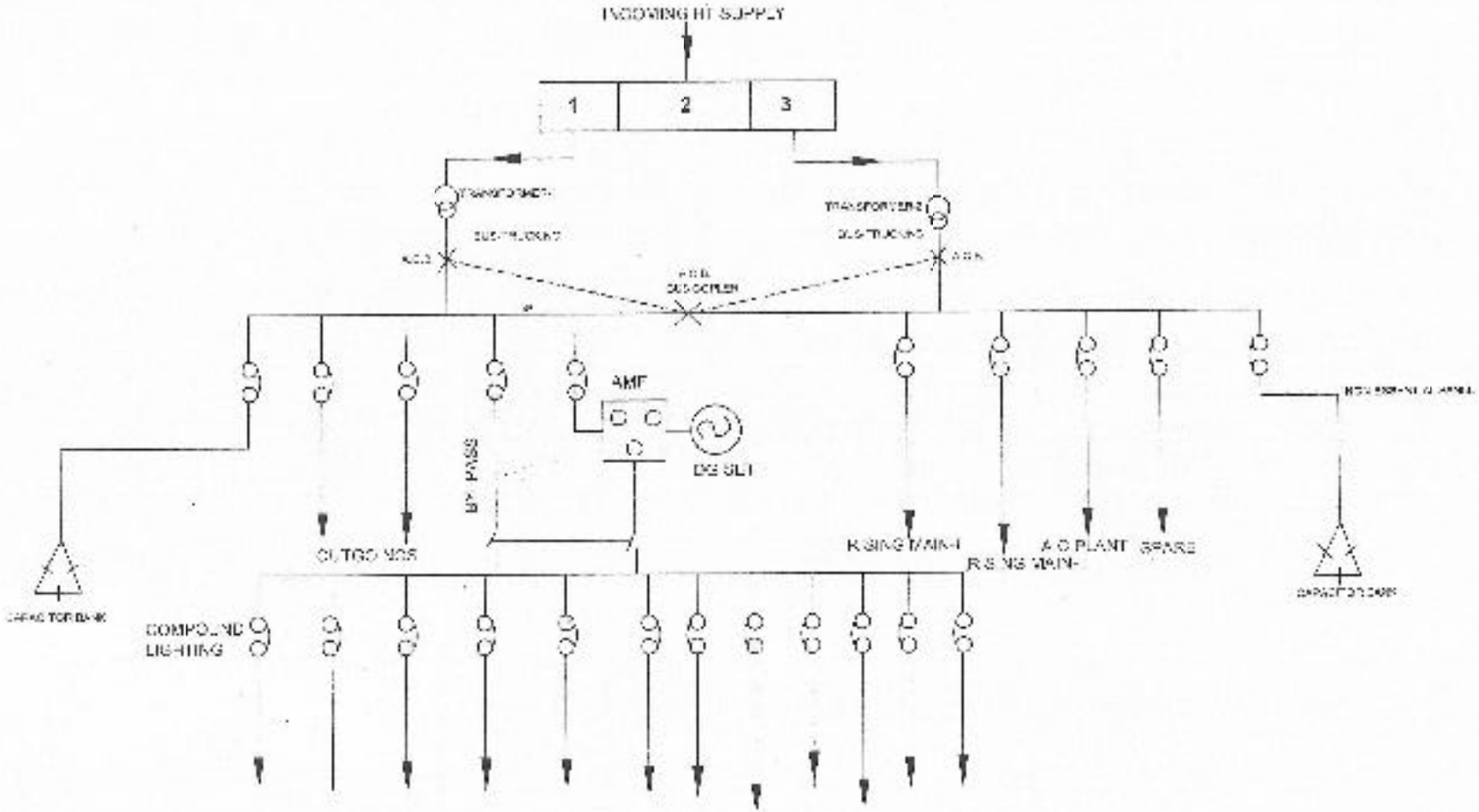
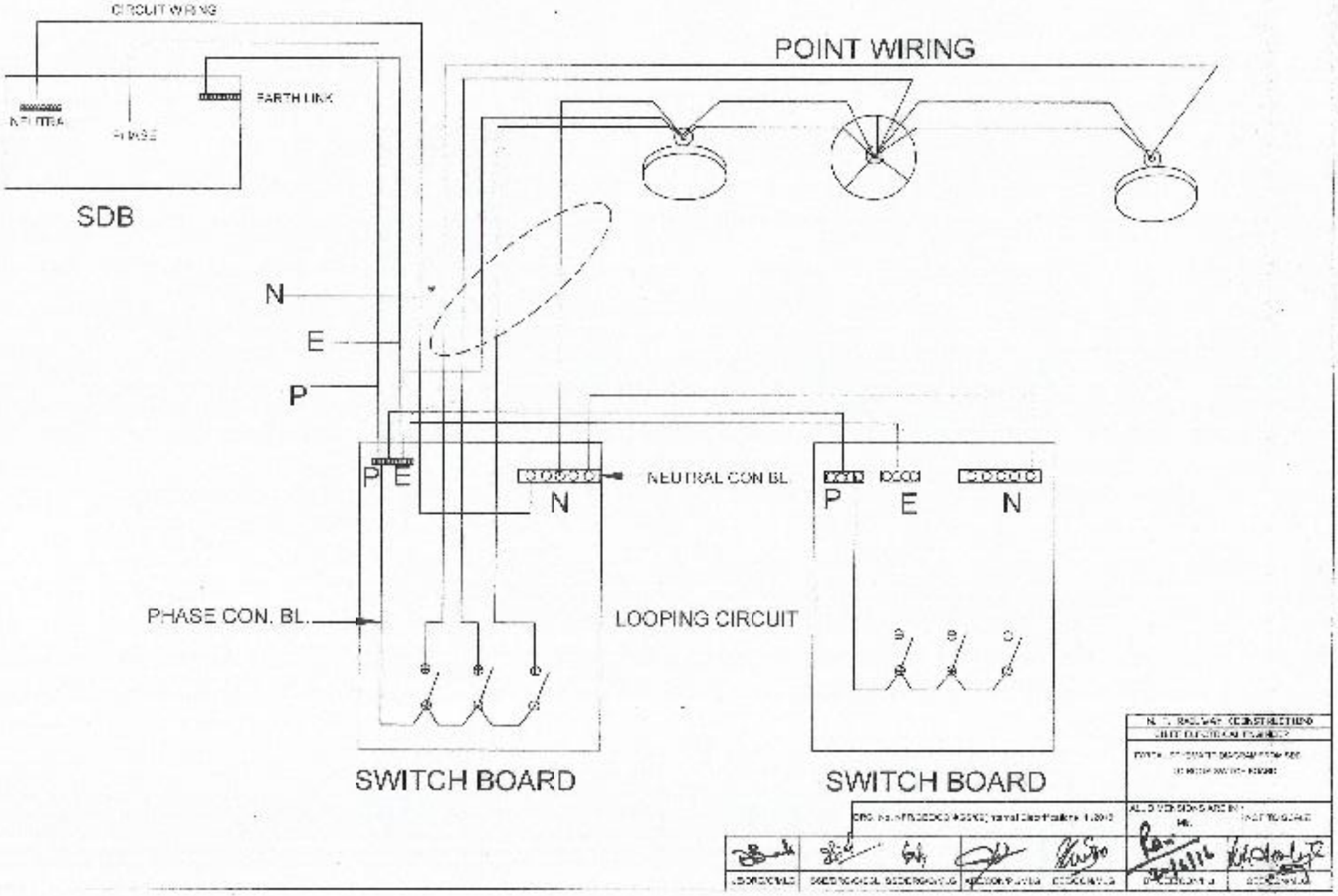
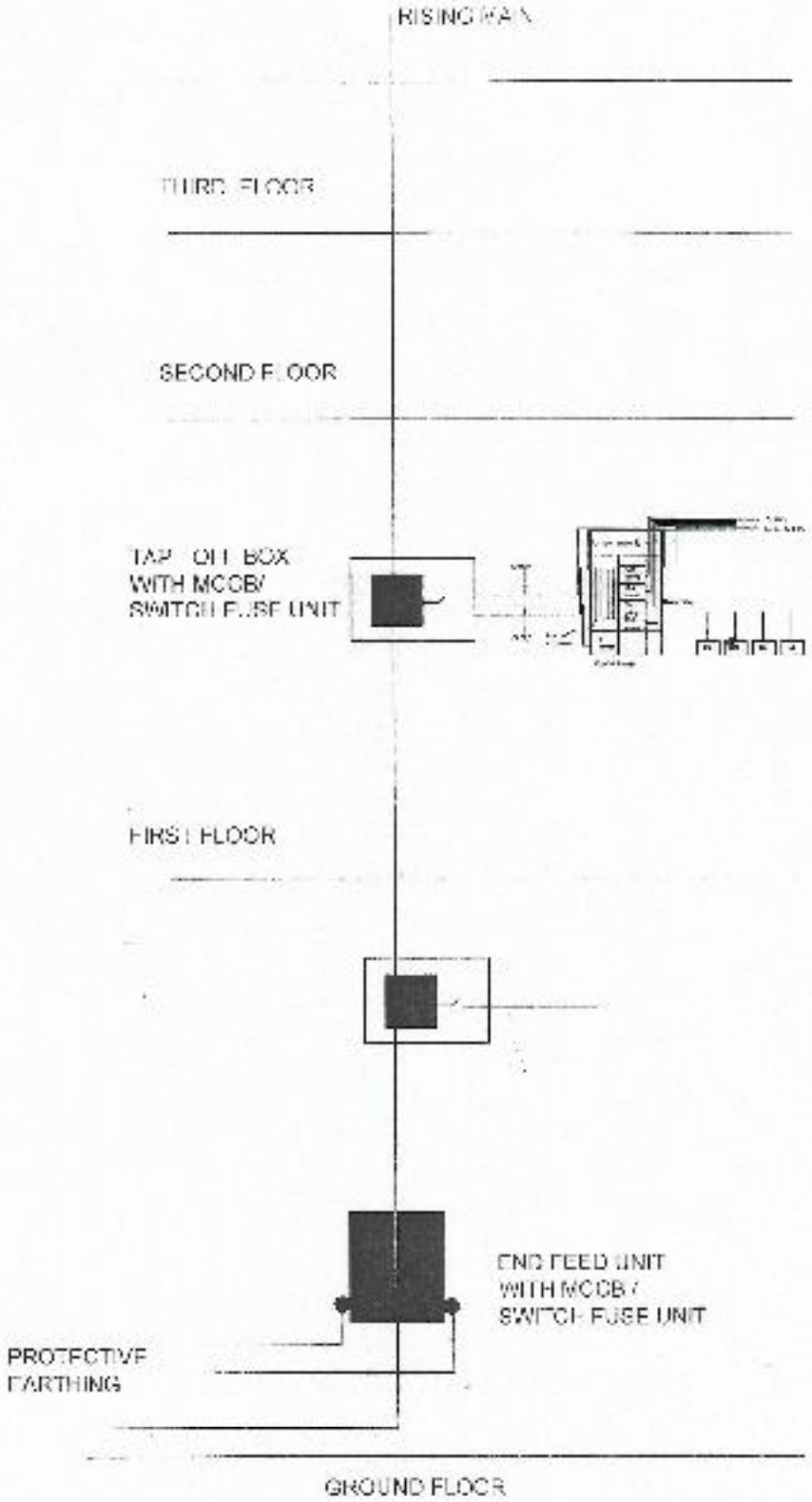


DIAGRAM FROM SDB TO ROOM SWITCH BOARD



Schematic Diagram for Power Distribution System



N. F. RAILWAY CONSTRUCTION

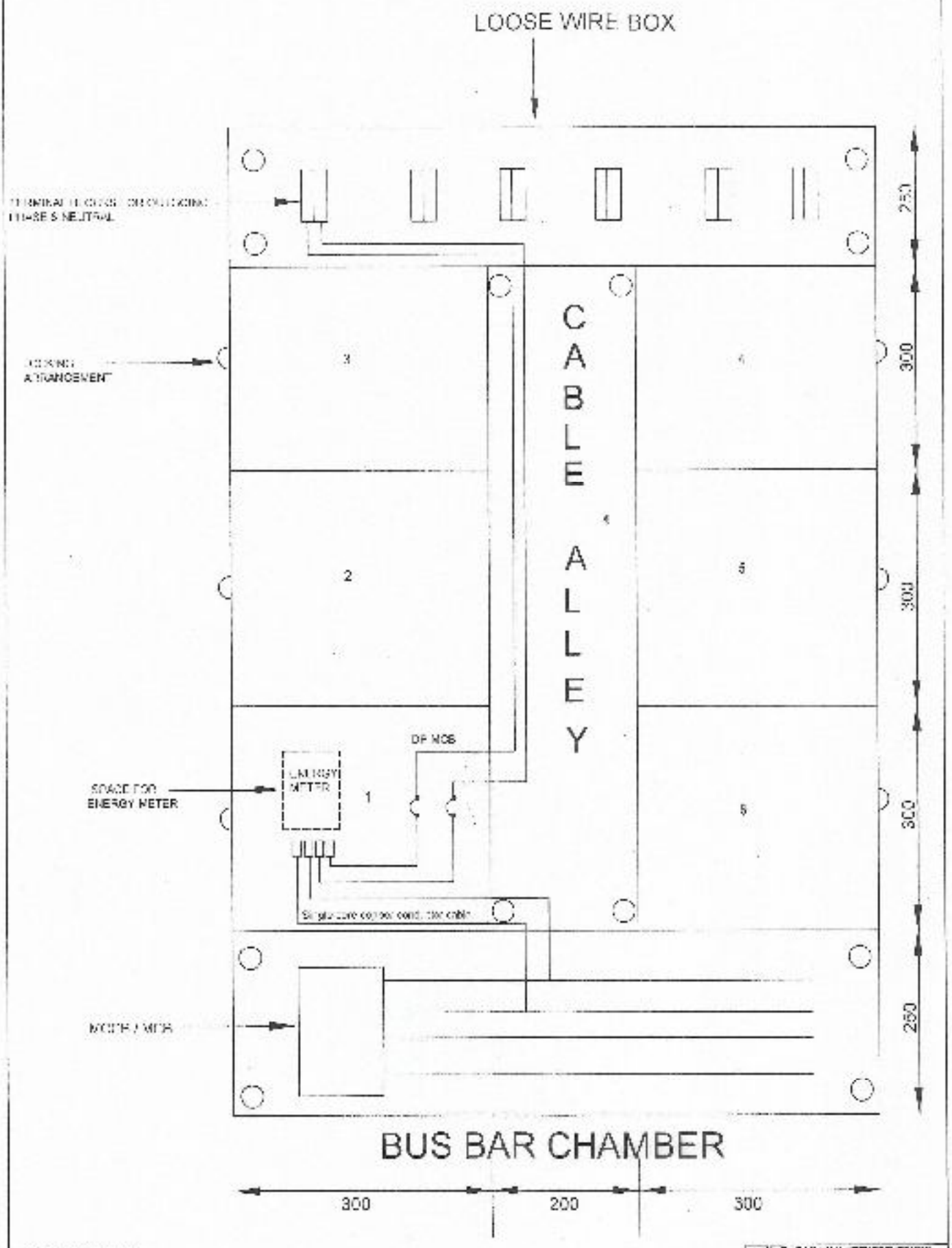
293

DRG. No. [illegible] Internal Distribution [illegible]

ALL DIMENSIONS ARE IN Mm.

NOT TO SCALE

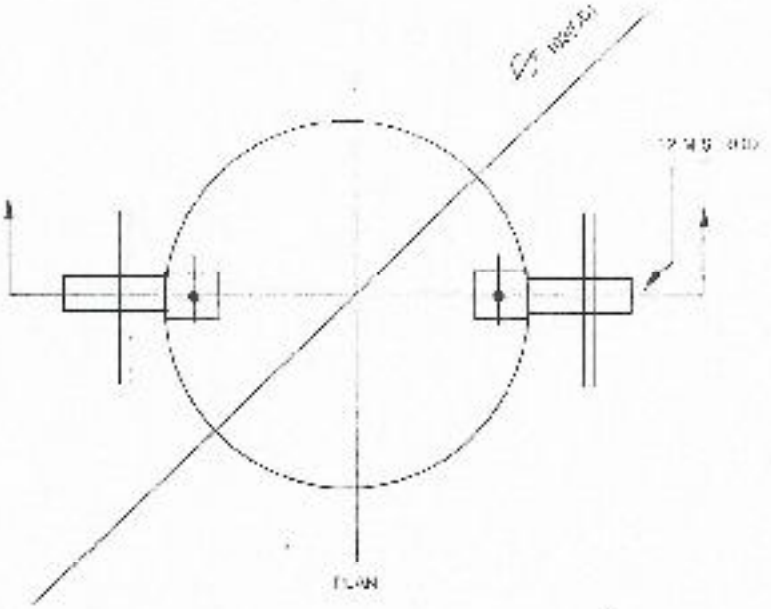
Typical Cubical Panel for Meter Board

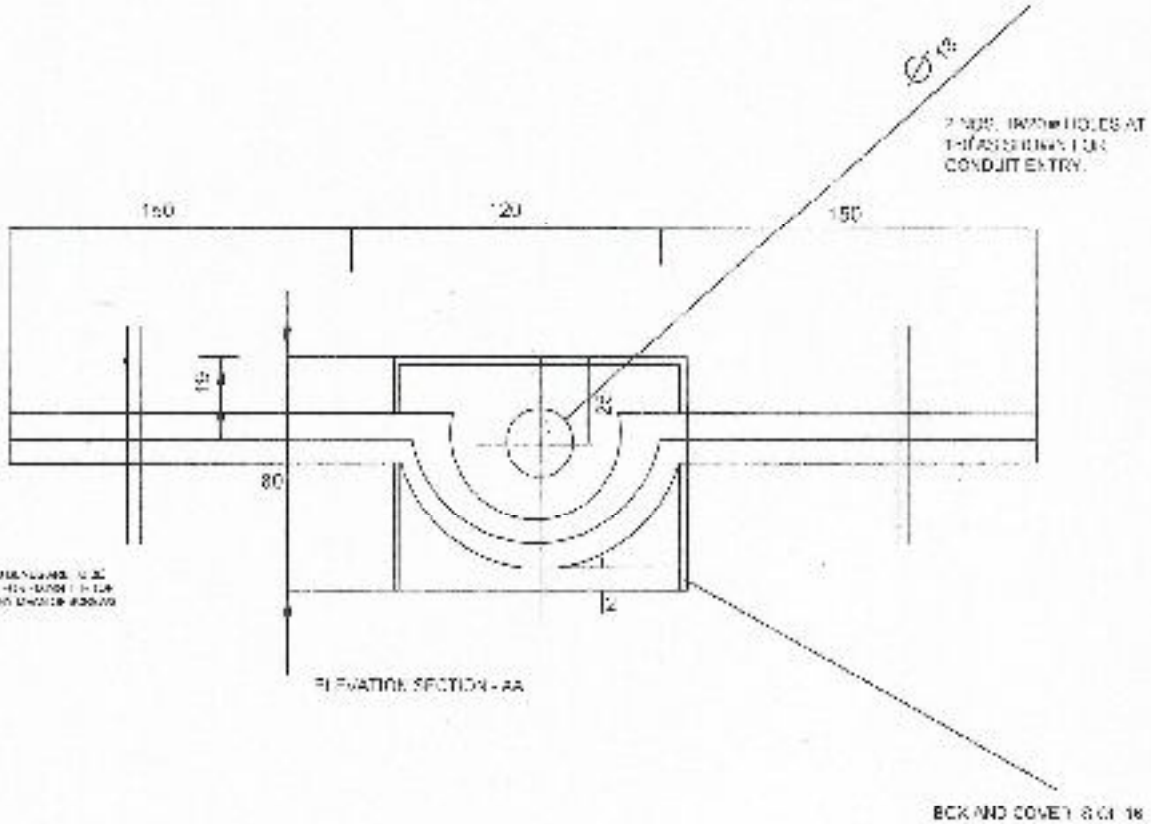


- All three phase and individual Meter box will have locking arrangement.
- Incoming cable, cable alley and bus bar chamber will have arrangement for sealing.
- Exact size and spacing are suggestive. Exact size and arrangement shall be decided by NHAI approving authority.

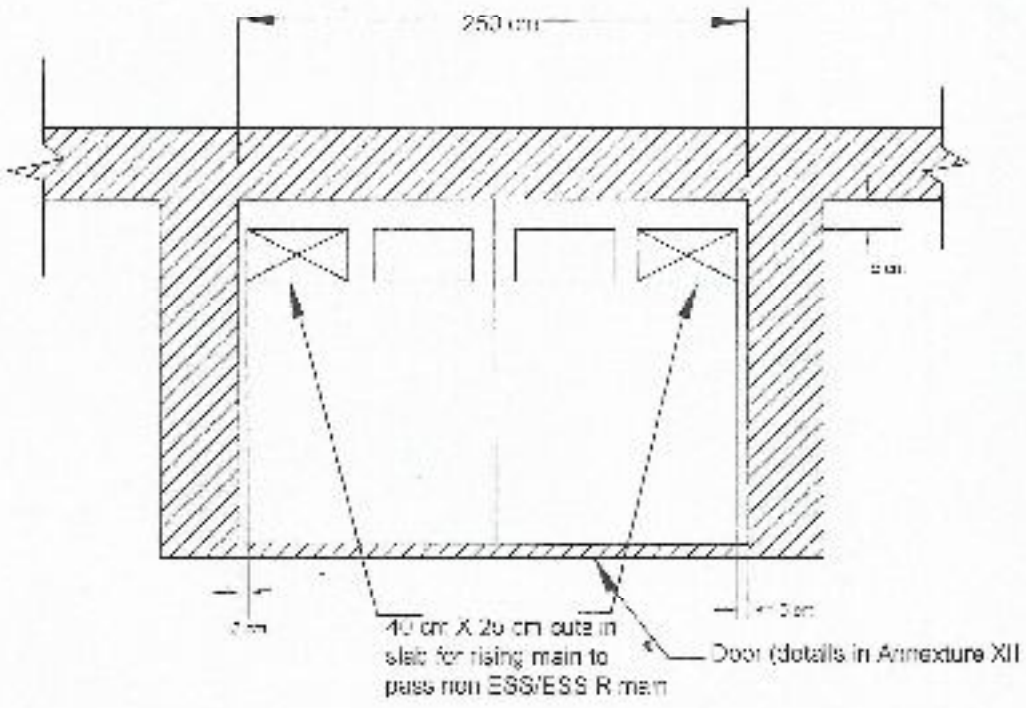
294

Typical Design of Circular Box Type Fan clamp

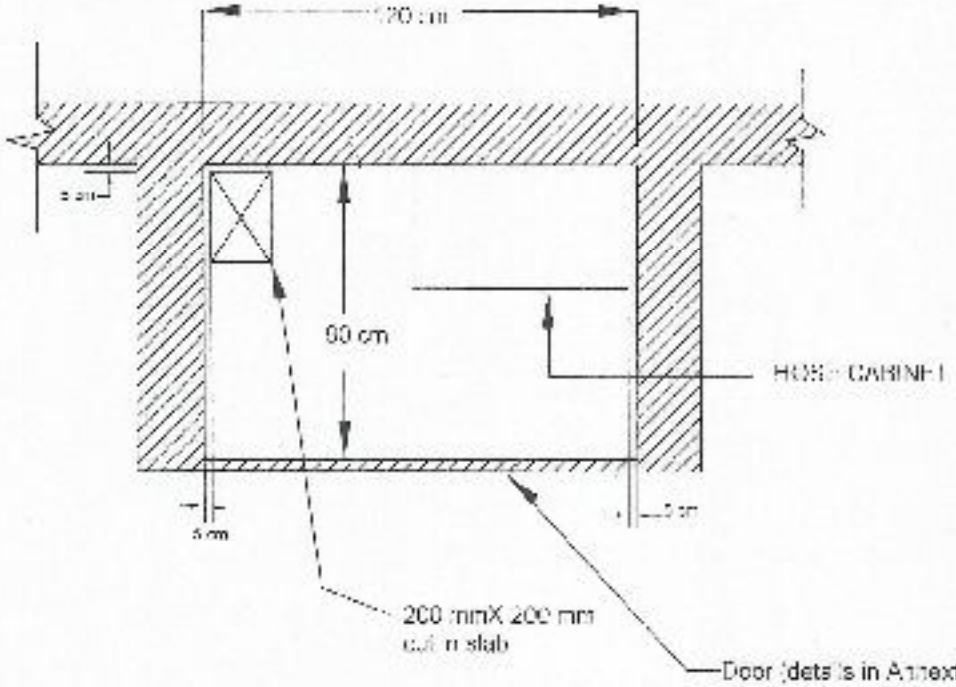




ELECTRICAL RISING MAIN AND WET RISER SHAFT



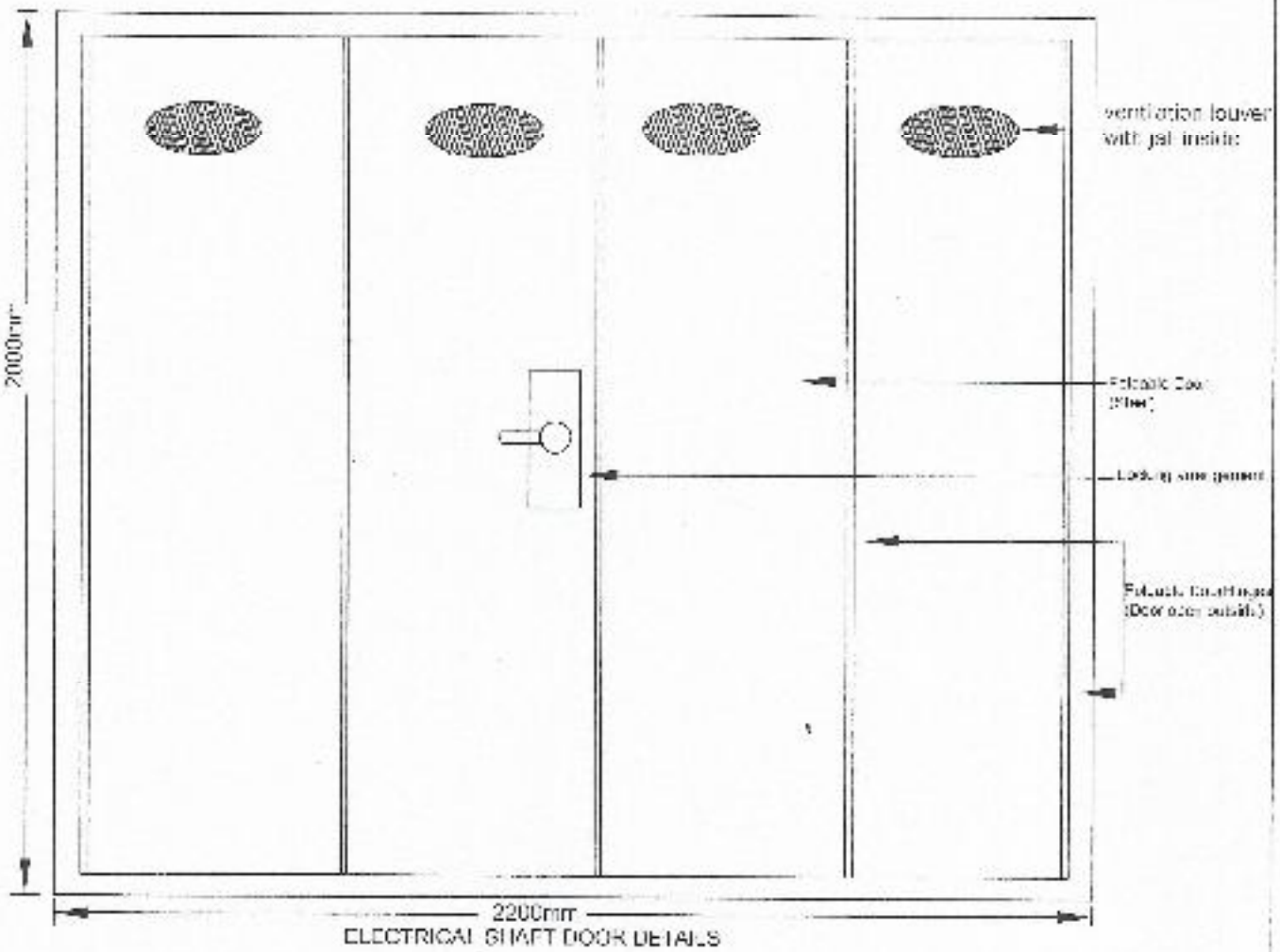
ELECTRICAK RISING MAIN SHAFT



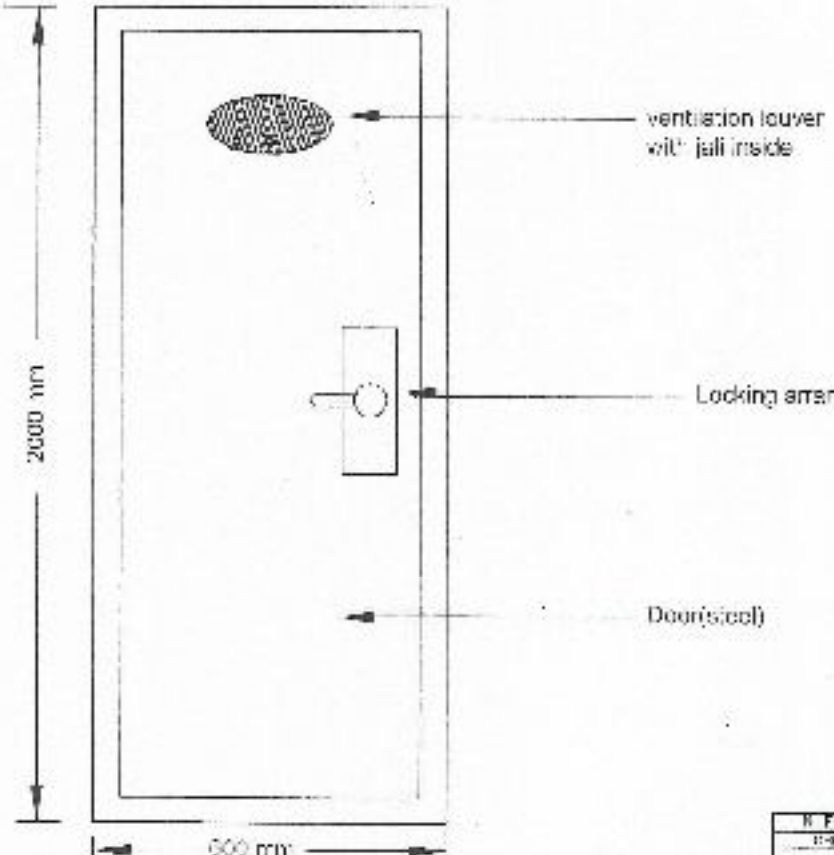
WET RISER SHAFT

One for 1000 sq. mtrs Floor Area

ELCTRICALSHAFT DOOR &TELEPHONE FIRE ALARM SHAFT DOOR



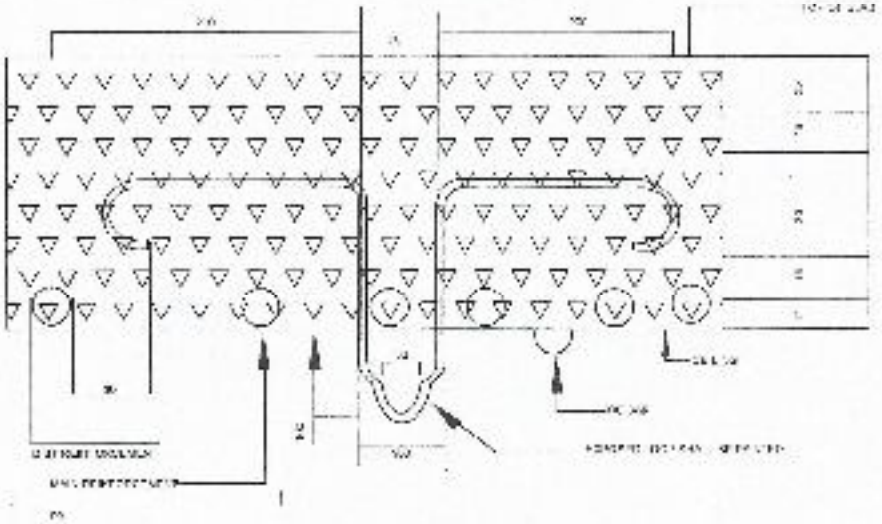
ELECTRICAL SHAFT DOOR DETAILS

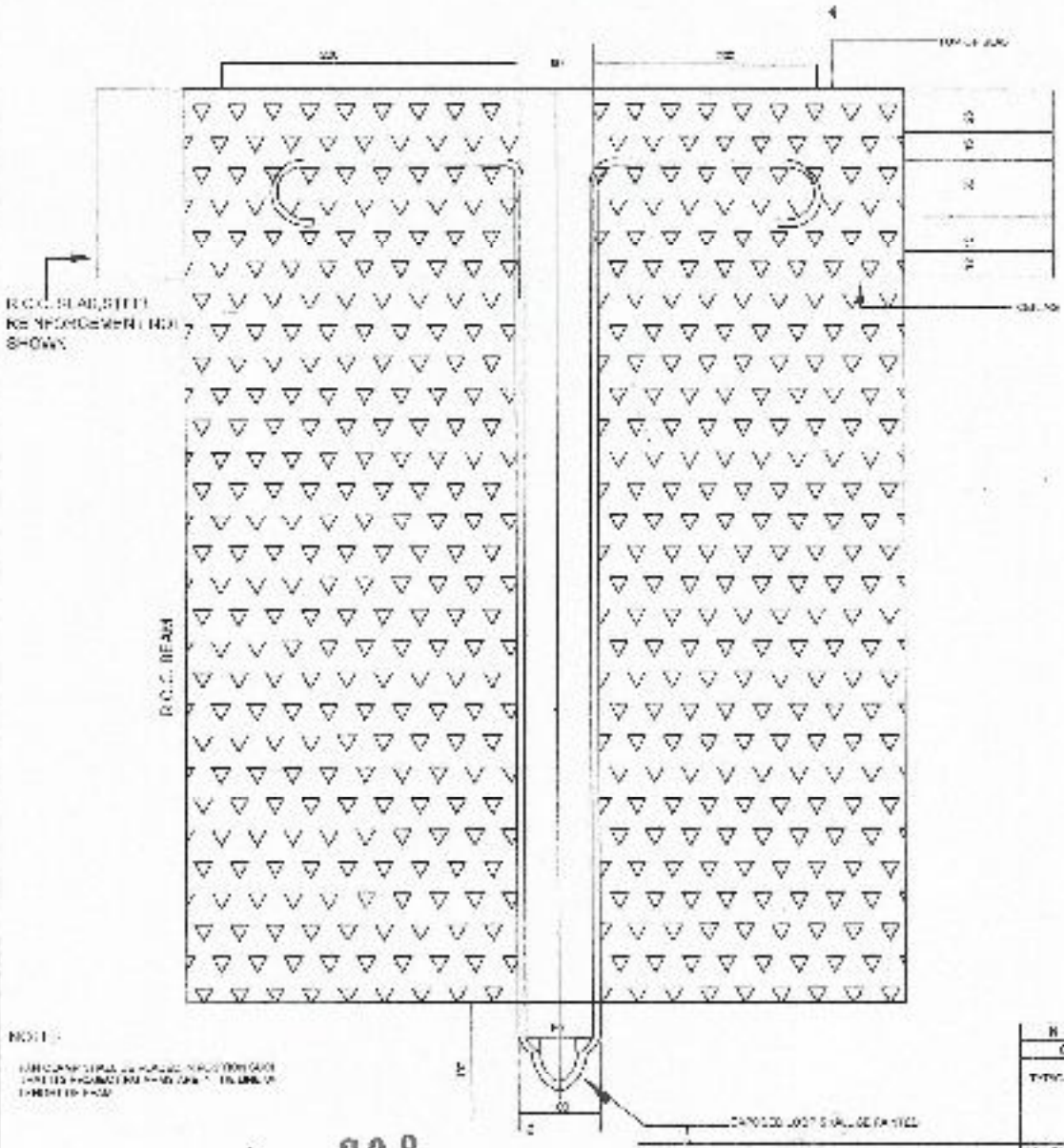


TELEPHONE/ FIRE ALARM SHAFT DOOR DETAILS

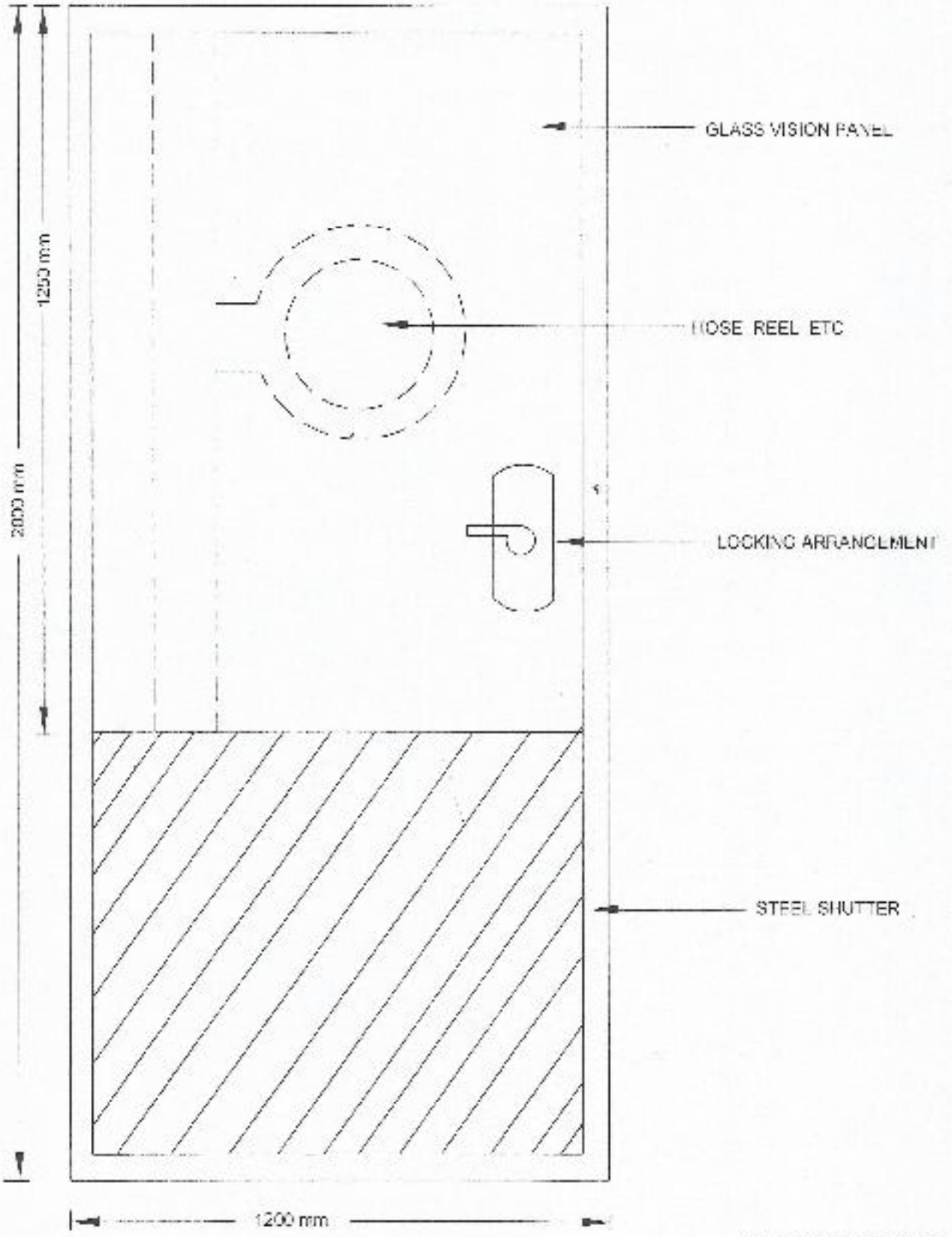
297

Typical Design of M.S. Fan Clamps

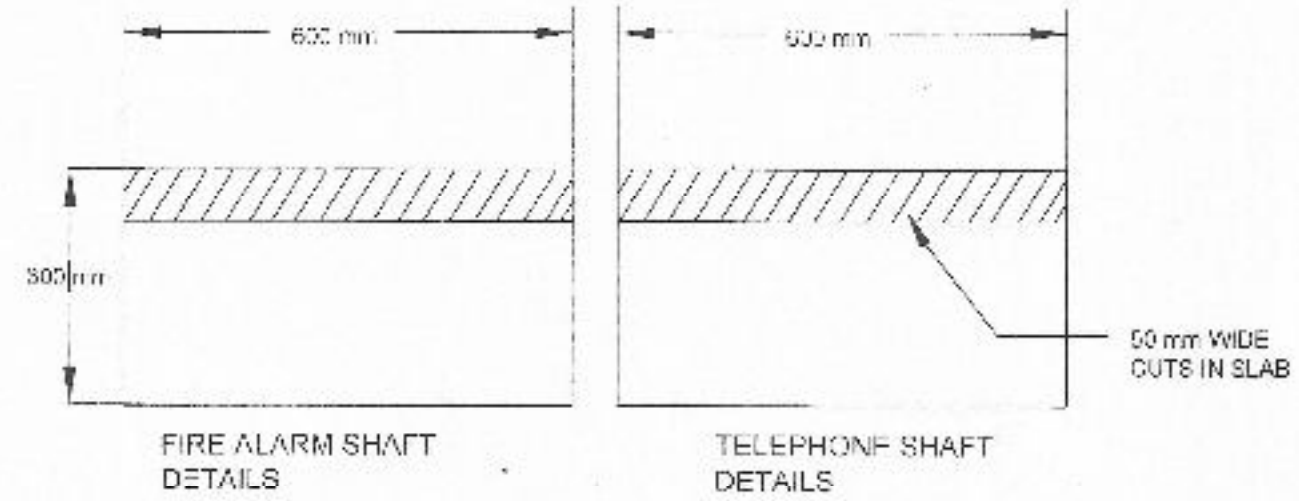




WET RISER SHAFT DOOR DETAILS

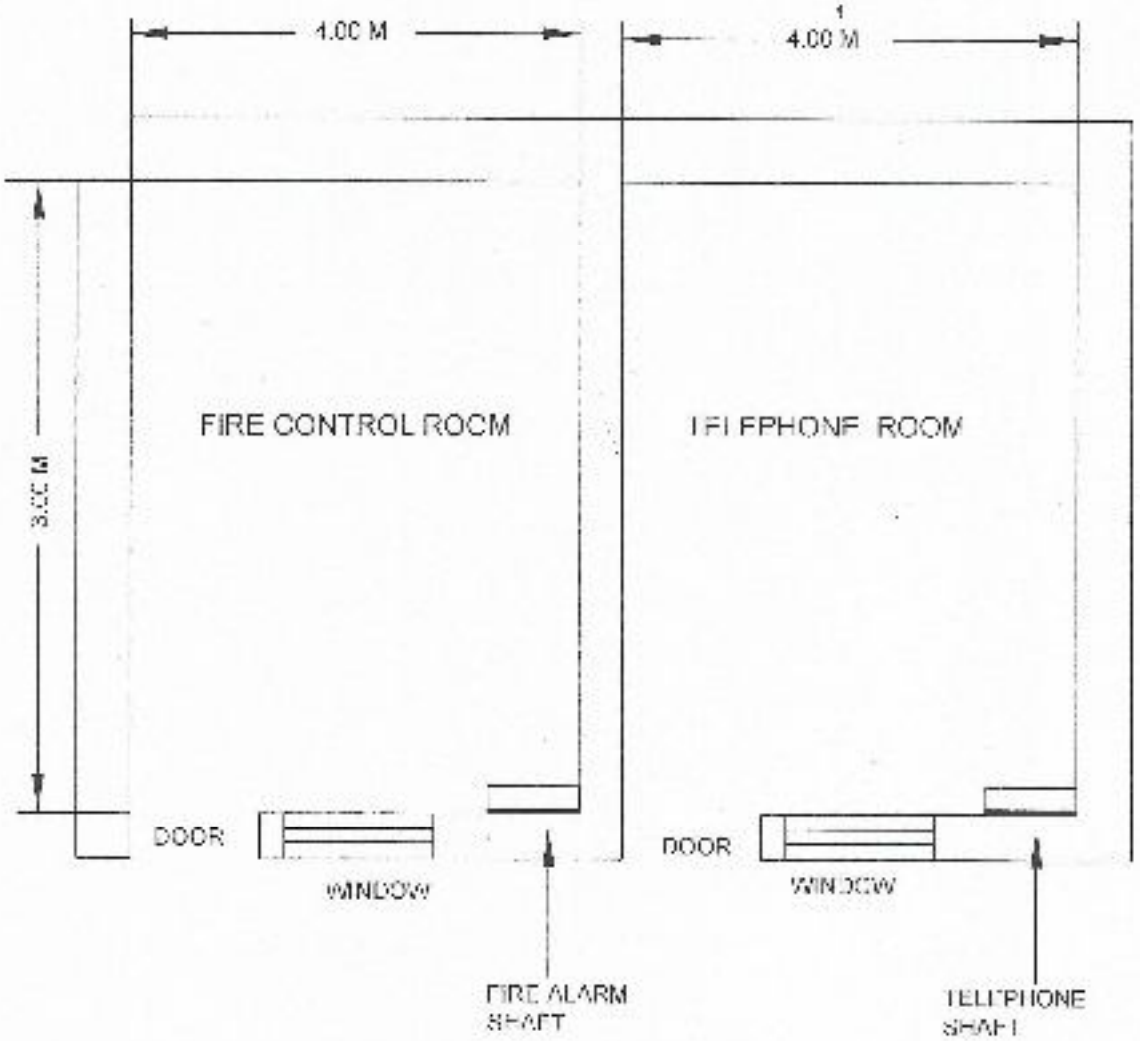


TELEPHONE & FIRE CONTROL ROOM



FIRE ALARM SHAFT
DETAILS

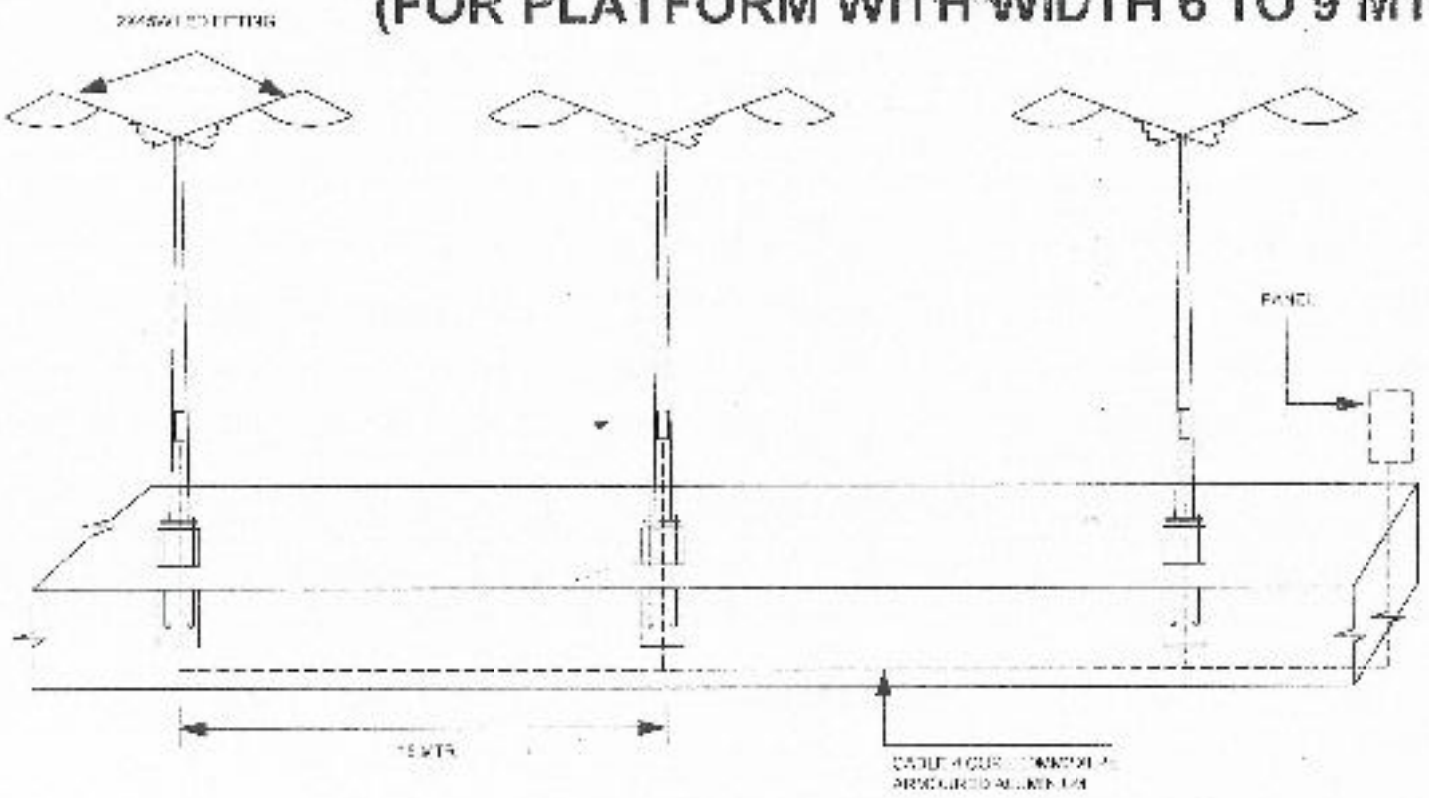
TELEPHONE SHAFT
DETAILS

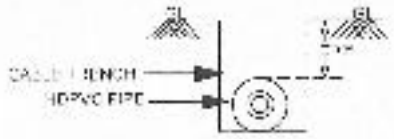


300

PLATFORM LIGHTING FOR A1/A2 CLASS STATION

(FOR PLATFORM WITH WIDTH 6 TO 9 MTR)





NOTE:

1. Complete pole - 2.5 kg
2. 4 nos x 10 amp x 3 pin socket
3. Depth of trench - 1M
4. For platform with 6 mtr width distance between pole will be 25 Mtr

DRG. NO. NFR/CEE/CONC/SOLUM/VARIES & EQUIPMENT/2016/13					ALL DIMENSIONS IN MM.	NOT TO SCALE
					2/6/16	
JE/CON/SOLUM	SSE/CON/SOLUM	SSE/ELECT/SOLUM	AEE/CON/PLUMS	CEE/CON/SOLUM	DY.CEE/CON/HQ	CEE/CON/N.F.R

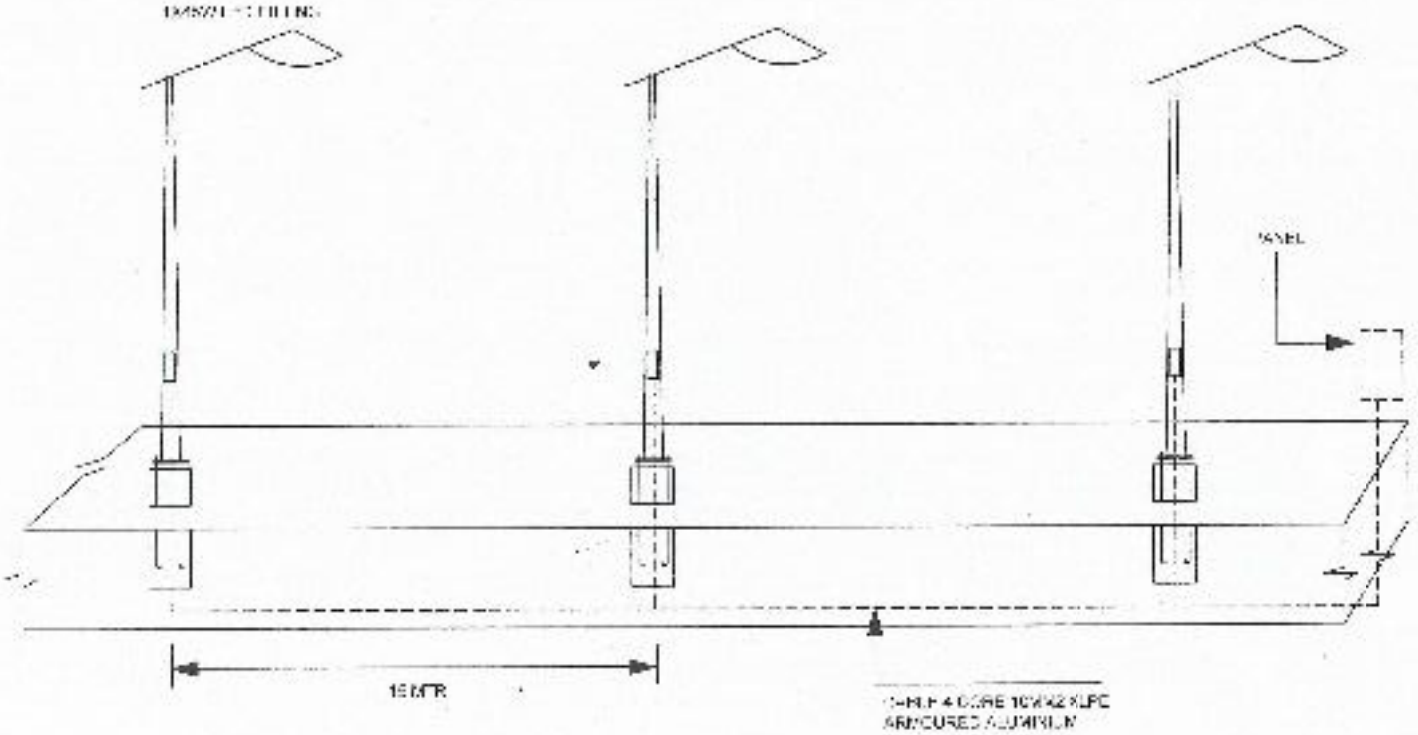
N. F. RAILWAY CONSTRUCTION

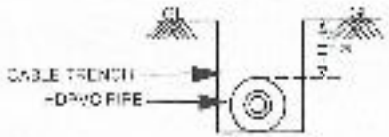
CHIEF ELECTRICAL ENGINEER

TYPICAL PLATFORM LIGHTING DRAWING

PLATFORM LIGHTING FOR B/C CLASS STATION

(FOR PLATFORM WITH WIDTH 6 TO 9 MTR)





NOTE :

1. Designed pole 7.0 M long
2. 4 core x 10mm2 Al. armoured XLPE cable
3. Height of bracket 2.0
4. For platform width 6 to 9 M distance between pole will be 15 M

N. F. RAILWAY CONSTRUCTION

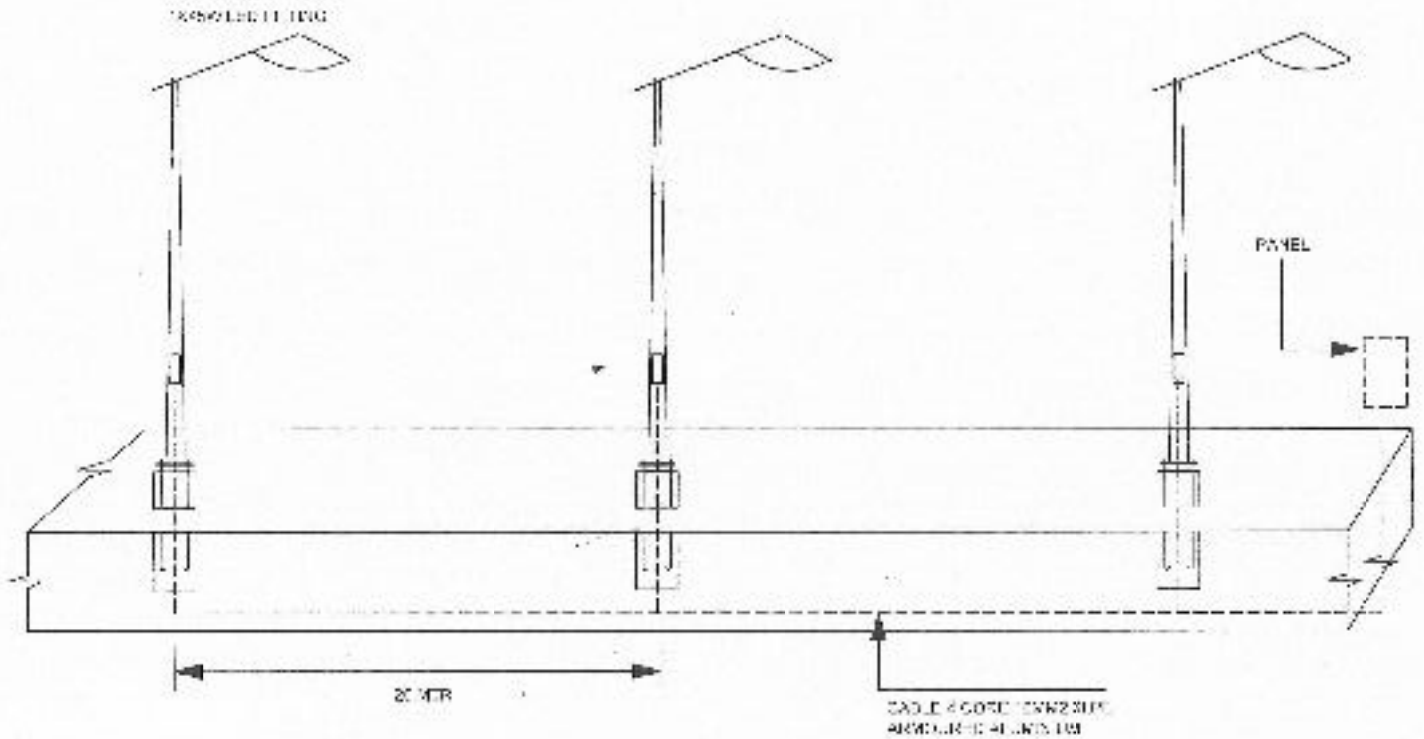
CHIEF ELECTRICAL ENGINEER

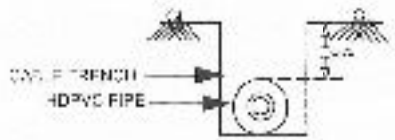
TYPICAL PLATFORM LIGHTING DRAWING

DRG NO. NFR/CTE/CONSTR/ELECTRICAL/LUMINAIRES & ECL/PMLA/ 03/2018					ALL DIMENSIONS ARE IN Mtr.	NOT TO SCALE
JE/ELECT/VLC	SSE/ELECT/VLC	SSE/ELECT/GONDA	AEE/ELECT/PLMLZ	SEE/ELECT/VLC	DY.CEE/ELECT/HQ	CEE/ELECT/HQ

PLATFORM LIGHTING FOR D/E CLASS STATION

(FOR PLATFORM WITH WIDTH 6 TO 9 MTR)





NOTE

1. Designed for ... Lux
2. 4 Core x 10mm2 Al. armoured ... cable
3. Required ... mm
4. For platform width 6 to 9 Mtr distance between pole will be 25 Mtr

N. F. RAILWAY (CONSTRUCTION)

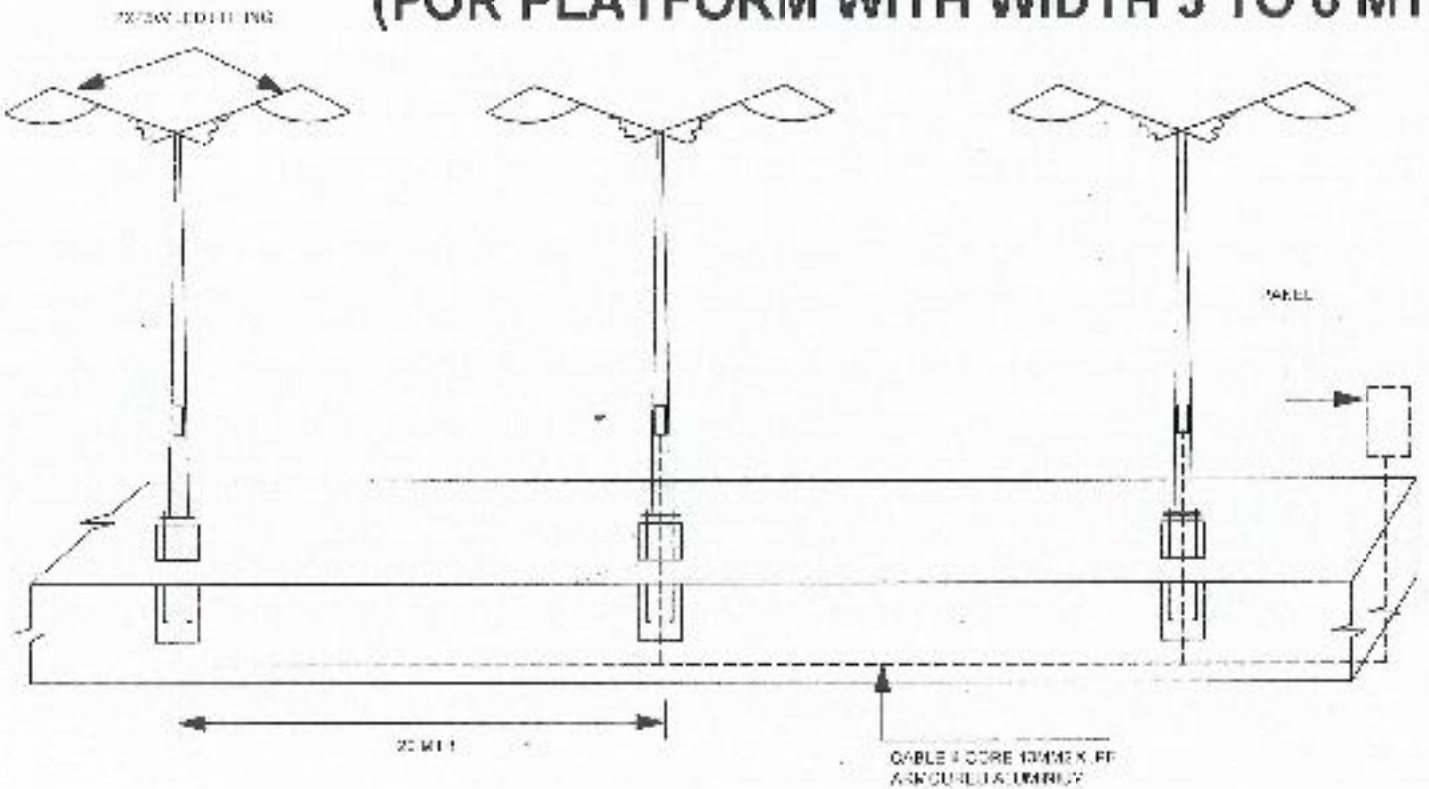
CHIEF ELECTRICAL ENGINEER

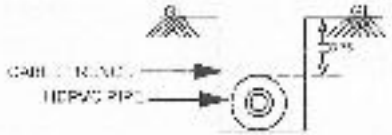
TYPICAL PLATFORM LIGHTING DRAWING

DRG. NO. MF/MCL/CONSG/SIGNAL WORKS & EQUIPMENTS/2018					ALL DIMENSIONS ARE IN MTS.	NOT TO SCALE
JE/DRGS/CONMLG	SSE/DRGS/CONSIG	SSE/DRGS/CONMLG	ASE/CONPLN/MLG	EE/CON/MLG	DY.CEE/CON/HQ	CEE/CON/MLG

PLATFORM LIGHTING FOR A1/A2 ALSS STATION

(FOR PLATFORM WITH WIDTH 3 TO 6 MTR)



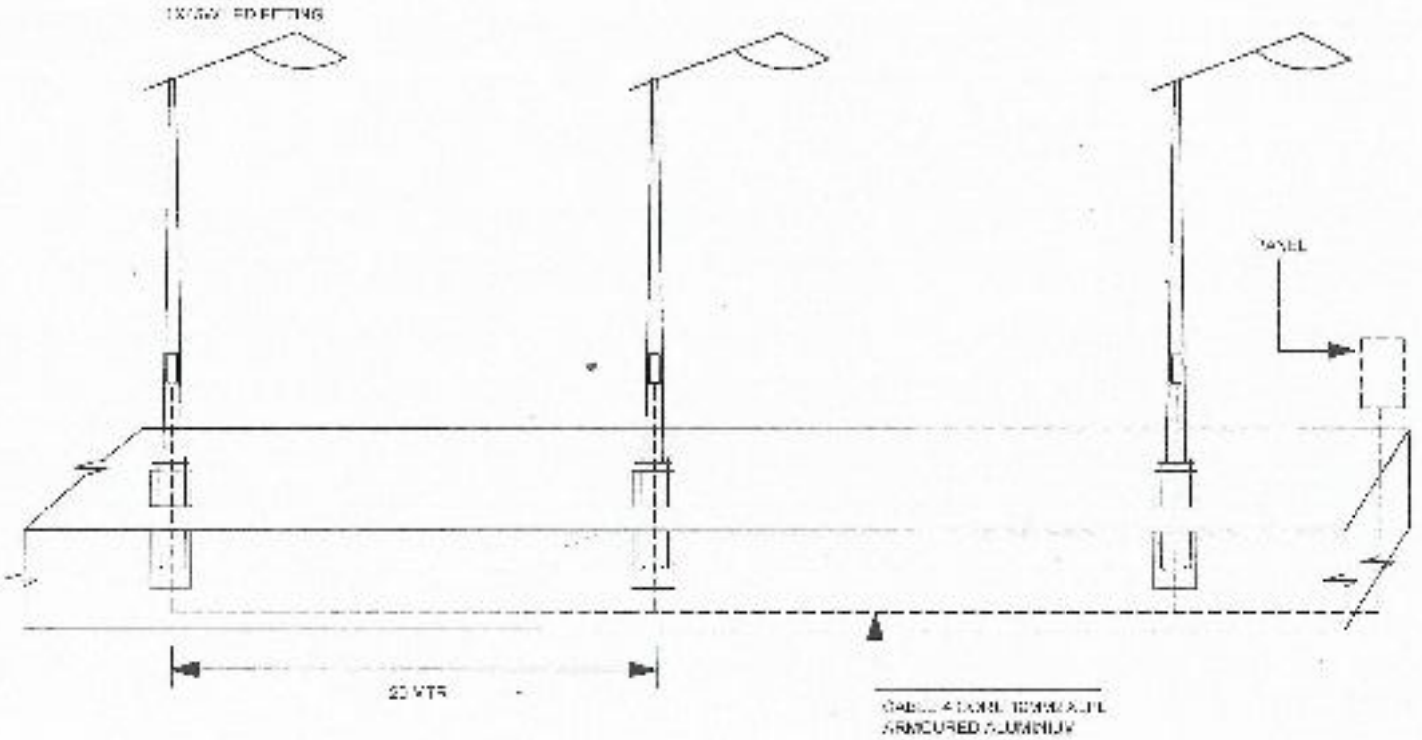


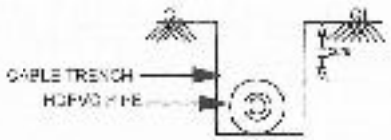
NOTE:

1. Designed for [illegible] W CFL lamp.
2. 4 core x 10 mm2 Al. armoured XLPE cable.
3. Ring earthing - 3C
4. For platform width 3 to 3.2M distance between pole will be 12 Mtr.

N. F. RAILWAY CONSTRUCTIONS	
CHIEF ELECTRICAL ENGINEER	
TYPICAL PLATFORM LIGHTING DRAWING	
DRG. NO. NFRCEE/CONSTRUCTION/ALWAR/ALS X...Q.../MEMO/TS/2016	ALL DIMENSIONS ARE IN MM. / NOT TO SCALE
JE/TRD/DMLG	SSE/DRG/ISO
SSE/DRG/DMLG	AEE/CON/FDMLG
SEE/CON/VLG	JA VEE/CON/VLG
DFO/CON/VLG	

PLATFORM LIGHTING FOR B/C CLASS STATION
(FOR PLATFORM WITH WIDTH 3 TO 6 MTR)





NOTE.

2. 4 core x 10mm 2 Al. armoured
3. Req. Pad Level 30
4. For platform width 3.0 Mtr distance between pole will be 16 Mtr

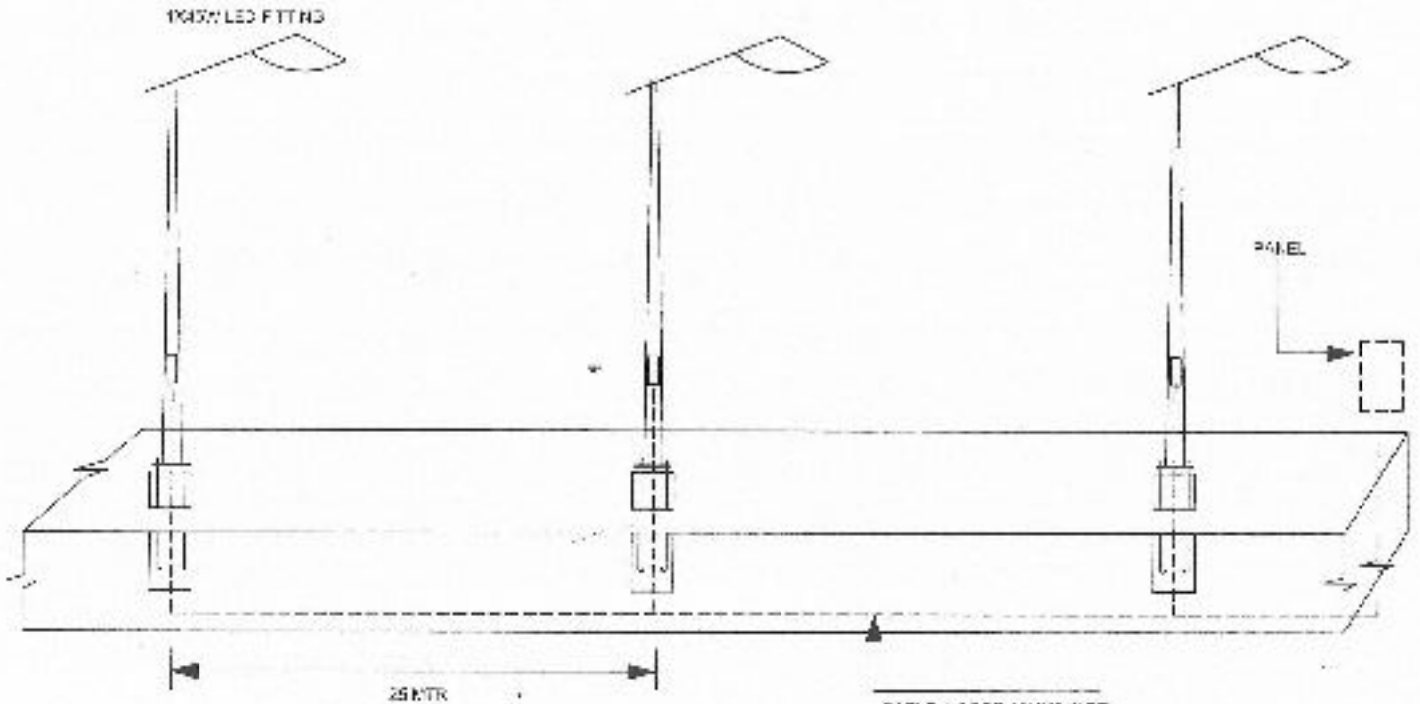
N. F. RAILWAY CONSTRUCTION
CHIEF ELECTRICAL ENGINEER

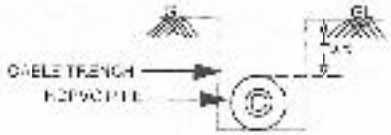
TYPICAL PLATFORM LIGHTING DRAWING

DRG. NO. NFR/CE/CON/GR/01/LUM VARIES & EQUIPMENTS/NOS/15						NOT TO SCALE
JE/DRG/CON/LG	SSE/DRG/CON/GI	SSE/DRG/CON/LG	AEE/CON/HQ/MLG	EE/CON/MLG	DY.CE/CON/HQ	CE/CON/MLG

PLATFORM LIGHTING FOR D/E CLASS STATION

(FOR PLATFORM WITH WIDTH 3 TO 6 MTR)





NOTE

1. Double [illegible] 2.5 kg
2. 4 core x 16mm2 Al armoured XLPE cable
3. Rated [illegible] 3C
4. For stations width 3 to 6 Mtr c/c distance between pole will be 25 Mtr

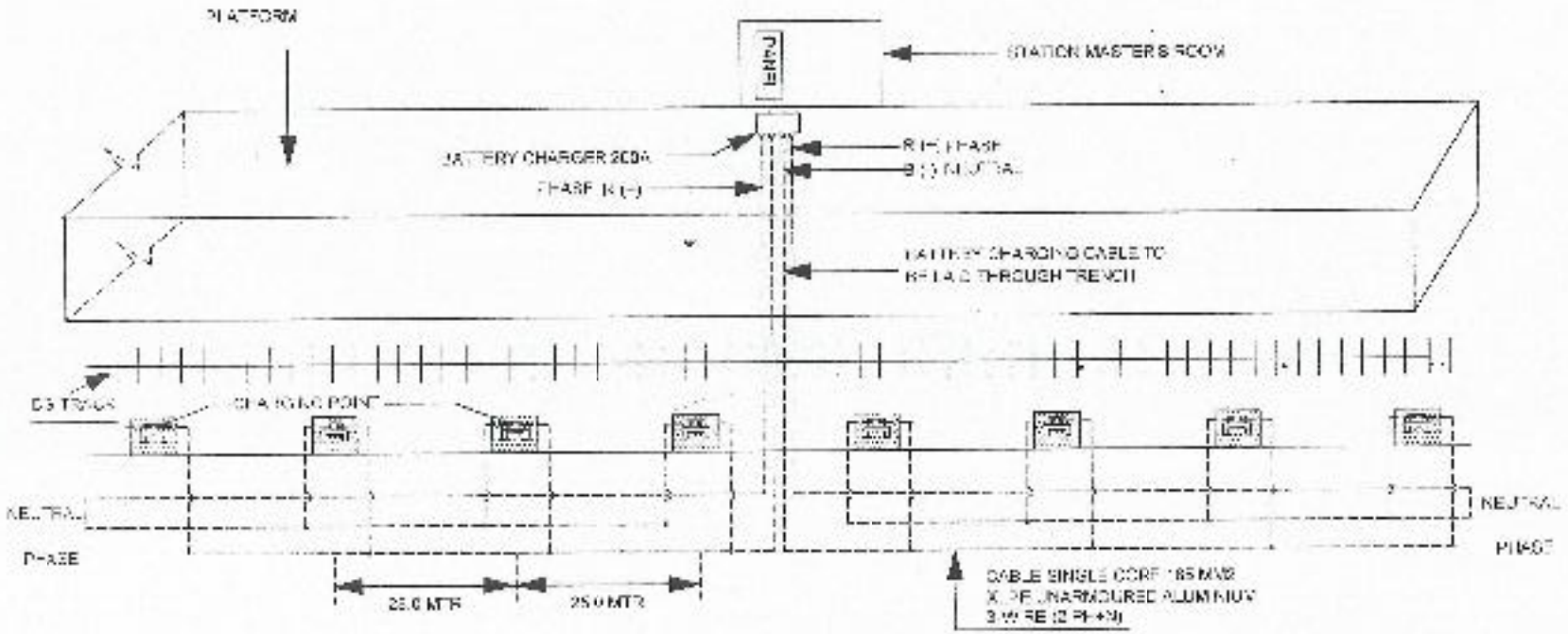
DRG. NO. NF/ACLE/CONSG/03/LUM VARIES & EQUIPVENTS/6201 5					ALL DIMENSIONS ARE IN MM.	NOT TO SCALE
JE/ORG/CONSG	SSE/URG/CONSG	SSE/DRG/CONSG	AEE/CONSTN/LWLG	EEE/CONSTN/LWLG	DY.CEE/CONSTN/LWLG	CEE/CONSTN/LWLG

N. F. RAILWAY CONSTRUCTION

CHIEF ELECTRICAL ENGINEER

TYPICAL PLATFORM LIGHTING DRAWING

SCHEMATIC DIAGRAM FOR BATTERY CHAGING FACILITIES AT PLATFORM



NOTE :

1. The chassis of the battery charging point shall be grounded vertically by earthing rod conforming to specification no. ETI-40 (1.2.2).
2. Clearance between the channel and edge of foundation shall be 240 mm. earthing shall be 200 mm above ground level.
3. Cable XLPE single core 185 mm2 aluminium unarmoured, 3 core (2 Ph + N).
4. Cable shall be laid underground through 110 mm dia HDPVC pipe.
5. Tapping interval between two battery charging terminal shall be 25 Mtr.
6. Battery charger for each tapping point shall be 1 no. 24V, 20A.

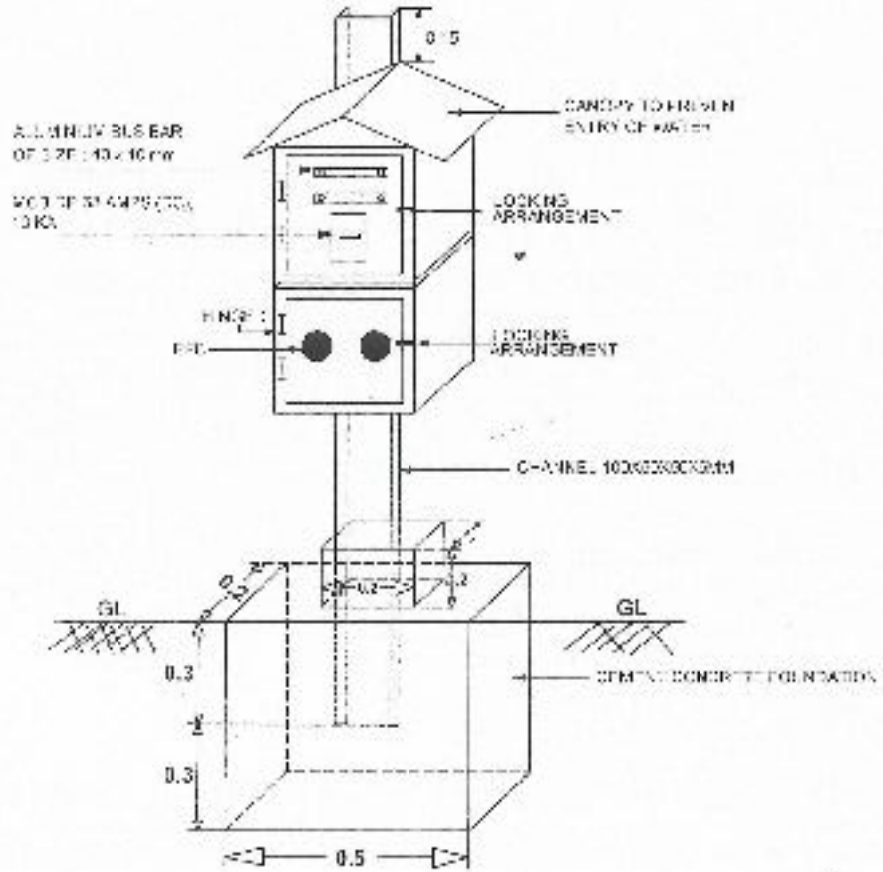
N. F. RAILWAY (CONSTRUCTION)
CHIEF ELECTRICAL ENGINEER

TYPICAL BATTERY CHARGING POINT

DRG. NO. NFR/CEE/CON/GSM/7/BATTERY CHARGING POINT/2016

JE/DRG/C/MLG	SSE/DRG/C/SC	SSE/DRG/C/VLG	AEE/CON/PL/MLG	EEE/CON/MLG	DY CEE/CON/HQ	CEE/CON/MLG

TYPICAL DIAGRAM FOR BATTERY CHAGING TERMINAL



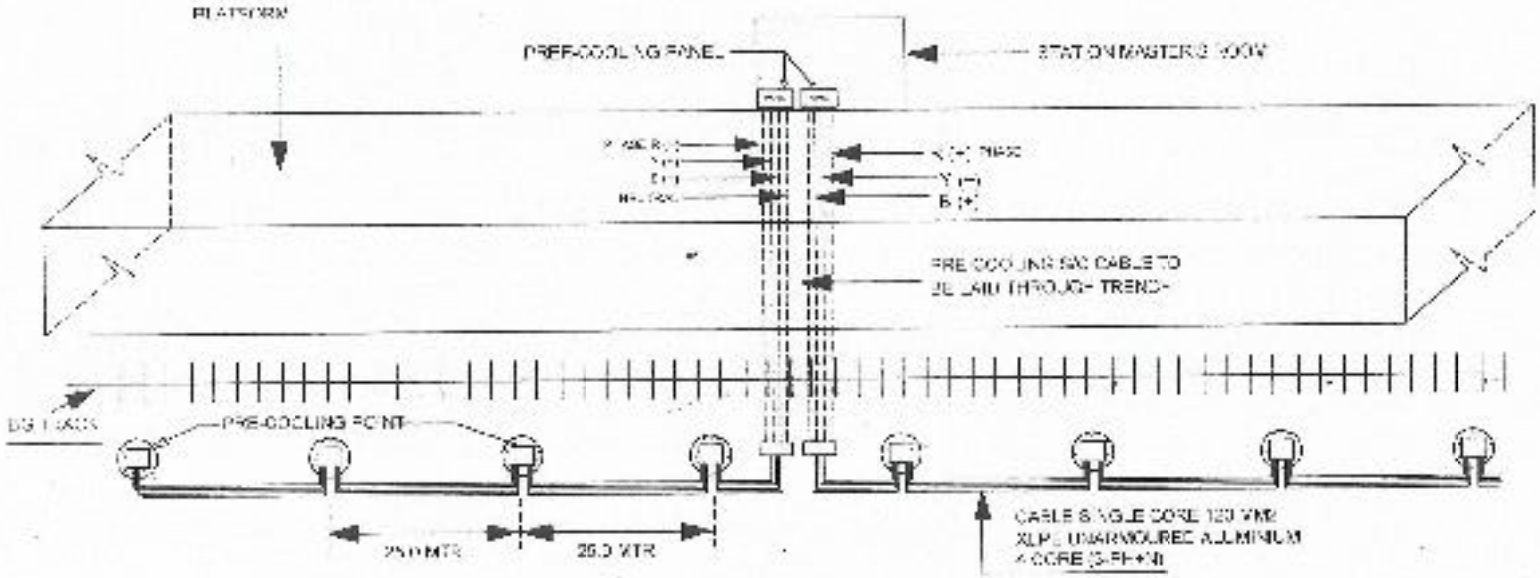
NOTE :

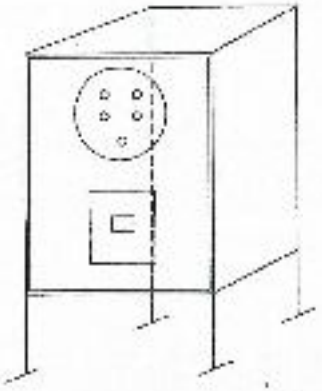
1. Battery charging terminal shall be manufactured in accordance with relevant drawing and specification.
2. Upper portion shall consist of 2 Nos. MCB, 2 Nos. of 5 amp. industrial pin socket, coupling hook, padlock and key. Other accessories as per relevant drawing of RDSO.
3. Lower portion shall consist of EPT terminals for battery charging.
4. Battery charging terminal shall be duly approved by RDSO and shall be given type test report as per clause 15.4 of RDSO specification no. ETI/PSI/SPN/0001 (Rev. 1) 2004.
5. Proper earthing shall be provided to the equipment with right size flexible.
6. The canopy shall be fabricated with 2 mm GI sheet and CRCA sheet with pockets of 45 Channel of size 100x50x3000 mm. 200mm long.
7. The terminal shall be provided with 2 Nos aluminum bus bar of size 40 x 10 mm.
8. Detachable plate shall be provided on bottom for entry of incoming and outgoing cables with suitable cable gland.
9. EPT shall be galvanized mild steel suitably mounted on channel. The channel size shall be 12 mm thick and as per RDSO design.
10. Feeding system shall be marked Red & Black for polarity (+ve and -ve).
11. Earthing shall be double earthing terminals.

N. F. RAILWAY (CONSTRUCTION)		
CHIEF ELECTRICAL ENGINEER		
TYPICAL BATTERY CHARGING POINT		
DRG. NO. NFR/CEE/CON/GS/U/BATTERY CHARGING POINT/02/2018	ALL DIMENSIONS ARE IN MM.	NOT TO SCALE

JE/DRG/CON/MLG	SSE/DRG/CON/SCL	SSE/DRG/CON/MLG	AEE/CON/PLM/LC	EEE/CON/MLG	DY CEE/CON/HQ	CEE/CON/MLG

SCHEMATIC DIAGRAM FOR PRE-COOLING FACILITIES AT PLATFORM





NOTE :

This Pedestal is made of MS angle of size 65x65x6mm & base frame of 45 angle of size 65x65x6mm.

Pedestals shall be grouted vertically 300mm deep by using cement concrete of M-10 (1:3:6) 300mm dia foundation

N. F. RAILWAY (CONSTRUCTION)

CHIEF ELECTRICAL ENGINEER

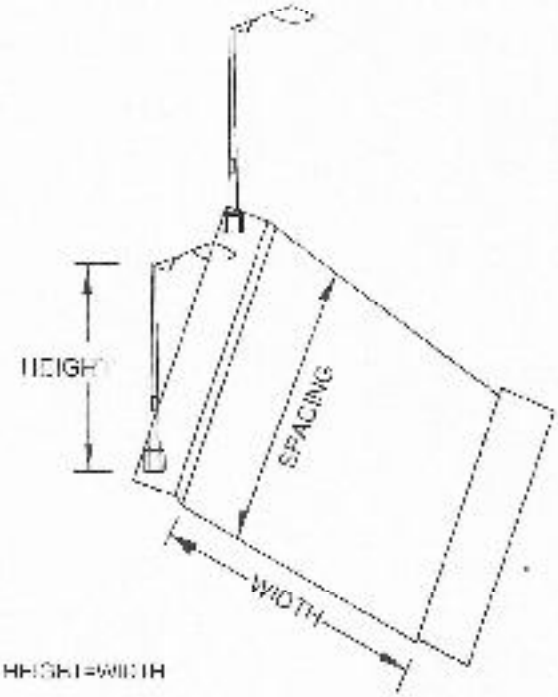
TYPICAL PRE-COOLING POINT

DRG NO. NFR/CEE/CON/GSAU/PRE COOLING POINT/03/2016

JE/DRG/C/MLG	SSE/DRG/C/SCL	SSE/DRG/C/MLG	AEE/CON/PL/MLG	EEE/CON/MLC	DY.CEE/CON/HQ	CEE/CON/MLG

Typical Design for Road lighting arrangement

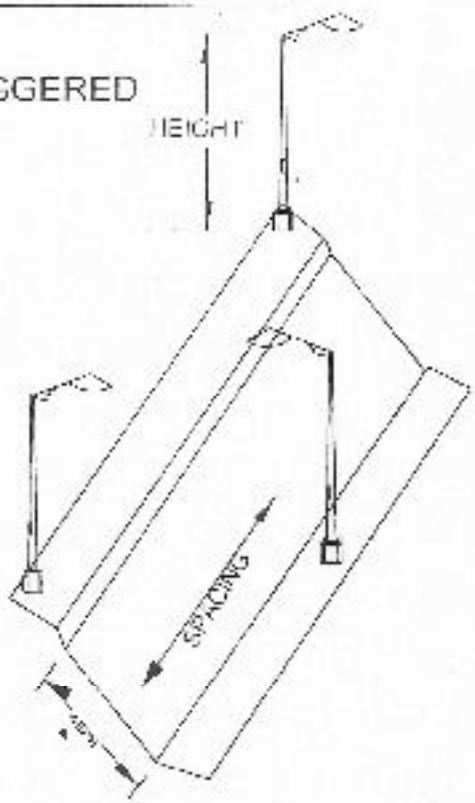
SINGLE SEDED



HEIGHT=WIDTH

SPACING= 3.5 TO 4 TIMES HEIGHT

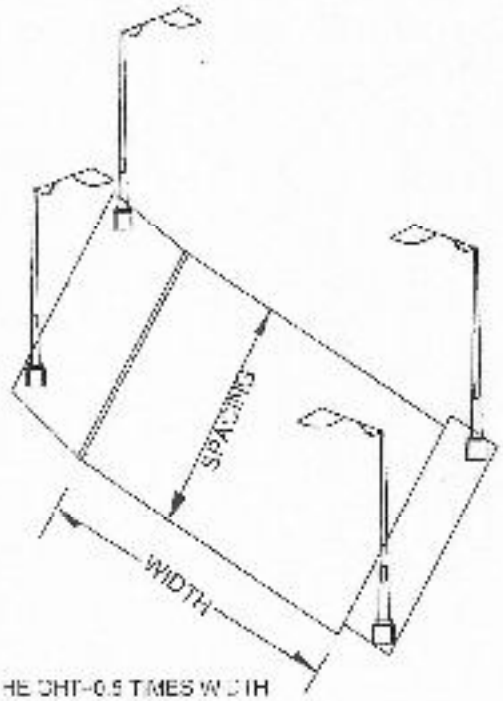
STAGGERED



HEIGHT=0.8 TIMES WIDTH

SPACING= 3.5 TO 4 TIMES HEIGHT

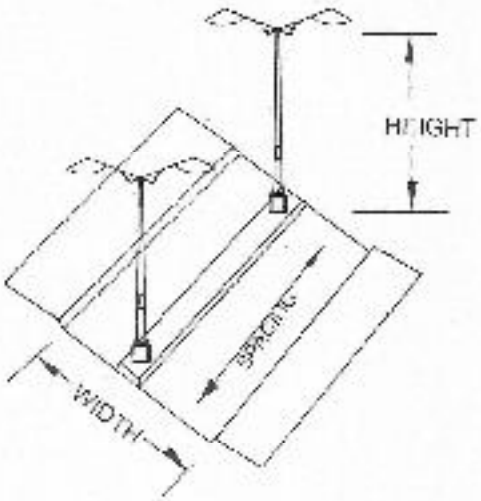
OPPOSITE



HEIGHT=0.8 TIMES WIDTH

SPACING= 3.5 TO 4 TIMES HEIGHT

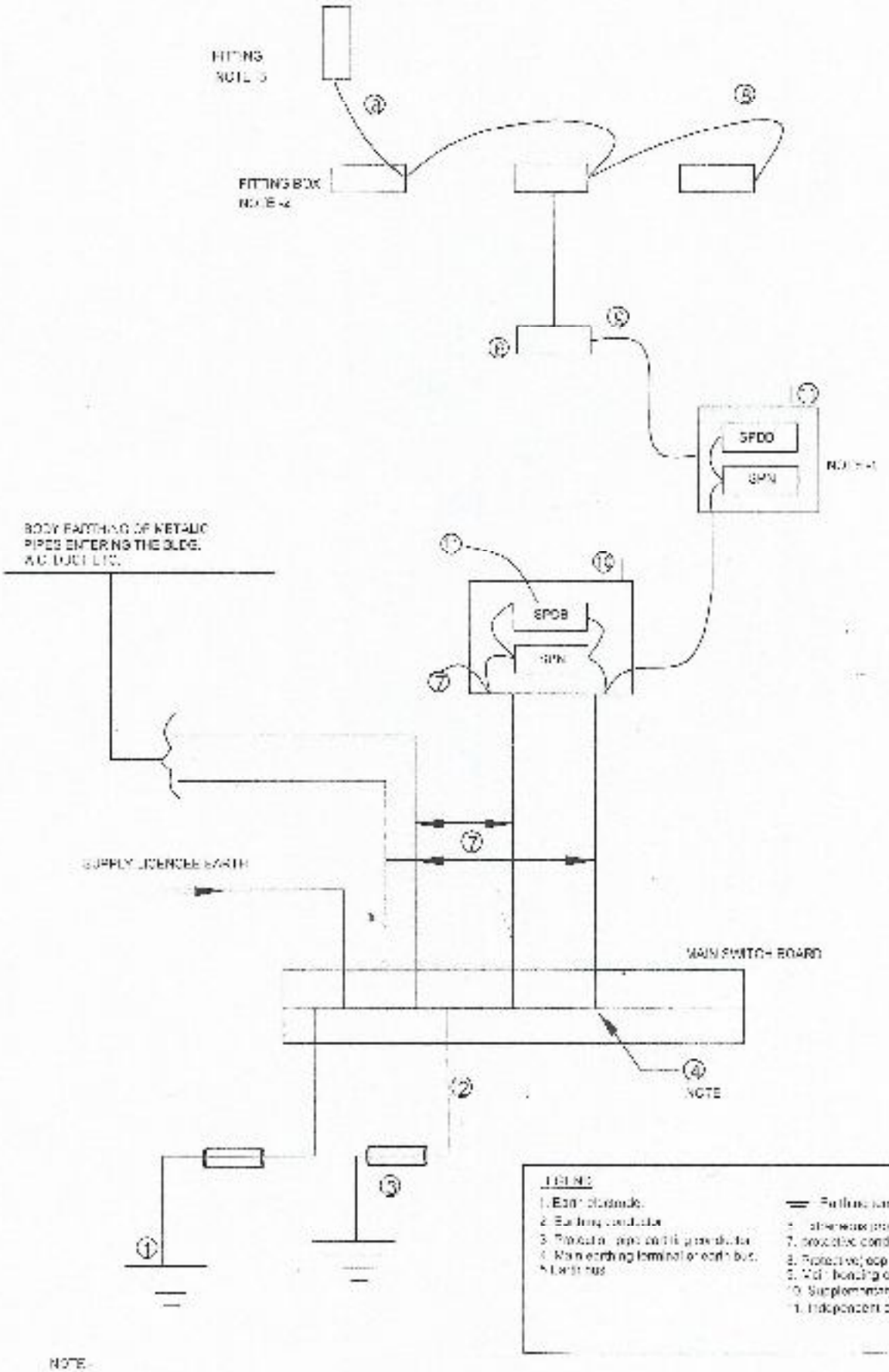
CENTRAL



HEIGHT=0.8 TIMES WIDTH

SPACING= 3.5 TO 4 TIMES HEIGHT

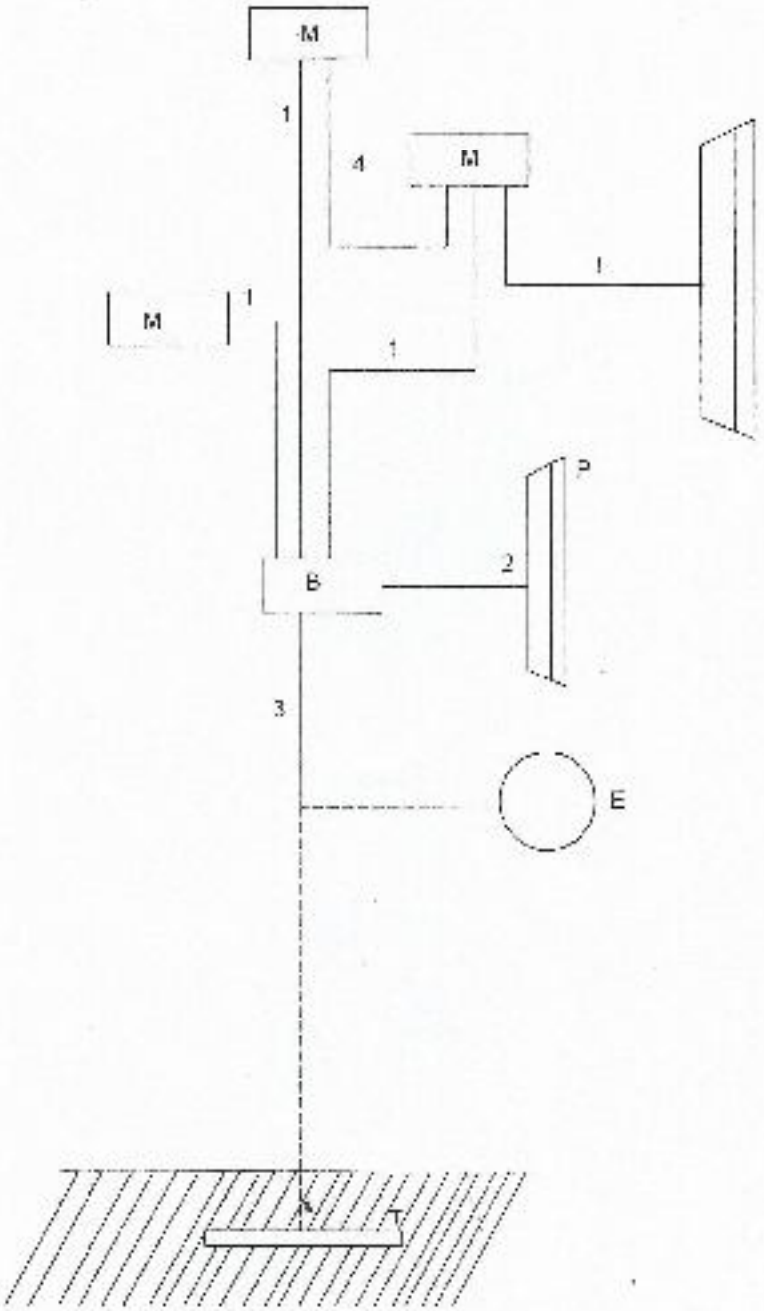
TYPICAL EARTHING SCHEMATIC FOR INTERNAL E.I



NOTE:

1. (illegible) TERMINATED TO (illegible) BY SCREWS
2. (illegible) SHALL BE METALLIC PART OF (illegible) SHALL BE CONNECTED TO THE SWITCH BOXES
3. (illegible) AND EARTH BOX (illegible) SHALL BE CONNECTED TO (illegible) METALLIC BOXES
4. WHEN DISTRIBUTION IS BY U.G. CABLE PROTECTIVE CONDUCTORS SHALL BE (illegible) CABLES (illegible) CORE & ARMOURING
5. (illegible) SHALL BE (illegible) SHALL BE MADE (illegible) MAIN EARTHING TERMINAL SHALL BE MARKED AS SAFETY EARTH - DO NOT DISCONNECT

EARTHING CONCEPT



1 2 3 4 — Protective conductors
1 — Circuit Protective Conductors
2 — Main equipotential bonding conductor
3 — Earthing conductor
4 — Supplementary equipotential bonding conductor (where required)

B — Main earthing terminal
M — Exposed conductive part
C — Extraneous conductive part
P — Main water service pipe
— Earth electrode (TT & IT systems)
E — Other means of earthing (Not shown)

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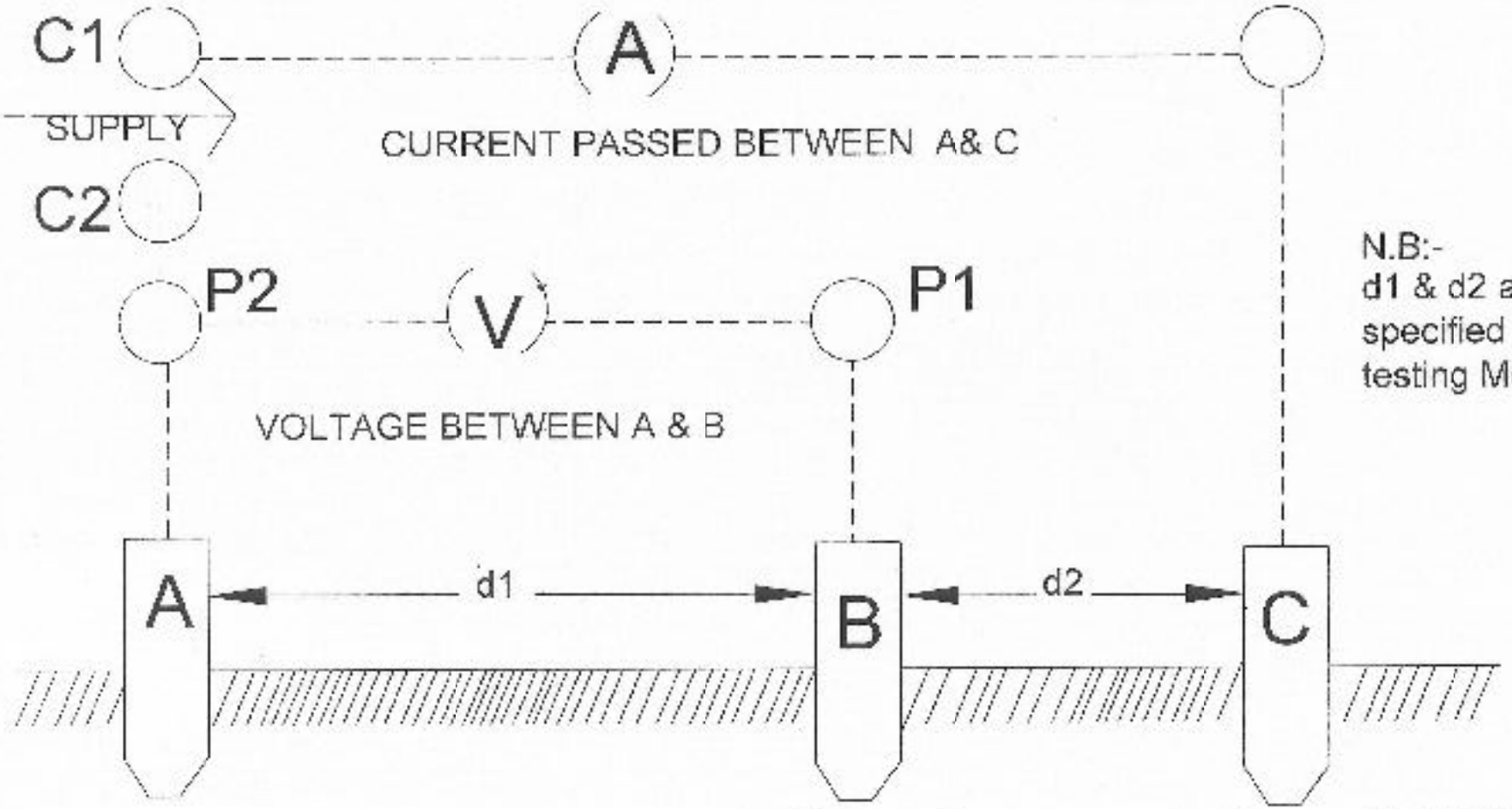
EARTH TESTING



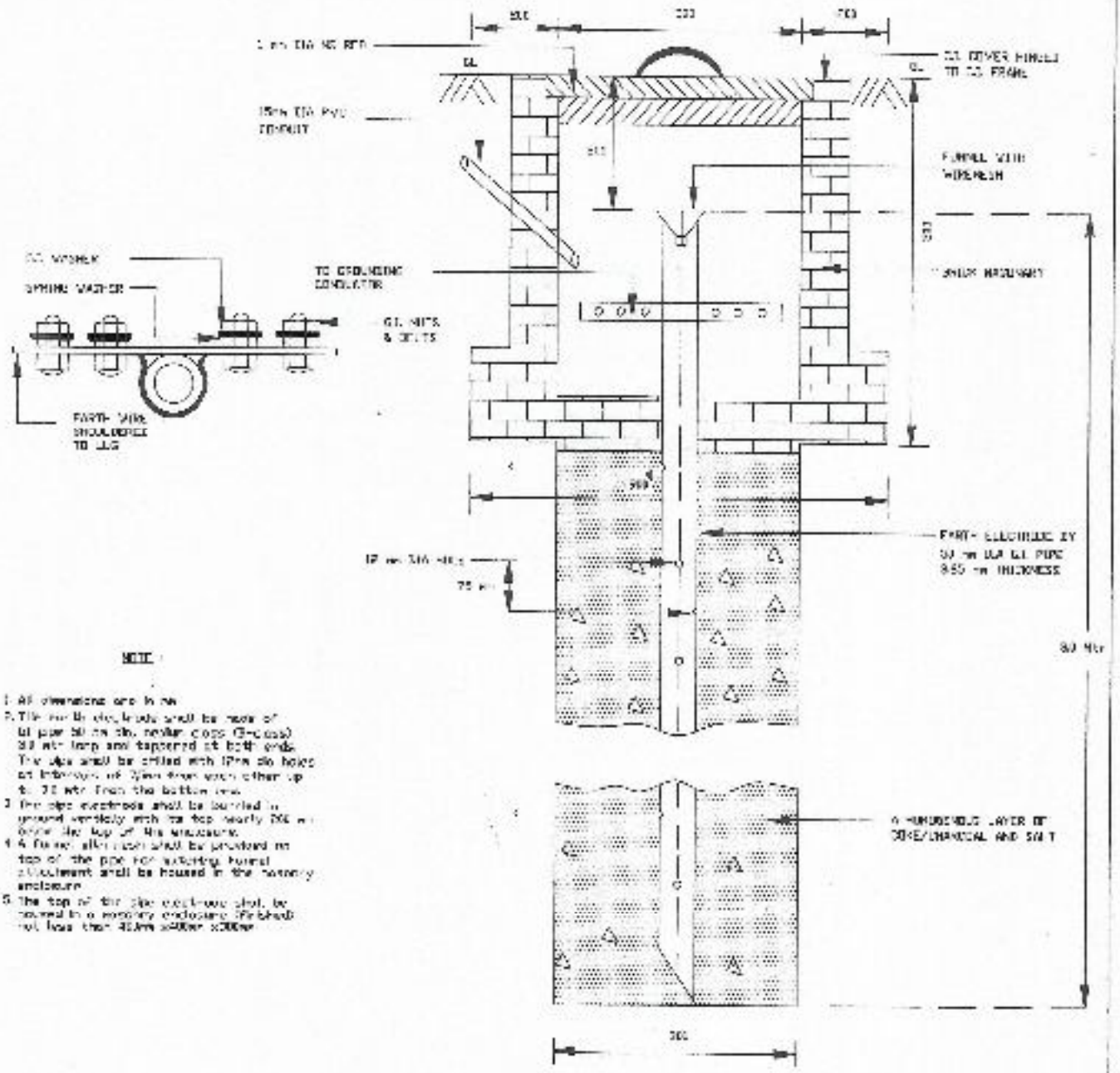
N.B:-
d1 & d2 as specified in earth testing Meggers

Earth electrode to be tested

Auxillary earth electrode

Auxillary earth electrode

ARRANGEMENT OF PIPE EARTHING



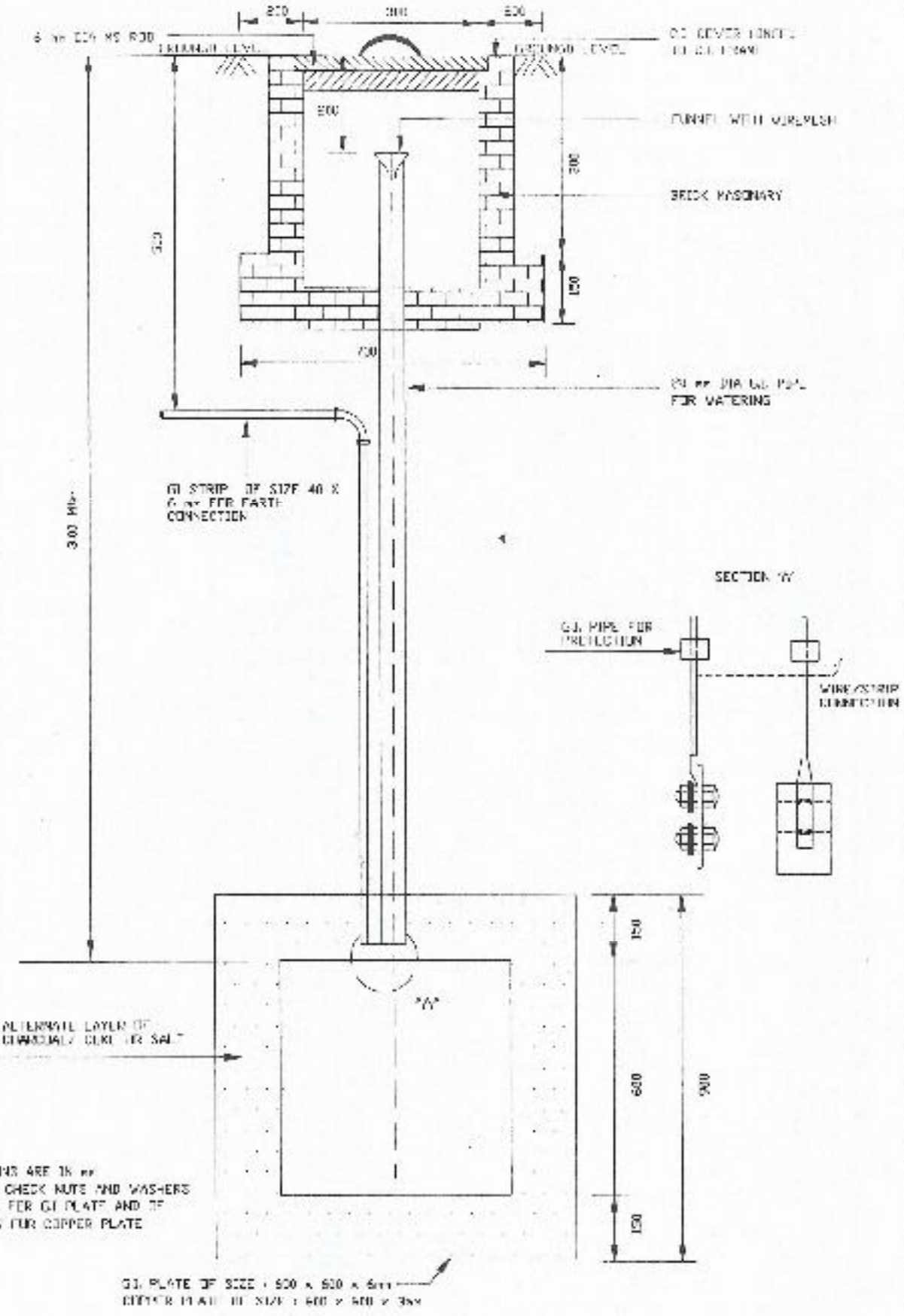
NOTE :

1. All dimensions are in mm
2. The earthing electrode shall be made of GI pipe 50 mm dia, medium class (3-class) 3.0 mtr long and tapered at both ends. The pipe shall be drilled with 12mm dia holes at intervals of 15cm from each other up to 2.0 mtr from the bottom end.
3. The pipe electrode shall be buried in ground vertically with its top nearly 200 mm below the top of the enclosure.
4. A funnel with mesh shall be provided on top of the pipe for watering. Funnel arrangement shall be housed in the masonry enclosure.
5. The top of the pipe electrode shall be covered by a masonry enclosure (Brick) not less than 450mm x450mm x300mm

DRG No. NER/CEE/CDN/GS/IC EARTHING SYSTEM/04/2016

JE/Drg/CDN/HLG	SSE/E/Drg/CDN/HLG	SSE/E/Drg/CDN/HLG	AEE/CDN/HLG	EEE/CDN/HLG	Dy.CEE/CDN/N/HLG	CE/CDN/N.E

ARRANGEMENT OF PLATE EARTHING



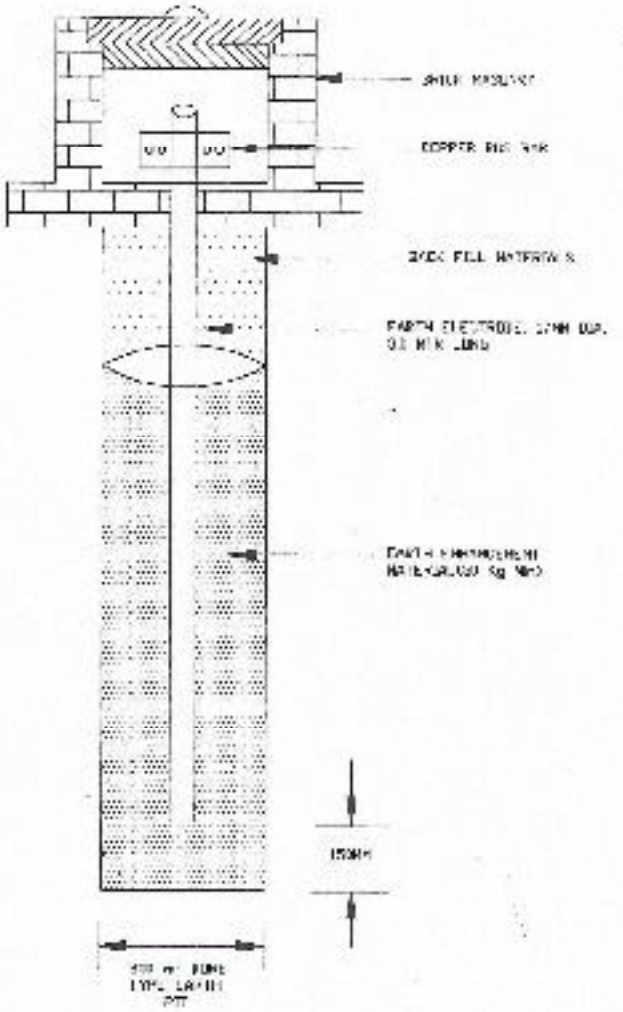
NOTE:
1. ALL DIMENSIONS ARE IN mm
2. BOLTS, NUTS, CHECK NUTS AND WASHERS TO BE OF G.I. FOR GI PLATE AND OF TINNED BRASS FOR COPPER PLATE

DRG No. MFR/CEE/CEN/GS/10 (EARTHING SYSTEM)/05/2006

					20/6/16	

03 Pages 5

TYPICAL ARRANGEMENT OF MAINTENANCE FREE EARTHING (ROD EARTH ELECTRODE)

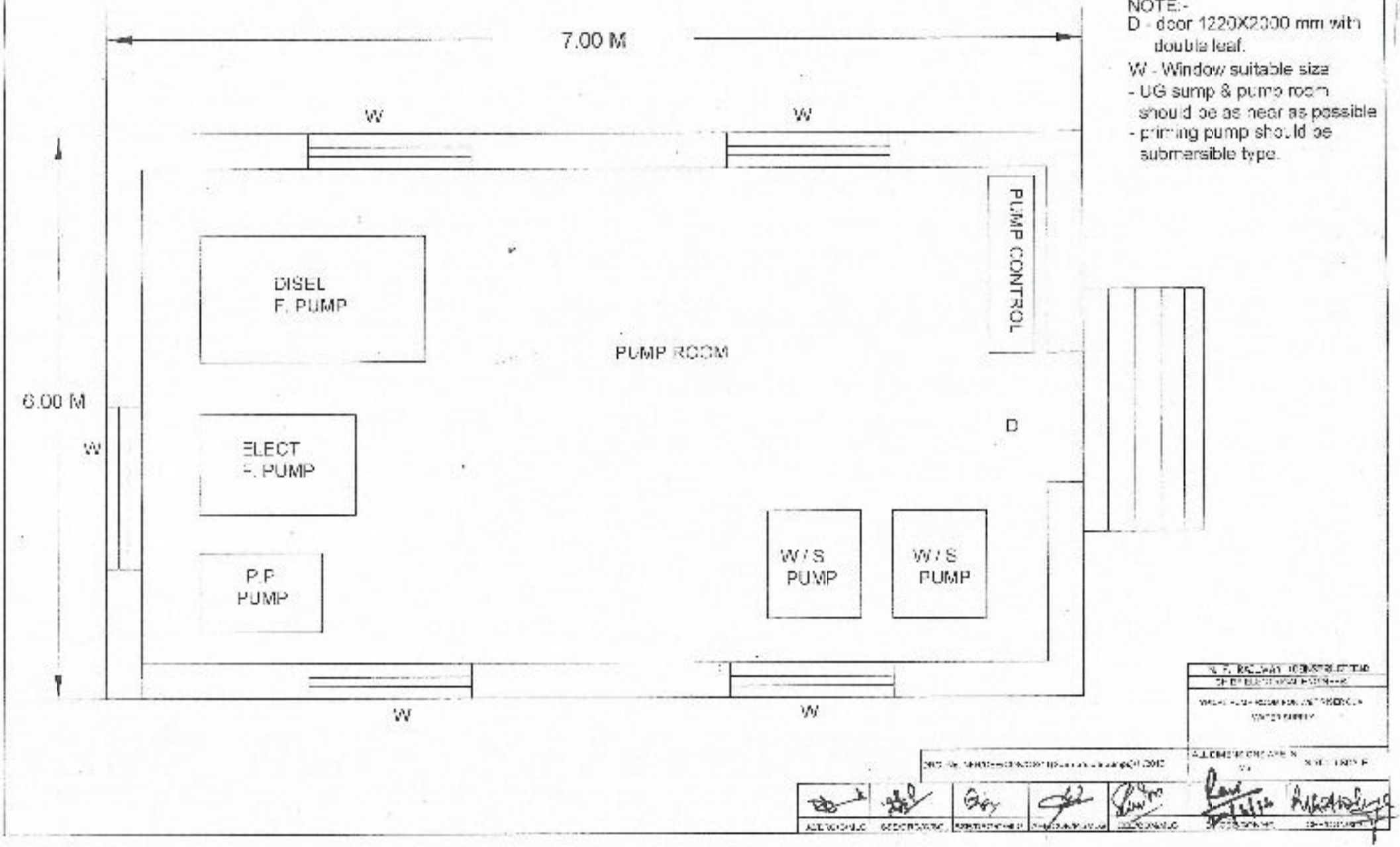


NOTE

1. Earth electrode shall be 17mm dia (min), 3 mtr long
2. Earth electrode shall be high tensile carbon steel rod molecularly bonded by 99.99% pure high conductivity copper on outer surface with copper coating not less than 250 micron.
3. Copper bus bar of size 250mm x 50mm x 6mm having electrical conductivity of 101% IACS, minimum 99.99% copper content shall be exothermally welded to rod with 4 holes of 12 mm dia (2 on each side) for connecting earthing conductor.
4. The design of the electrode should be such as to have more than 10 KA current carrying capacity for 1 second.
5. Length of electrode may be increased in multiple of 1.0 mtr to ensure earth resistance, if required.
6. To increase the length, pieces of similar earth rod shall be either exothermally welded to basic 3 mtr electrode or connected using socket of suitable size.

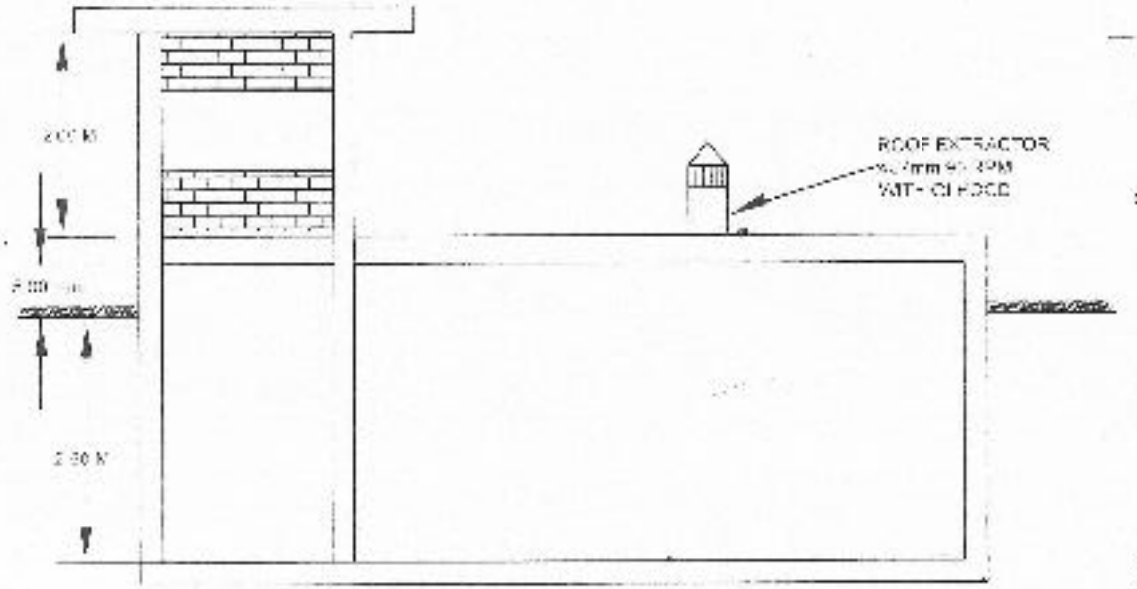
JE/CON/Drg/MLG	SSE/E/CON/Drg/SCL	DRG No. NER/CEE/CON/GS/10 (EARTHING SYSTEM)/06/2016		
SSE/E/Drg/CON/MLG	AEE/CON/PL/MLG	EEE/CON/MLG	Dy. CEE/CON/HQ/MLG	CEE/CON/MLG

PUMP ROOM FOR WET RISER CUM WATER SUPPLY

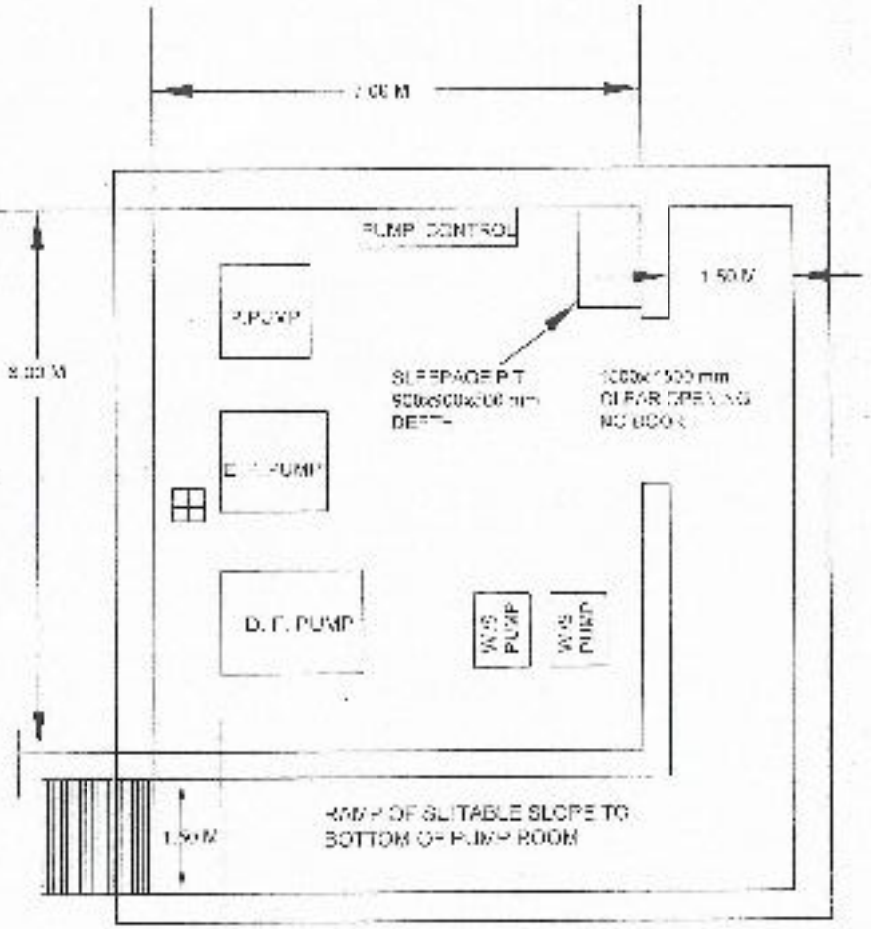


NOTE:-
D - door 1220X2300 mm with double leaf.
W - Window suitable size
- UG sump & pump room should be as near as possible
- priming pump should be submersible type.

Under ground Wet riser Pump Room for Positive Suction



SECTION AA

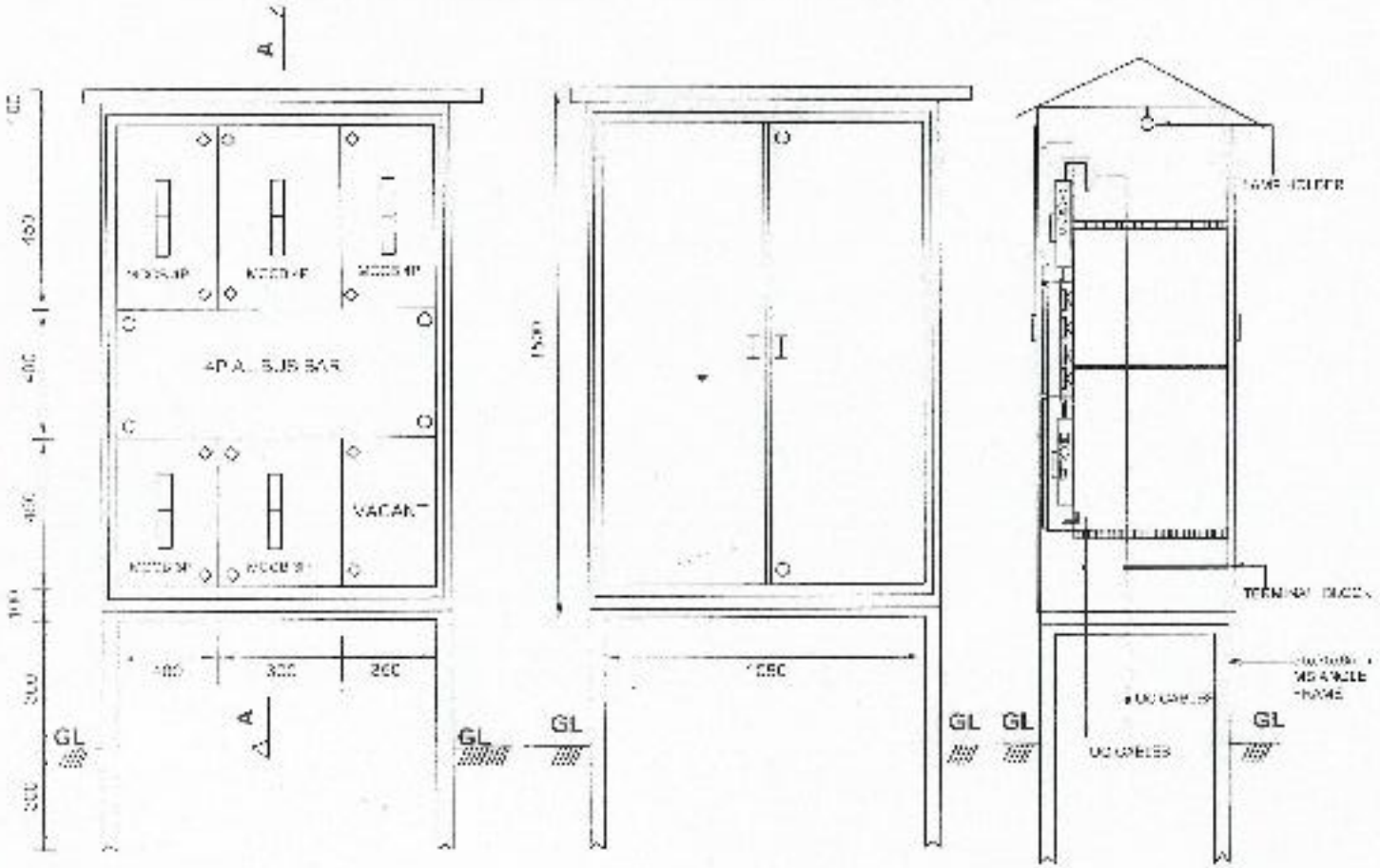


NOTE

ROOF EXTRACTOR SHALL BE CONNECTED TO FIRE PUMP CONTROL FOR AUTOMATIC OPERATION WHEN THE FIRE PUMP STARTS

AA

TYPICAL DRAWING FOR FEEDER PILLER



NOTE:-

(a) The fabrication will be done out of 2mm thick CRCA sheet with double door and inbuilt locking arrangement & partitions are 1.6mm thick CRCA sheet.

(b) All connections(incoming and outgoing) will be taken out in cable alley with suitable rated solid copper conductor.

(c) The feeder pillar will have to be supplied with suitable pedastal(MS angle iron frame) of MS channel base for grouting in the RCC and proper gland at the bottom.

(d) The feeder pillar will be having one 10 Amp 3 pin socket outlet with 10 amp switch and one brass batten holder fitted in metering pane compartment and directly fed from incoming.

(e) The depth of the feeder pillar has been considered as 400 mm.

(f) The bus bars made of hard drawn tinned copper are fitted on insulated DMC supports.

(g) Sizes and arrangement are suggestive Exact size and arranggement will be decided by NIT approving authority.

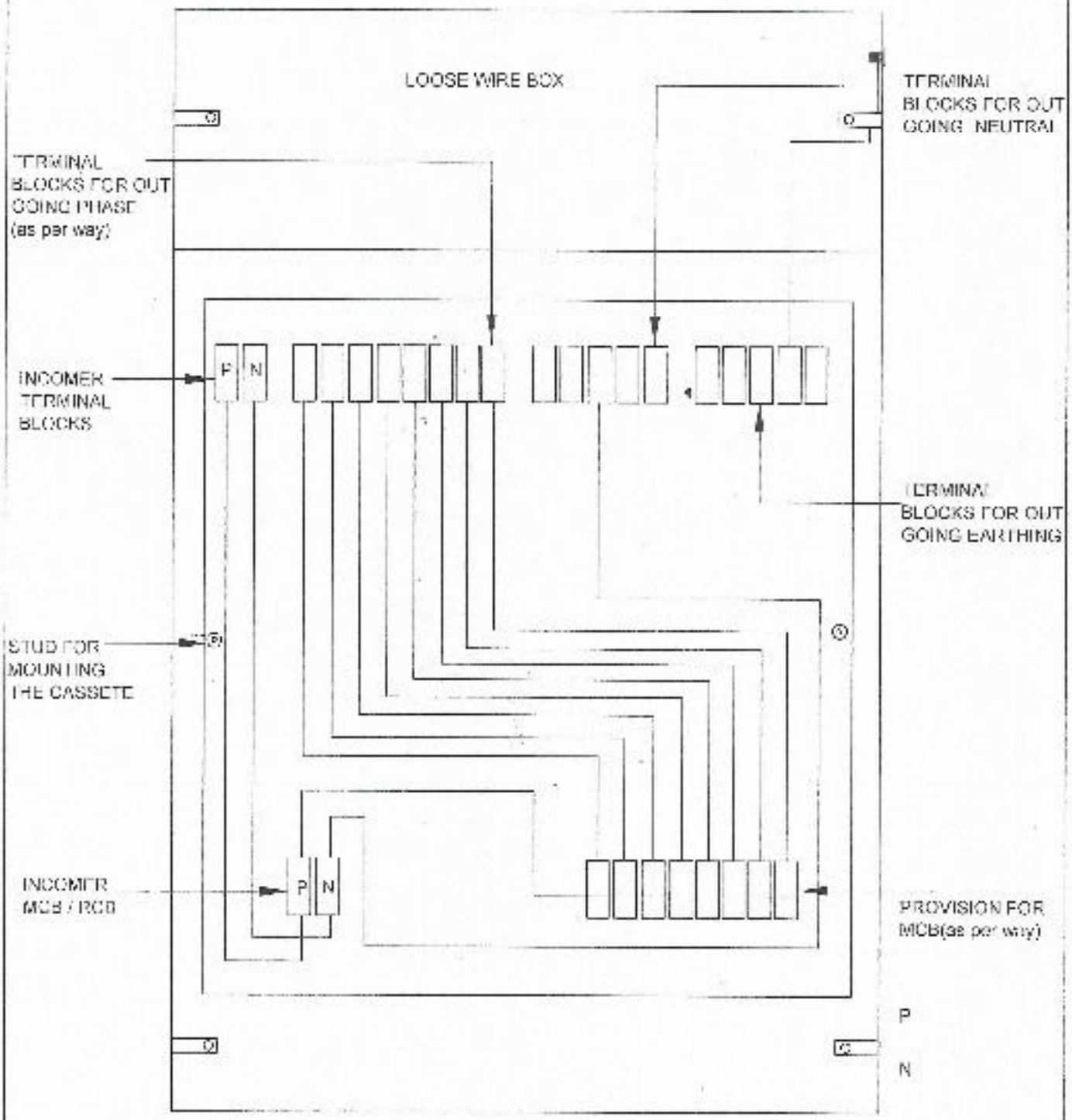
(h) The feeder pillar should be provided with terminal blocks for incoming & outgoing cables from MCCB to terminal block wiring will be done with copper conductor suitable cables. Incoming /outgoing UG cable will be terminated in terminal blocks. This will very much reduce congestion of cables.

(i) All dimension in mm..

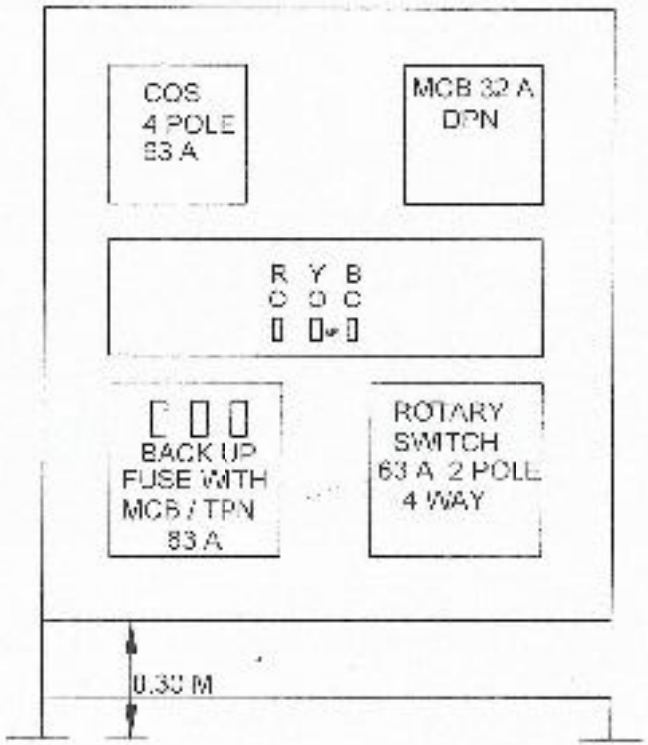
N. F. RAILWAY CONSTRUCTION
CHIEF ELECTRICAL ENGINEER

DRG. NO. NFR/CEE/CON/GS/13(FEEDER PILLAR)/01/2016			ALL DIMENSIONS ARE IN MTR.		NOT TO SCALE
JE/DRG/C/MLG	SSE/DRG/C/SCL	SSE/DRG/C/MLG	AEE/CON/PL/MLG	FEE/CON/MLG DY.CEE/CON/HQ	CEE/CON/MLG

TYPICAL PRE-WIRED MCB DISTRIBUTION BOARD (SINGLE PHASE)



Schematic line diagram



NOTE:-

CABLES USED FOR THE SWITCH BOARD SHOULD BE OF COPPER WITH CRIMPED TERMINALS.

PANEL SHOULD PROVIDED WITH INESPECTION WINDOW ON BOTH SIDE

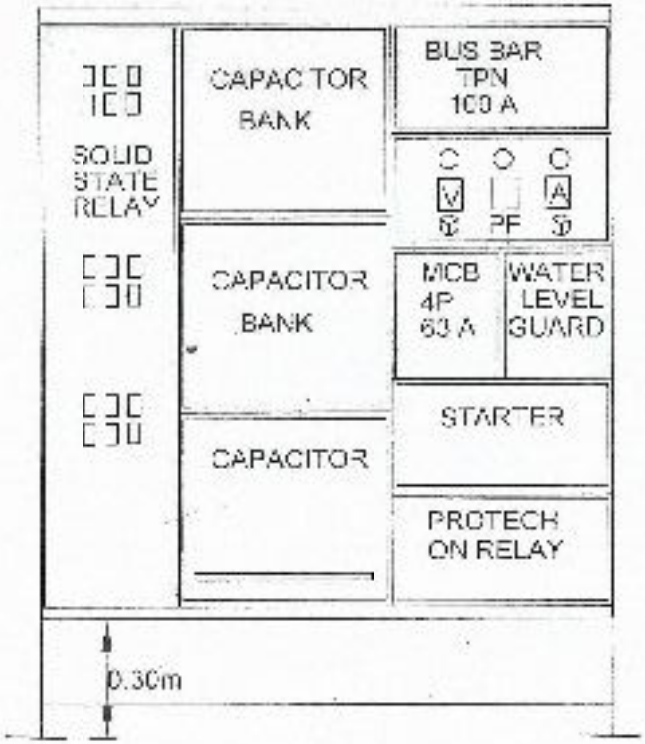
N. F. RAILWAY CONSTRUCTION

CHIEF ELECTRICAL ENGINEER

TYPICAL DRAWING OF

SWITCH BOARD PANEL FOR R.B.S. ROOM

DRG. No. NFR/CEE/CON/CS-1/MV FEEDER PILLAR/SWITCH BOARD/STRIBUTATION BOARD/2016					ALL DIMENSIONS ARE IN METRES	NOT TO SCALE
JE/DRG/CON/LG	SSE/DRG/CON/LG	SSE/DRG/CON/LG	AEE/CON/PLN/LG	SEE/CON/MLG	DY.CEE/CON/HQ	CEE/CON/MLG



NOTE:-

CAPACITOR SHALL BE LOW LOSS, SELF HEALING MPP TYPE AS PER IS 13340.

PANEL SHOULD BE COMPARTMENTALIZED, FIXED TYPE, MANUFACTURED AS PER IS 8623 pt.I & II/1993 & POWDER COATED WITH SPECIFIED COLOR.

N. F. RAILWAY CONSTRUCTION

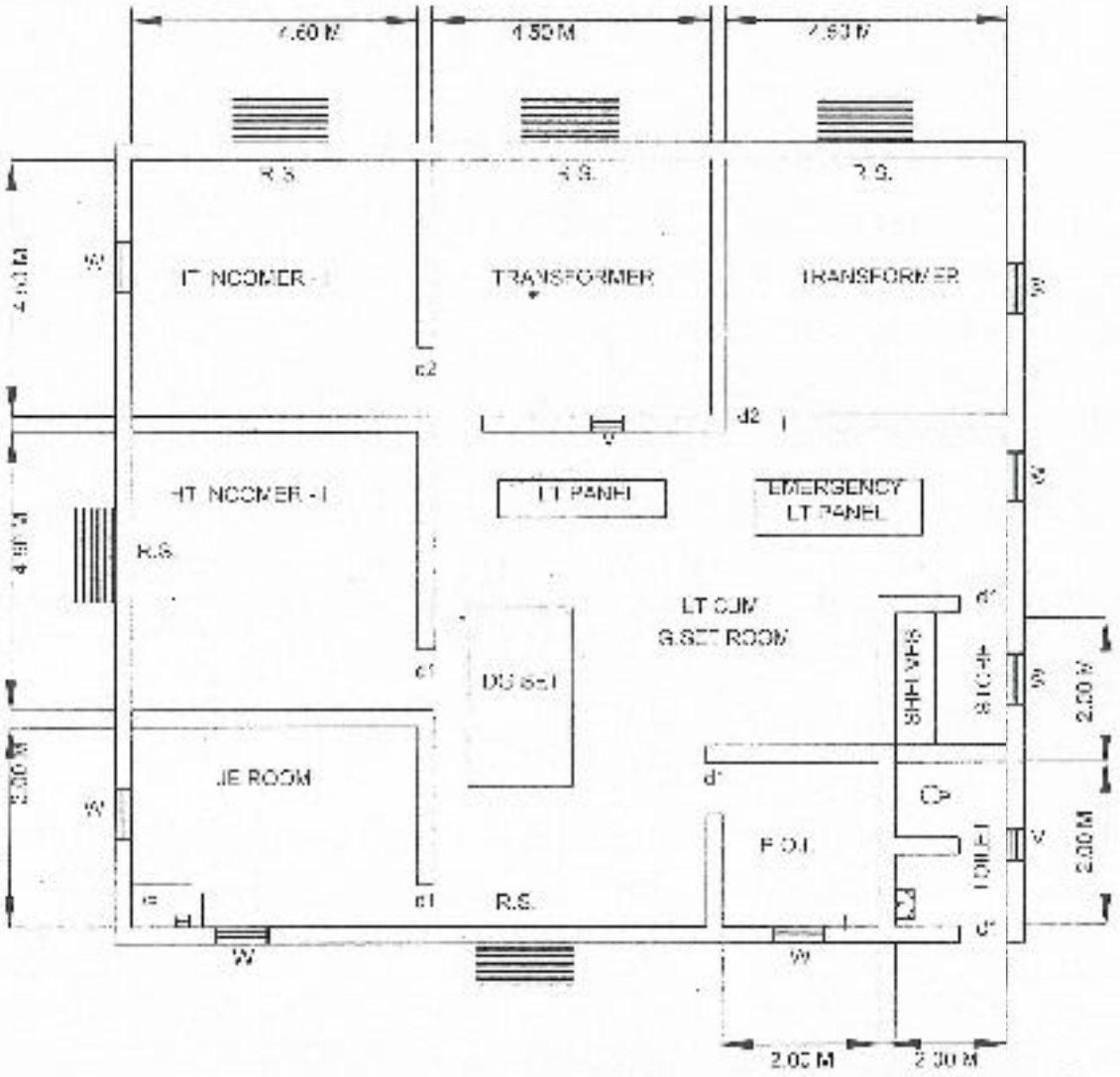
CHIEF ELECTRICAL ENGINEER

TYPICAL DRAWING OF APFC PANEL FOR PUMP

DRG. No: NFR/CE/CON/GSW 14/APFC/1223/0	ALL DIMENSIONS ARE IN METRES	NOT TO SCALE

JE/D/GSM/LG	SSE/DRG/GSM	SSE/DRG/GSM/LG	ASE/CON/PL/MLG	EE/CON/M/LG	DY.CEE/CON/ID	CED/CON/MLG

Typical Electric Sub-station Building



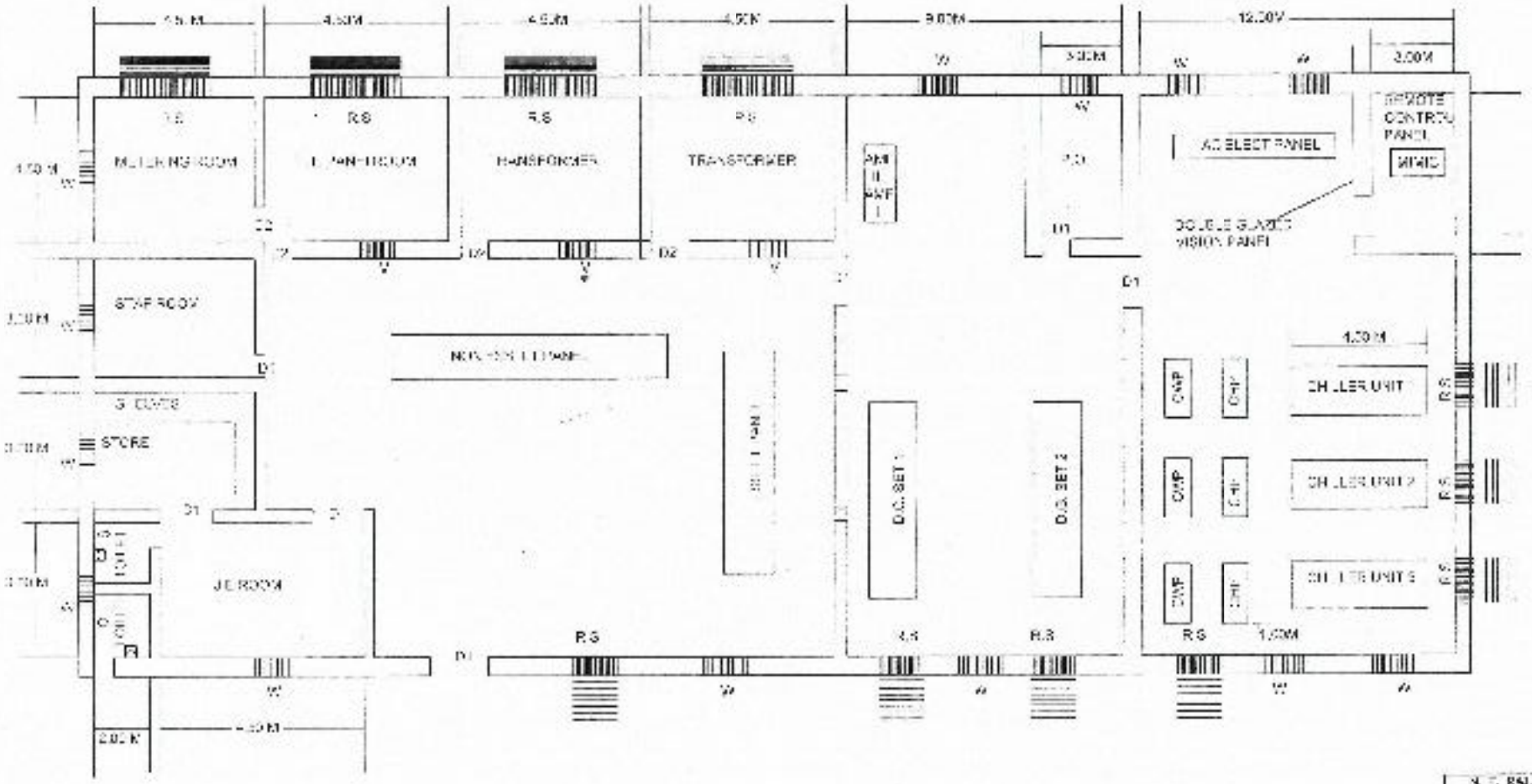
NOTE :

1. Rolling shutter 2.5 m wide - 3.0 m height as per Annexure and with ventillation grill.
2. All doors of steel normal projection
   d1 - 1 m wide - 2 m height.
   d2 - 0.75 m wide - 1.5 m height
3. W - window - normal size with grill
4. V - ventilator Size : 75 cm wide - 60 cm height made of steel frame with heavy wire mesh 50cm below ceiling.
5. No toilet is required where sub-station is located in the main building itself.
6. Store shelves - 0.75 m deep, RCC. 1 m, 2 m, 3 m above ground level

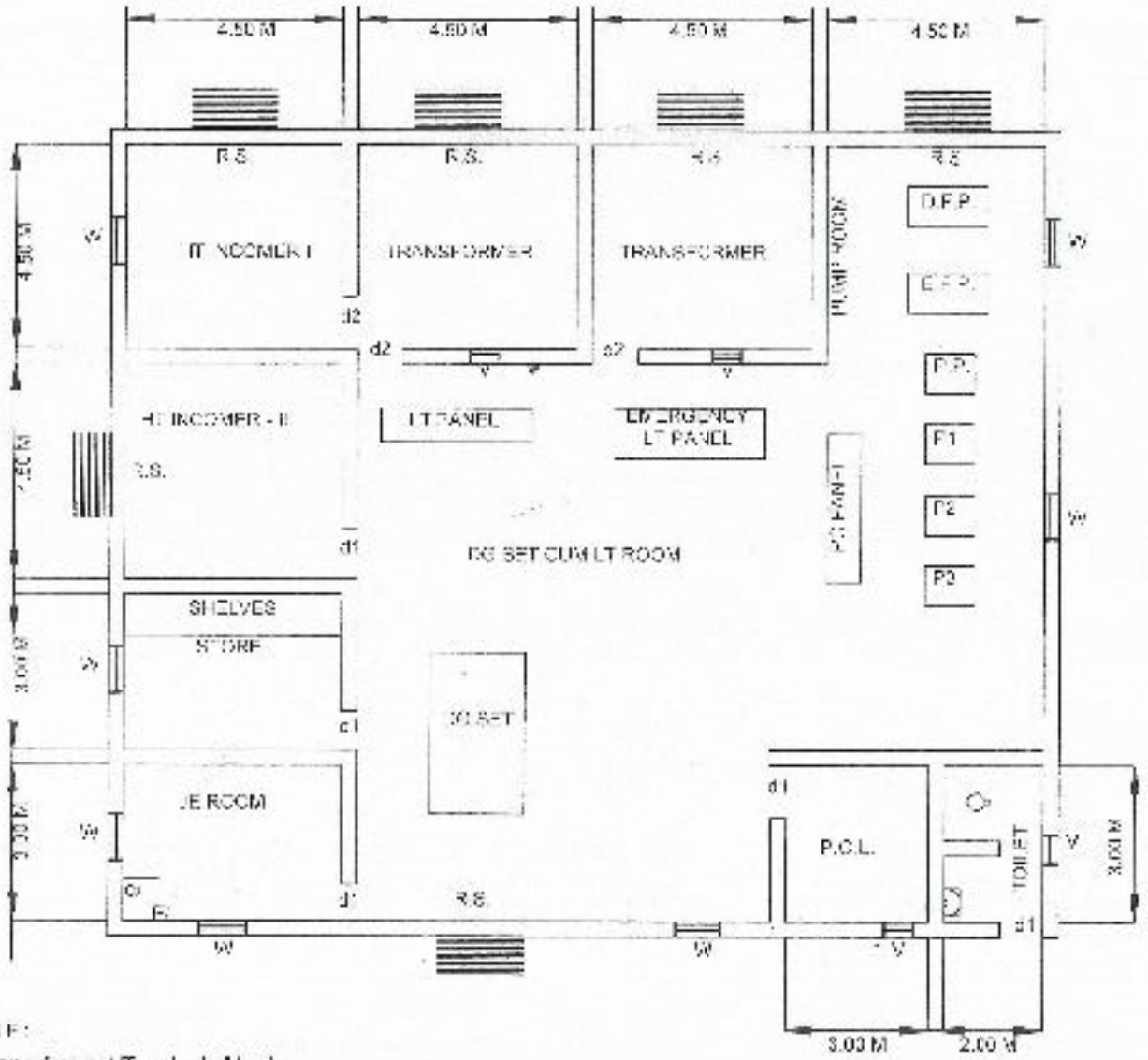
NOTE :

1. Transformer LT panel shall be dry type when sub-station is housed with main building ; It is not a separate building away from main building)
2. Room with wall enclosure, in case of Dry transformer is not essential.

TYPICAL LAYOUT OF DG SETS, SUB-STATION EQUIPMENT AND A.C. PLANT ROOM
2X 1000 KVA TRANSFORMER 2X 500 KVA D.G. SET 300 TR*3 AC PLANT



TYPICAL Electric Sub-station Cum Fire Pump House
(where Sub-station is a Separate Building)



NOTES :

1. Floor to ceiling height - 4.5 m
   Floor level - 30 cm above ground level
2. Motorable concrete approach road all around.
3. Partition walls - 30 cm thick abs
4. Heavy duty steel ladder with safe railing upto sub-station roof for roof drainage maintenance
5. 1 m wide chajja protection all around.
6. Underground water tank as near as possible to pump room.
7. Rolling shutter 2.5 m wide - 3 m height as per Annexure and with ventilation grill.
8. All doors of steel for fire protection
   d1 - 1 m wide - 2 m height.
   d2 - 0.75 m wide - 1.8 m height.
9. W - window - normal size with grill
10. V - ventilation size - 75cm wide - 0.3 cm height made of steel frame with heavy wire mesh 60cm below ceiling
11. D.F.P. - Diesel Fire Pump.
    E.F.P. - Electrical Fire Pump
    P.P. - Jockey Pump.
    P1, P2, P3. - Water supply Pumps.
12. Cable entry pipes - Executive Engg. will give position and details
13. Cable trenches - Executive Engg. will give details.
14. Protection boundary wall with gate - If sub-station is a protected premise surface boundary walls with gate to be provided.
15. Store shelves - 0.75 m deep RCC, 1 m, 2 m, 3 m above ground level

NOTES :

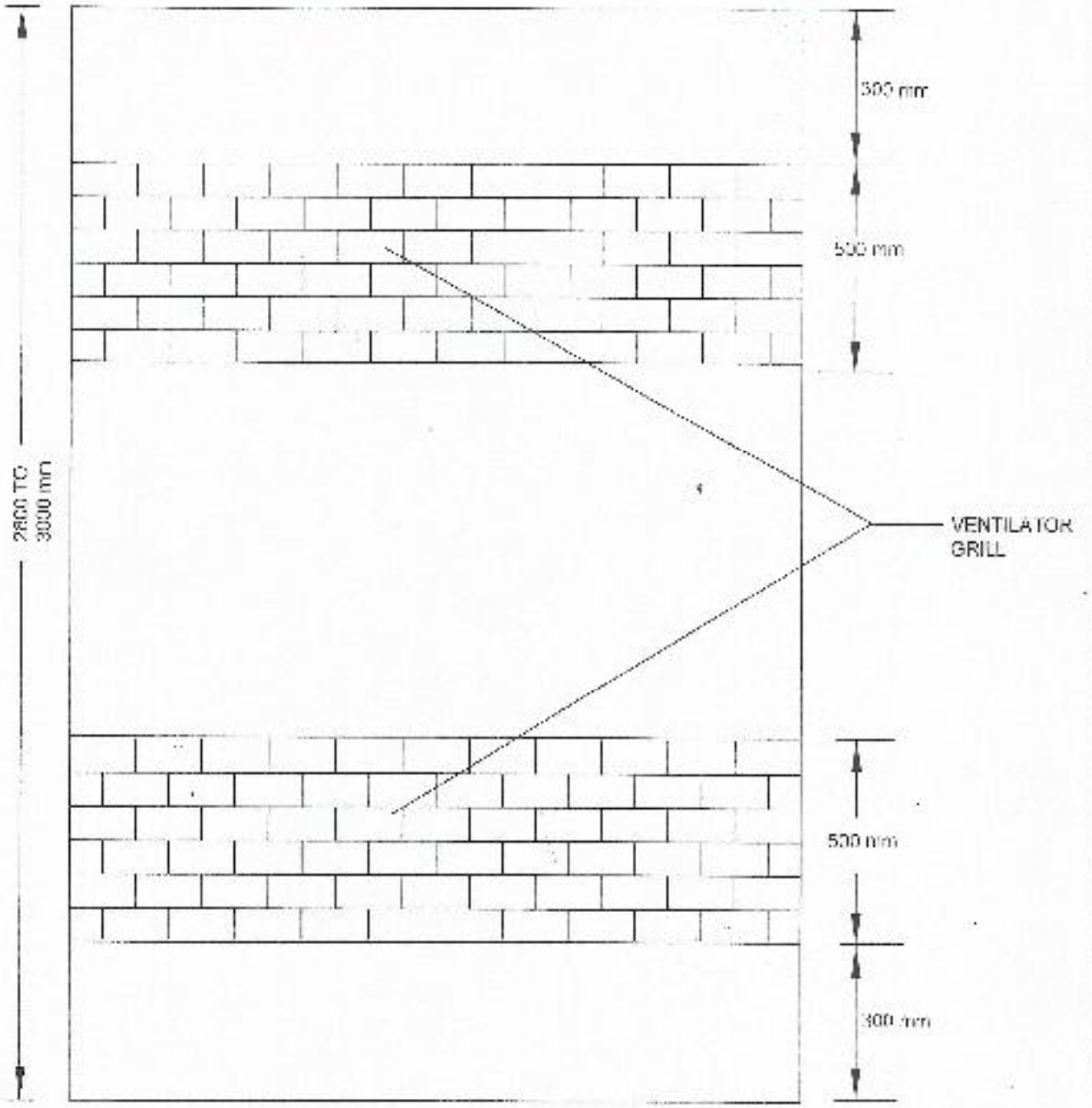
1. HT side for new LT panels shall be dry type when sub-station is housed with main building ; It is not a separate building away from main building)
2. Room with wall enclosure, in case of Dry transformer is not essential.

N. F. RAILWAY CONSTRUCTION
CHIEF ELECTRICAL ENGINEER
TYPICAL DESIGN OF ELECTRIC SUB-STATION
(Where sub-station is a separate building)

DRG. No. NF/ELECTRICAL/Transformer/2015	N.T. DRAWING No. NF	NOT TO SCALE

DESIGNED	CHECKED	CHECKED	CHECKED	CHECKED	DY. CEE (CONS)	CEE (CONS)

ROLLING SHUTTER FOR SUB-STATION



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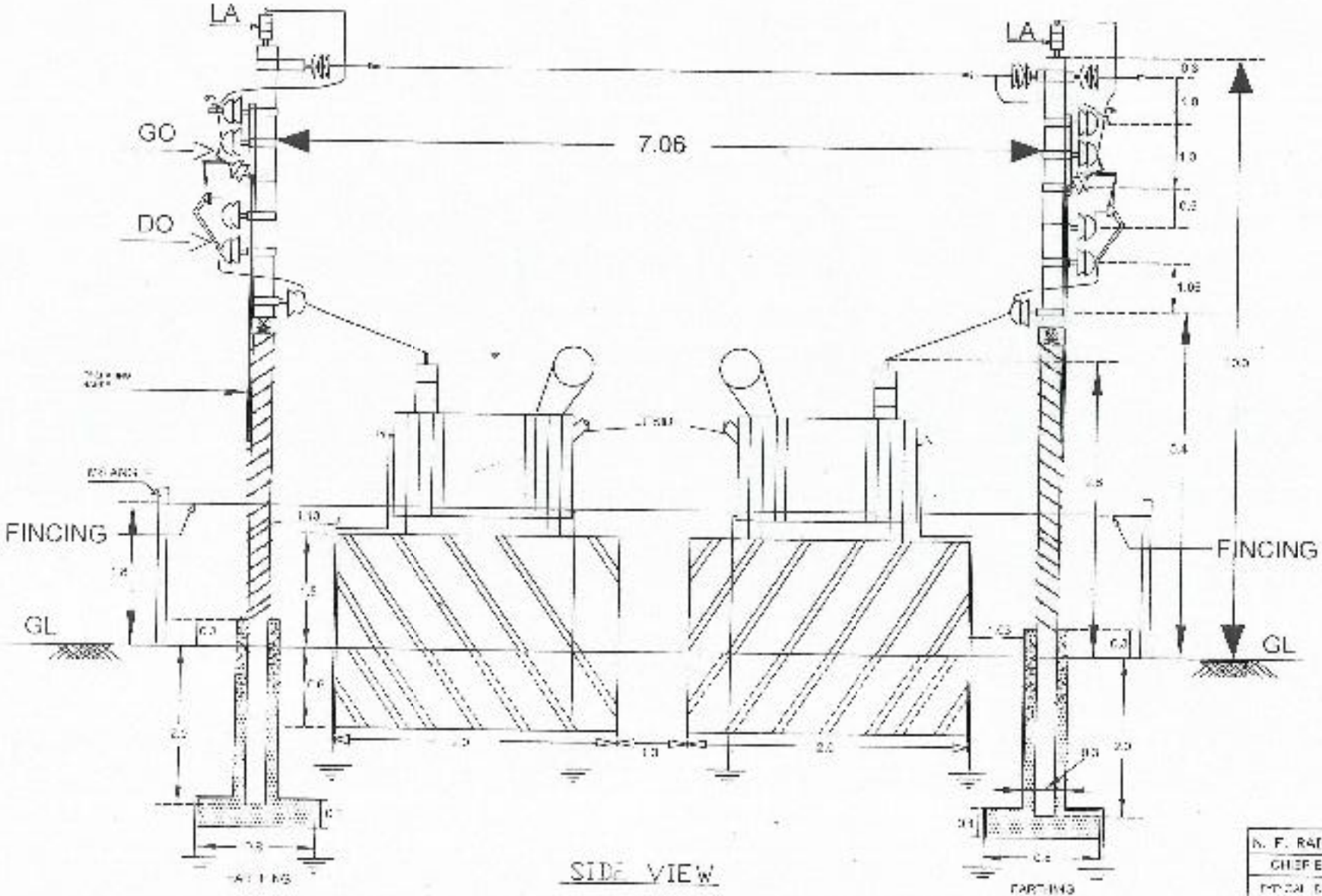
NOT TO SCALE

TYPICAL DRAWING PAD MOUNTED TRANSFORMER

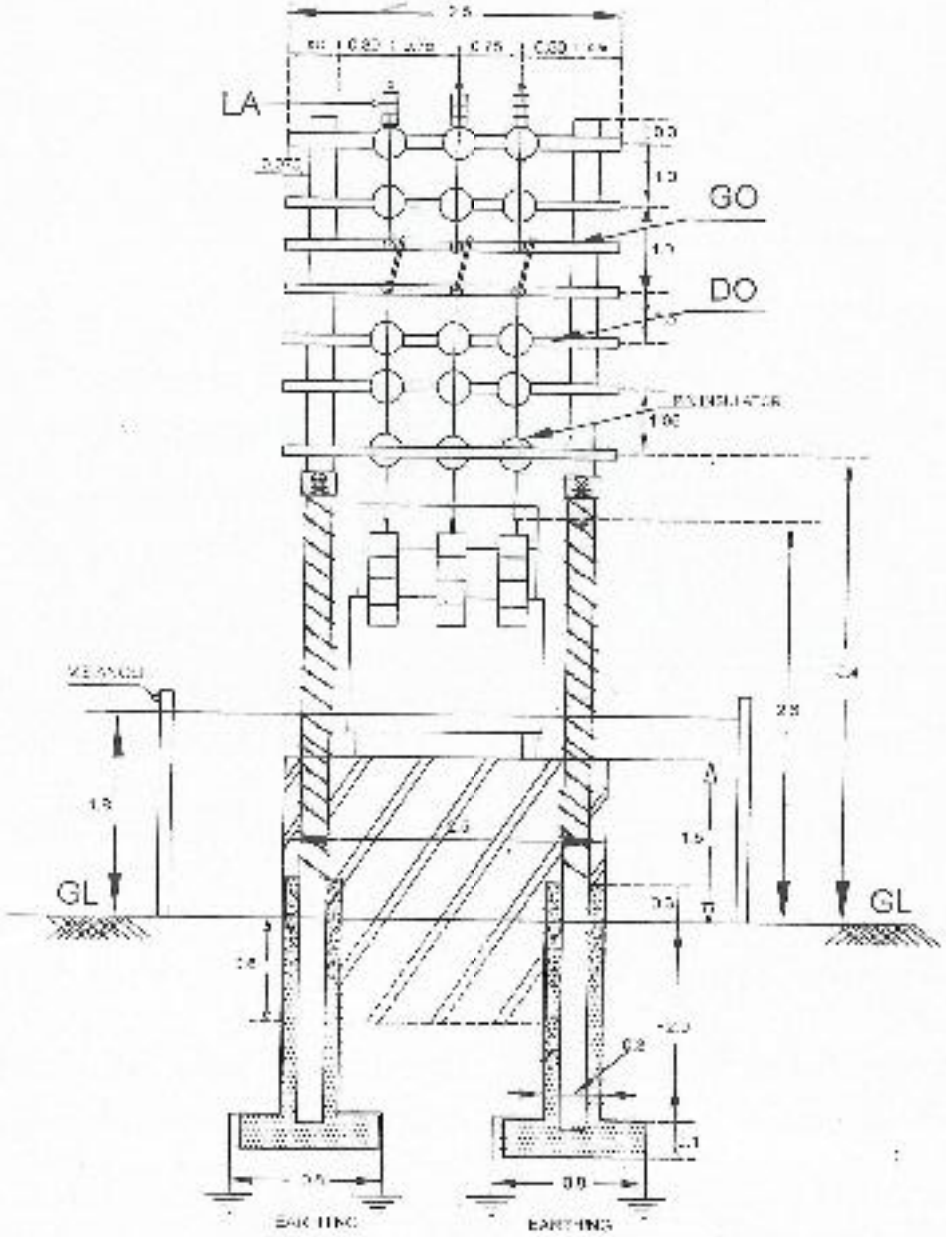


SIDE VIEW

N. F. RAILWAY CONSTRUCTIONS
CHIEF ELECTRICAL ENGINEER
TYPICAL DRAWING OF PAD MOUNTED TRANSFORMER 33/0.433 KV SUB STATION

DRG. NO. NFR/CFE/CON/GS/21(SUB STATION)/05/2016 | AS SHOWN IN THE DRG. | NOT TO SCALE

JE/DRG/C/MLG	SSE/DRG/C/SCL	SSE/DRG/C/MLG	AEE/CON/PL/MLG	EEE/CON/MLG	DY.CES/CON/HQ	CES/CON/MLG



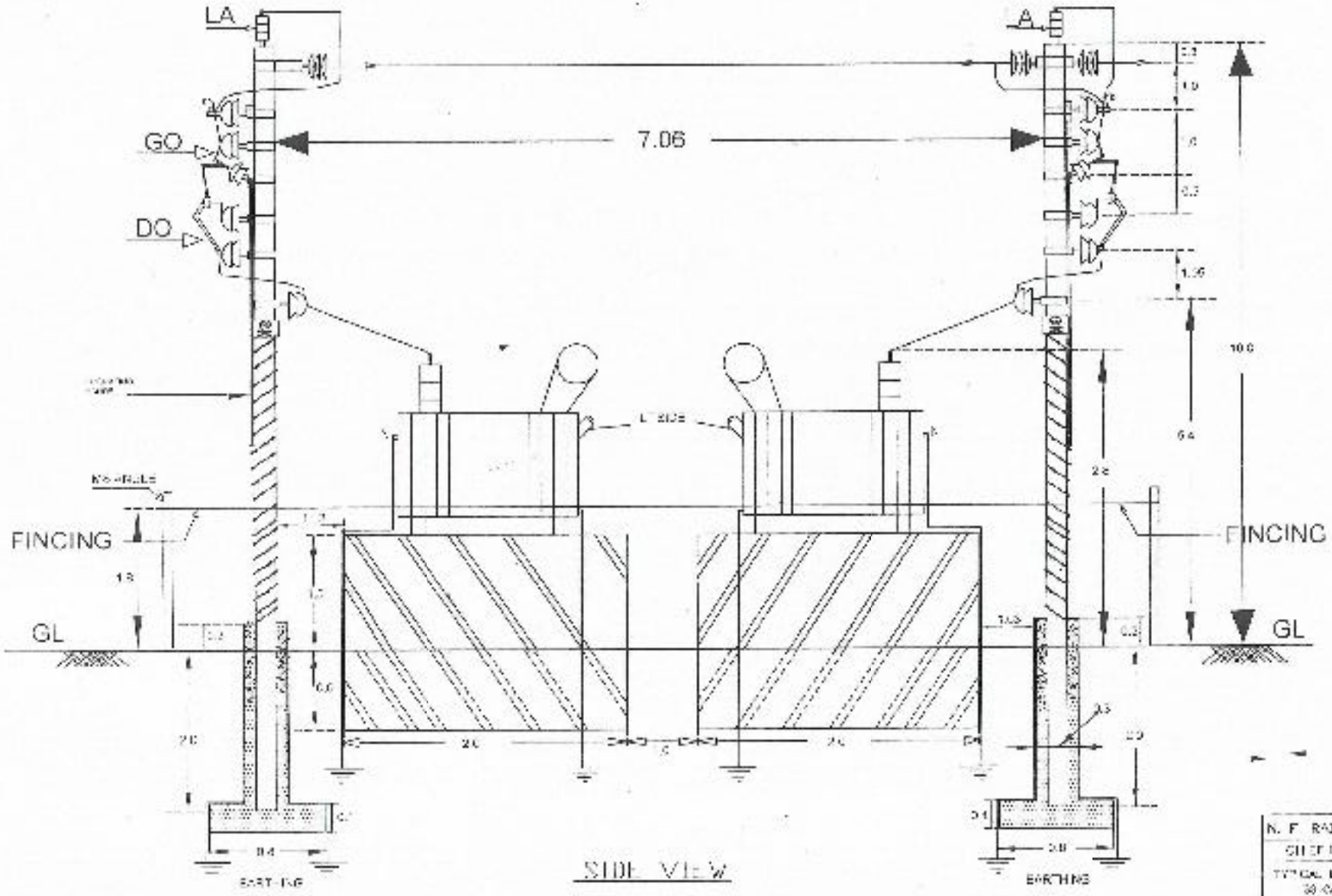
FRONT VIEW

DRG NO. NFR/CEE/CON/GS/21(SLB STATION)/03/2016

N. F. RAILWAY CONSTRUCTION
CHIEF ELECTRICAL ENGINEER
TYPICAL DRAWING OF [illegible]
132/33 KV SUBSTATION

JE/DRG/C/MLG	SSE/DRG/C/GCL	SSE/DRG/C/MLG	AEE/CON/PL/MLG	EEE/CON/MLG	Dy. CEE/CON/HQ	CEE/CON/MLG

TYPICAL DRAWING PAD MOUNTED TRANSFORMER



JE/DRG/C/MLG	SSE/DRG/C/SC_	SSE/DRG/C/M_G	AEE/CON/PL/MLG	EEE/CON/M I G	DY CEE/CON/HQ	CEE/CON/M_G

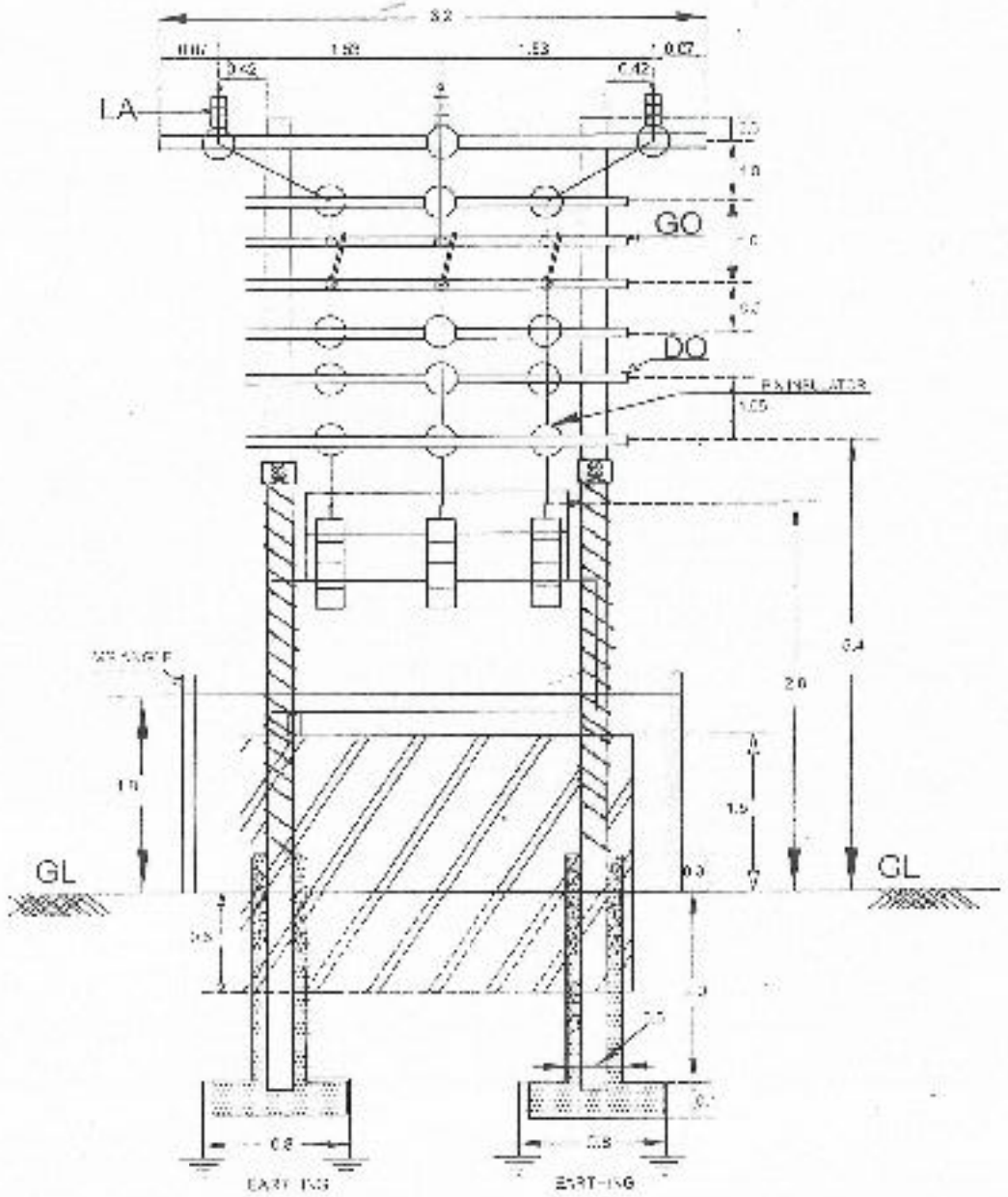
N. F. RAILWAY CONSTRUCTION

CHIEF ENGINEER

TYPICAL DRAWING OF TRANSFORMER 33 KV/11 KV SUBSTATION

DRG. NO. NFR/CEE/CON/GS/21(SUBSTATION)07/2016

NOT TO SCALE



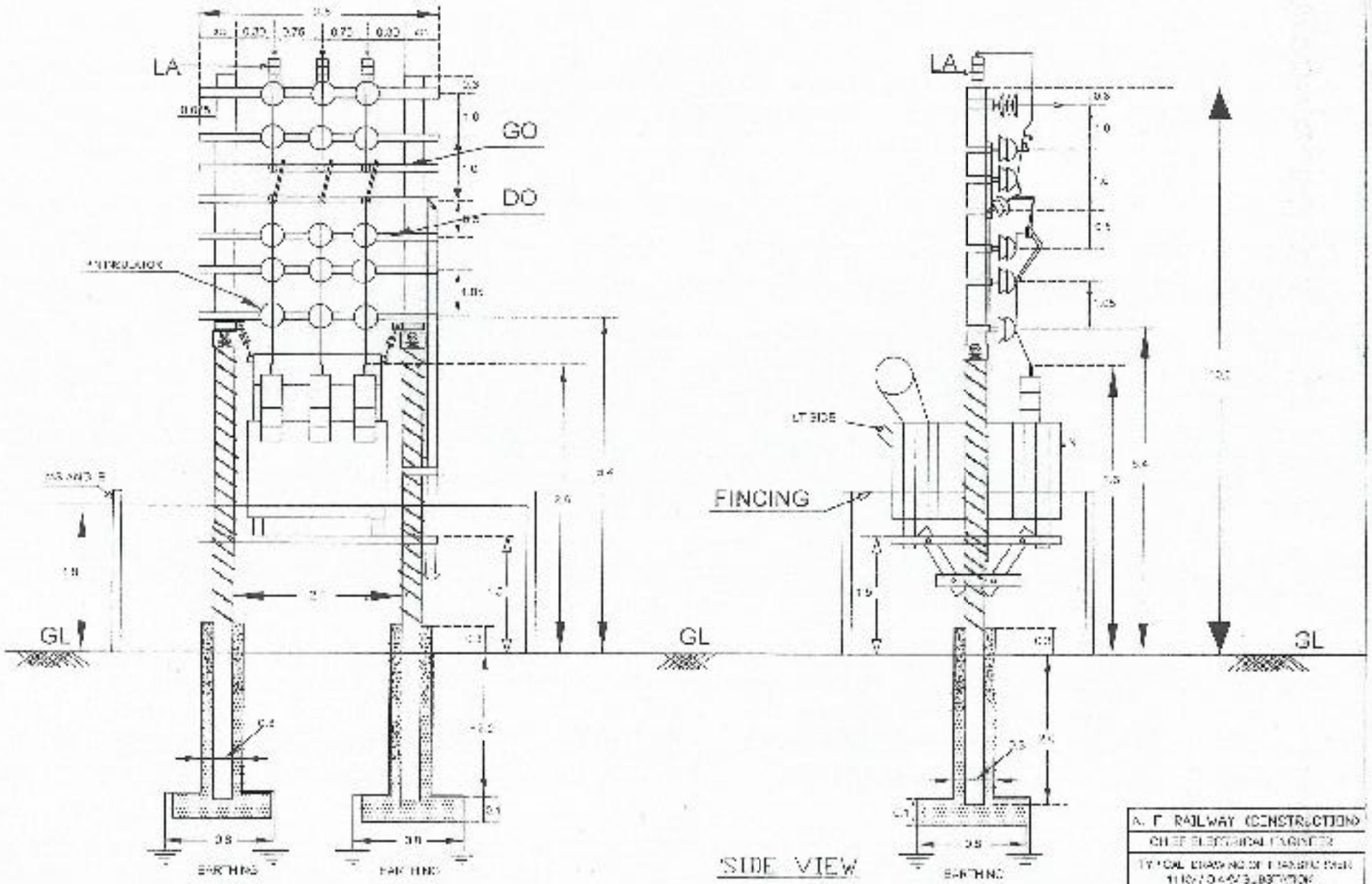
FRENT VIEW

DRC NO. NFR/CPE/CON/GS/21(SUB STATION)/05/2016

NOT TO SCALE

JE/DRC/C/MLG	SSE/DRG/C/SCL	SSE/DRG/C/MLG	AEE/CON/PL/MLG	EEE/CON/MLG	DY CEE/CON/HQ	CPE/CON/MLG

TYPICAL DRAWING OF POLE MOUNTED TRANSFORMER

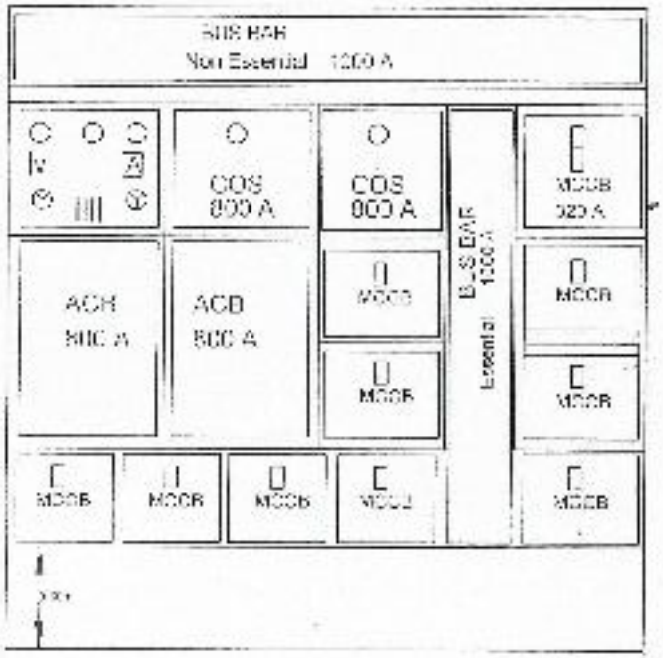


JE/DRG/C/MLG	SSE/DRG/C/SCL	SSE/DRG/C/MLG	AEE/CON/PJW LG	EEE/CON/V LG	DY.CEE/CON/Q	CEE/CON/V I G

DRG. NO. NFR/CEE/CON/GSC21/SJS STATION/09/2015

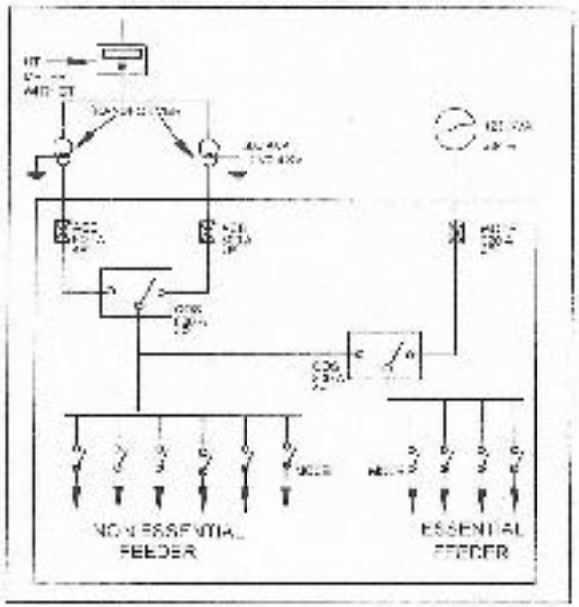
N. F. RAILWAY CONSTRUCTION
CHIEF ELECTRICAL ENGINEER
TYPICAL DRAWING OF PASSING LOOP STATION

MAIN PANEL BOARD FOR
500 KVA TRANSFORMER



FRONT VIEW

SCHEMETIC DIAGRAM OF SWITCH GEAR PANEL



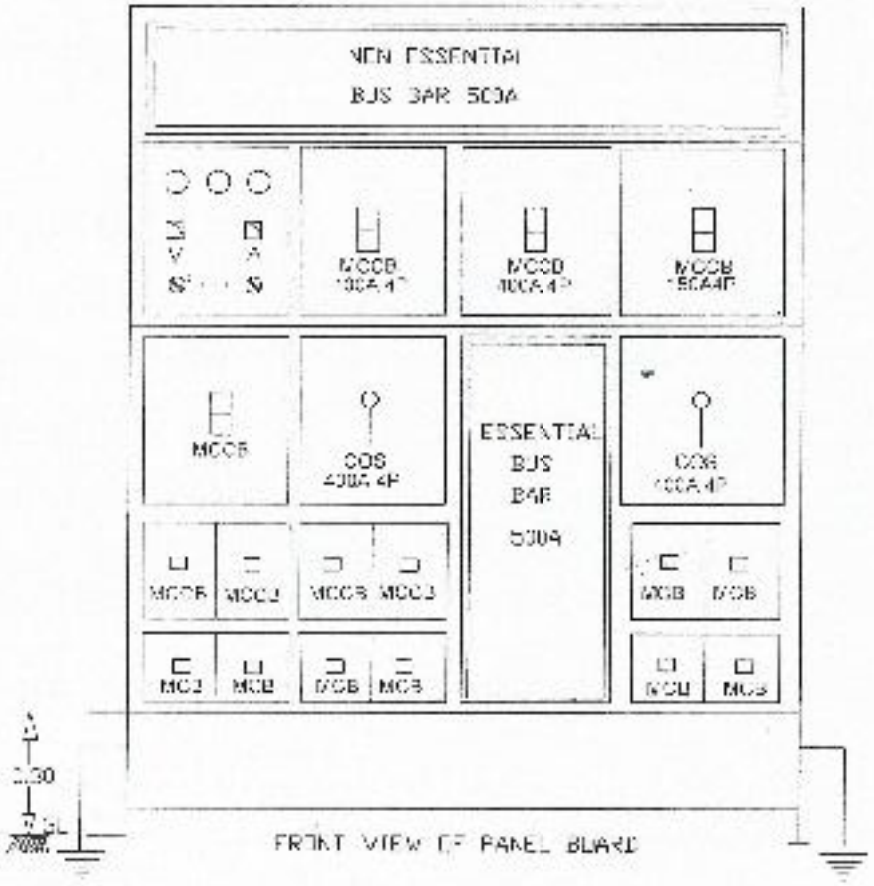
NOTE:
2mm thick CRCA sheet.
1.6 mm partitions CRCA sheet
Panel height not more than 2.4 mm.
Operating height between 0.30 to 1.70 m.
Bus bar not less than 50 x 6 m m

		DRG. No. NFR/GEE/CO/1/2020/Version/Voltage/01/2018			ALL DIMENSIONS ARE IN MM	NO TO SCALE
JE/DRG/CO/MLG	SEE/DRG/CO/MLG	SSE/DRG/CO/MLG	AEE/COMPILATION/MLG	EE/CONV/MLG	DY CE/CON/HQ	CE/CON/MLG

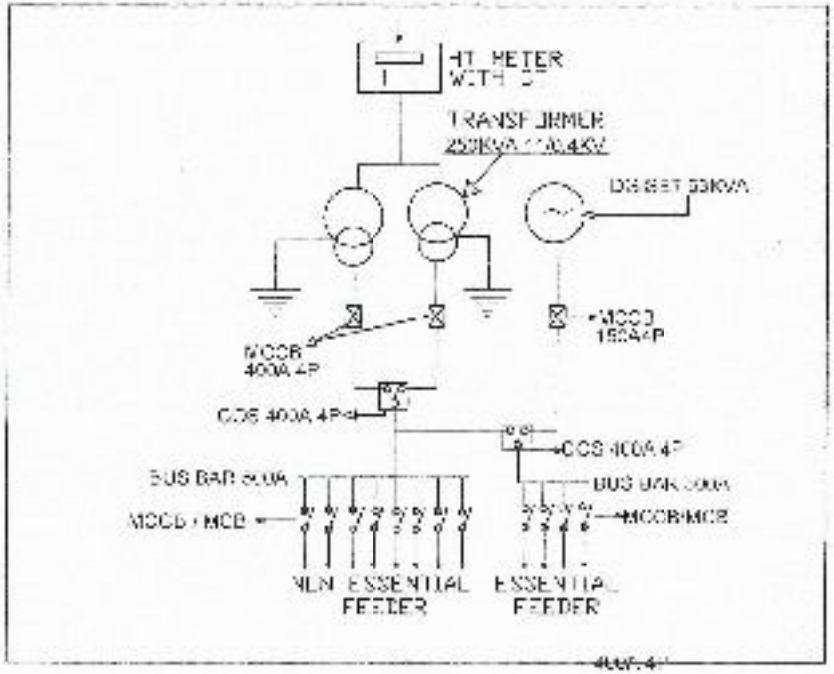
N. F. RAILWAY CONSTRUCTION
CHIEF ELECTRICAL ENGINEER

TYPICAL LT PANEL DESIGN FOR 500 KVA TRANSFORMER

MAIN PANEL BOARD FOR 250 KVA TRANSFORMER



SCHEMATIC DIAGARM OF SWITCHGEAR PANEL

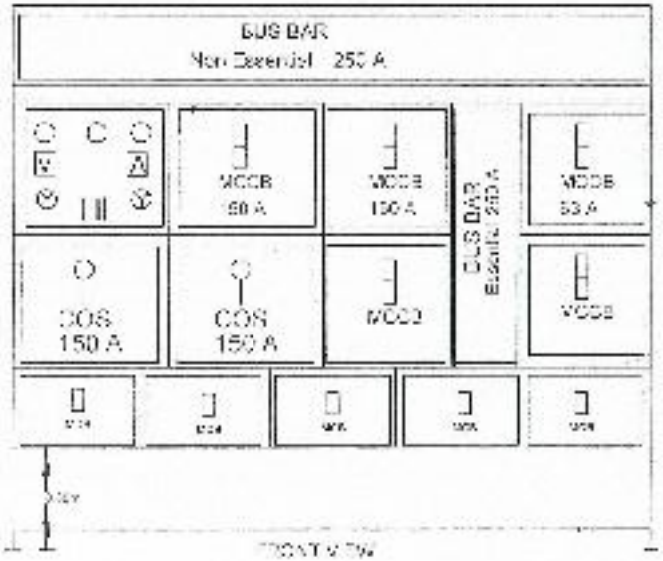


NOTE:-

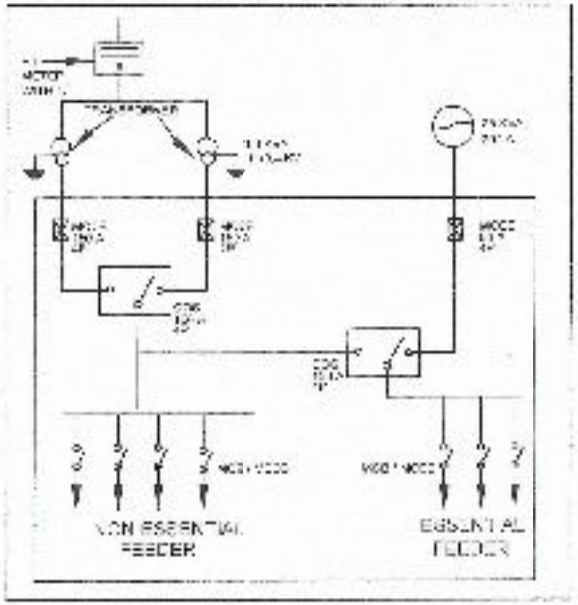
2 mm thick CRCA sheet
1.6 mm partitions CRCA sheet
Panel height not more than 2.4 mm.
Operating height between 0.30 to 1.70 m.
Bus bar not less than 50 x 6 mm.

N. F. RAILWAY CONSTRUCTION	
CHIEF ELECTRICAL ENGINEER	
TYPICAL LT PANEL DIAGRAM FOR 250KVA TRANSFORMER	
DRG. NO. N.F/CEE/CONSTN/22/MEDIUM VOLTAGE PANELS/2022/16	ALL DIMENSIONS IN M.M. NOT TO SCALE
JE/DRG/CONSTN	SSE/DRG/CONSTN SSE/DRG/CONSTN ALL CONCERNED
DY CEE/CONSTN/MAINT	CEE/CONSTN/MAINT

MAIN PANEL BOARD FOR100 KVA TRANSFORMER



SCHEMETIC DIAGRAM OF SWITCH GEAR PANEL

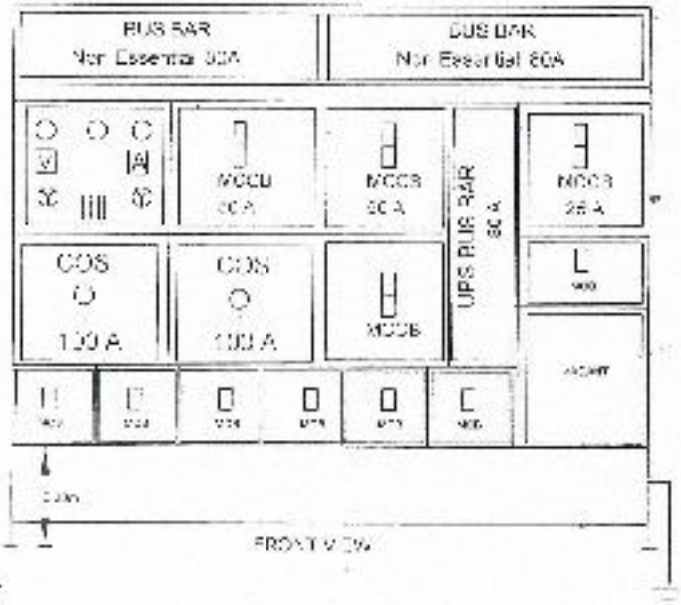


NOTE:

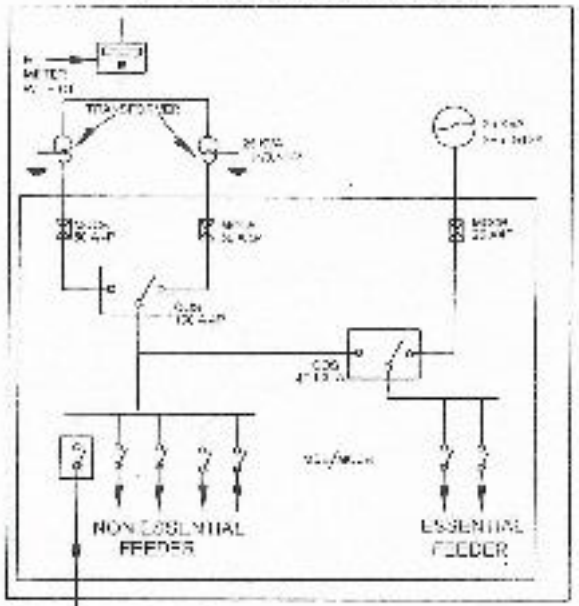
2mm thick CRCA sheet.
1.6 mm partitions CRCA sheet
Panel height not more than 2.4 mm.
Operating height between 0.30 to 1.70 m.
Bus bar not less than 50 x 6 mm.

				S. E. RAILWAY (CONSTRUCTION) CHIEF ELECTRICAL ENGINEER	
				TYPICAL PANEL DRAWING OF 100 KVA TRANSFORMER	
	DRG. No. N.FR/CEE/CON/MCS/22(Vacuum Voltage)/3/2019			ALL DIMENSIONS ARE IN MM.	NOT TO SCALE
JE/ORG/CON/LG	SSE/ORG/CON/HQ	SSE/ORG/CON/LG	AEE/CON-I/LG	EEE/CON/LG	DY.CEE/CON/HQ	CRE/CON/LG

MAIN PANEL BOARD FOR 25 KVA TRANSFORMER



SCHEMATIC DIAGRAM OF SWITCH GEAR PANEL

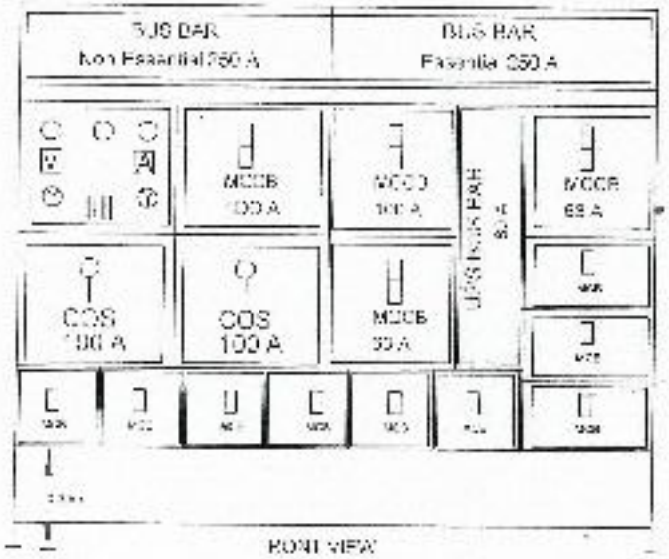


NOTES:

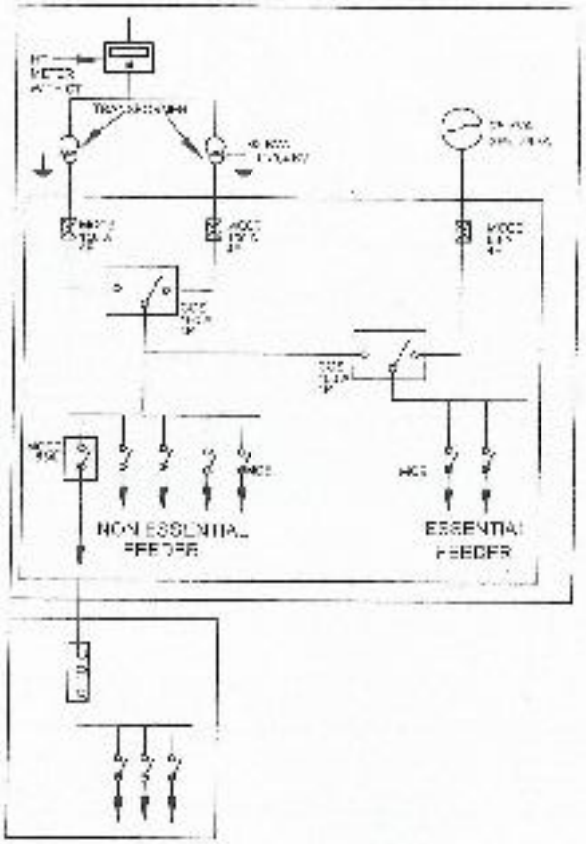
2mm thick CRCA sheet.
1.6 mm partitions CRCA sheet
Panel height not more than 2.4 mm.
Operating height between 0.30 to 1.70 m.
Bus bar not less than 50 x 6 mm.

					N. F. RAILWAY CONSTRUCTION CHIEF ELECTRICAL ENGINEER	
					TYPICAL LT PANEL DRAWING OF 25 KVA TRANSFORMER	
		JRG. No. NFR/CELL/CON/GS/222(Med Lin Voltage)/4-2016			ALL DIMENSIONS ARE IN Mtr.	NOT TO SCALE
JLO/GR/CNLG	SSE/DRG/CON	ASE/ORG/CON/LG	AEE/CON/PLG/VLG	EE/CON/VLG	DY.CEE/CON/HQ	CEE/CON/LG

MAIN PANEL BOARD FOR 63 KVA TRANSFORMER



SCHEMATIC DIAGRAM OF SWITCH GEAR PANEL



NOTE:-

2mm thick CRCA sheet

1.6 mm partitions CRCA sheet.

Panel height not more than 2.4 mm.

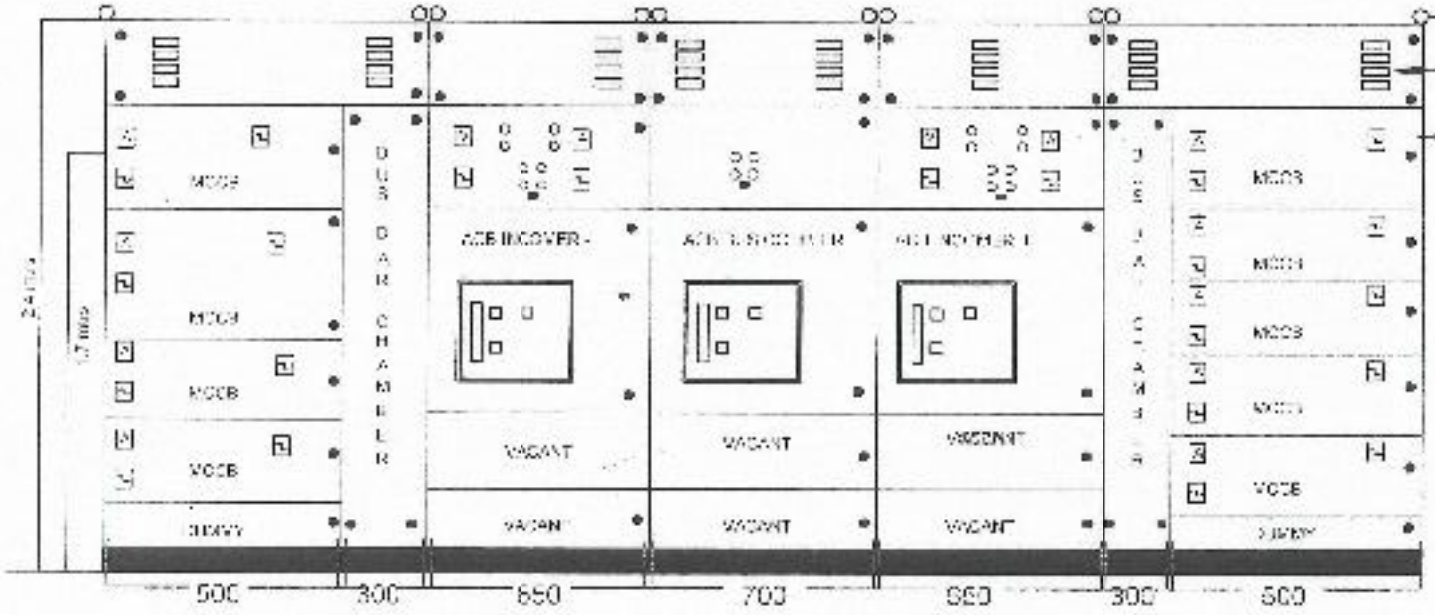
Operating height between 0.30 to 1.70 m.

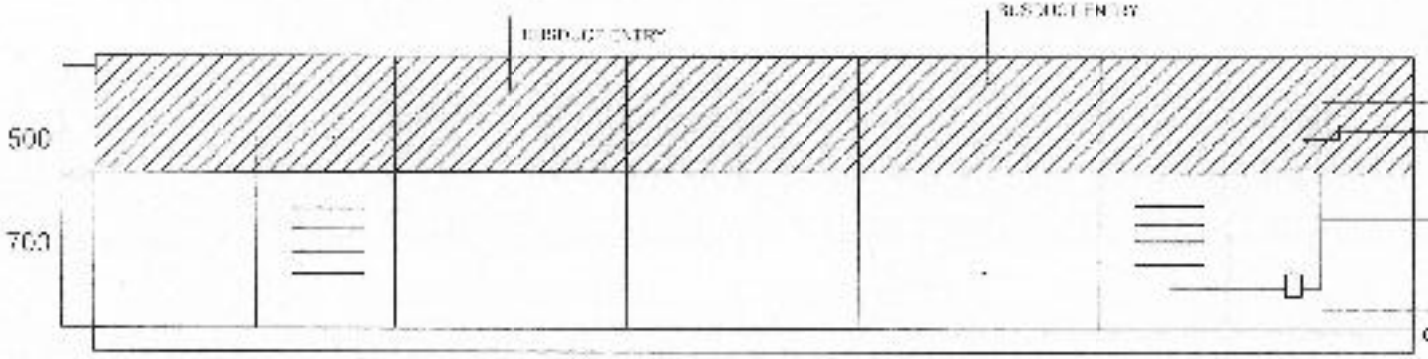
Bus bar not less than 50 x 6 mm.

LOCO/CWLG	SSE/ORG/CSCL	SSE/ORG/CWLG	AEE/WAT/PWLG	EE/LOCO/WLG	DY.CEE/CON/HQ	CEE/CON/W.Rly

N. F. RAILWAY (CONSTRUCTION) CHIEF ELECTRICAL ENGINEER		
TYPICAL PANEL DRAWING OF 63 KVA TRANSFORMER		
DRG. No. NF/CELL/CON/XSS/23W/cal/Lm Volume(2015)/01	ALL DIMENSIONS ARE IN mm.	NOT TO SCALE

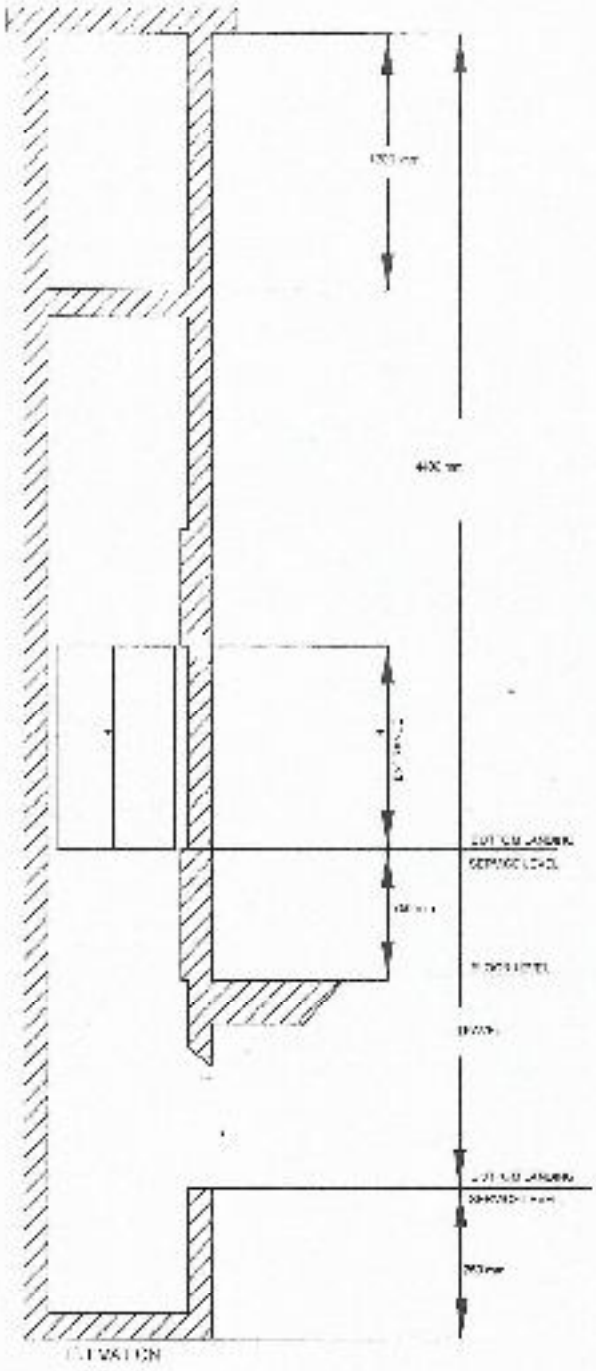
TYPICAL LAYOUT OF ELECTRICAL PANEL



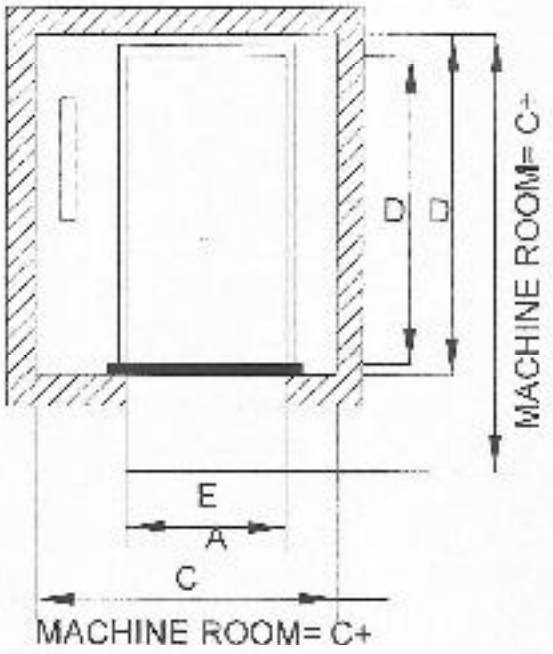


PANEL VIEW

RECOMENDED DIMENSIONS OF SERVICE LIFTS FOR SPEED UPTO 0 5 m/s



ELEVATION



LIFT NO.	CAR SIZE			ENTRANCE	
	A	B	C	D	E

ALL DIMENSIONS ARE IN MILLIMETERS

NOTE -

Drawings with 'C' in name are machine room provision and not operating clearances are drawn normally provided.

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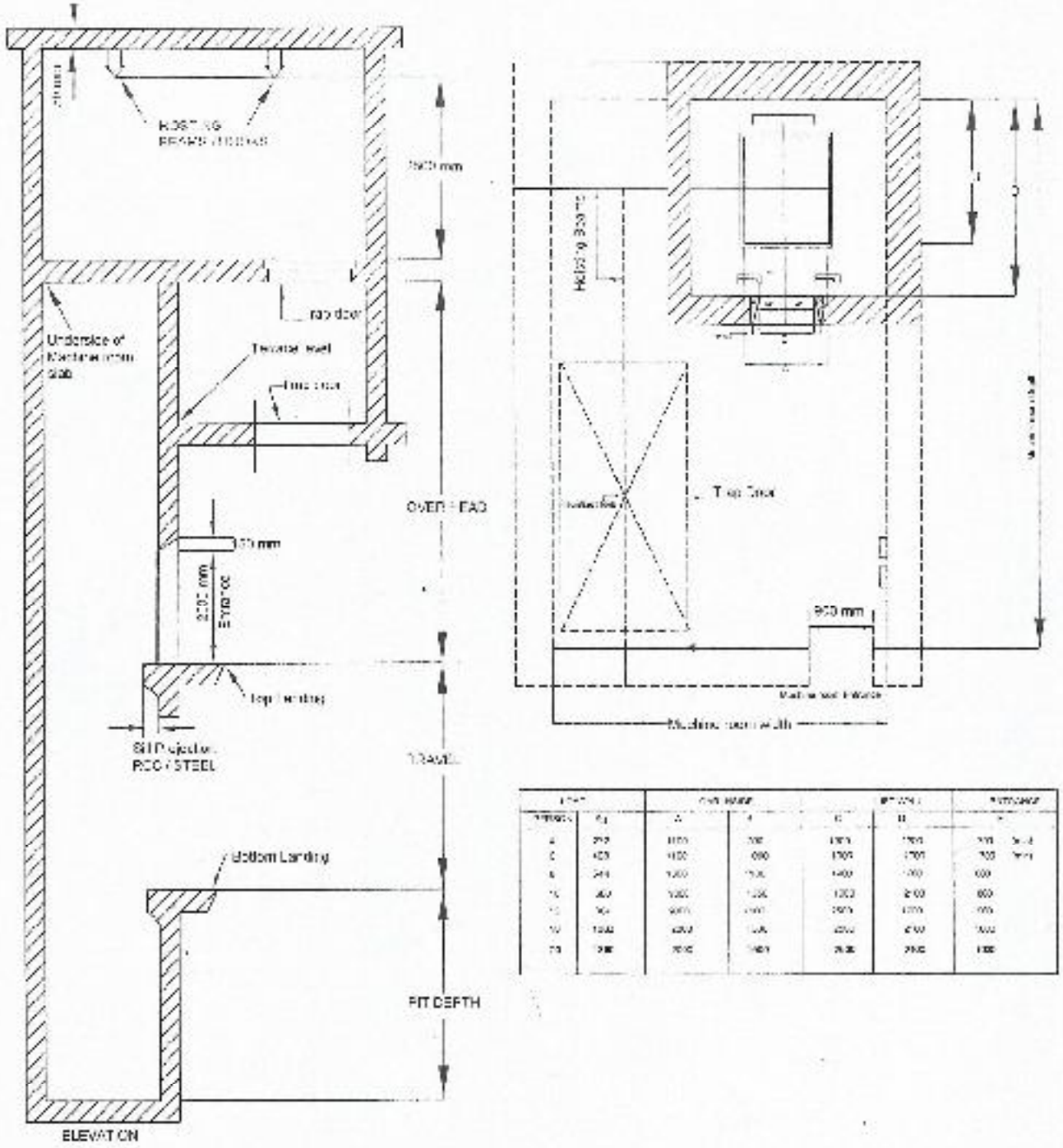
ALL DRAWING SHALL BE READ IN C.M.

NOT TO SCALE

RECOMENDED DIMENSIONS OF PASSENGER LIFTS



Load	Car size		Well size		Overhead	Pit depth
Persons	Kg	A	B	C	D	E
4	300	1100	1200	1500	1500	1400
6	450	1100	1600	1500	1500	1400
8	600	1200	1700	1600	1700	1600
10	750	1200	1700	1600	1700	1600
13	975	1200	1700	1600	1700	1600
15	1125	1200	1700	1600	1700	1600
20	1500	1200	1700	1600	1700	1600

Recommended dimensions for pit, Overhead and Machine room for passenger lifts.

SPEED IN M/S	Upto 0.75	>0.75<1	>1<1.5	>1.5<1.75	>1.75<2	>2<2.5
PIT DEPTH	1350	1500	1650	2100	2200	2400
OVERHEAD	4200	4250	4400	4900	5000	5400
MACHINE ROOM DEPTH	D+2000			D+2500		
MACHINE ROOM WIDTH	D+1000				D+1500	

All dimensions in millimeters

NOTES

1. The total head room has been calculated on the basis of car height of 2.4m
2. In the case of manually operated doors clear entrance will be reduced by the amount of projection of the sill guide
3. All car doors and landing doors shall have power operated doors with counterweight in case, automatic except domestic premises for use inside one building planners. Any variations may be agreed between manufacturer and purchaser are permitted. However, satisfying
   (i) Car inside dimensions shall be within the maximum area limits specified in Table 3 of IS: 4666(part 2/sec.1)
   (ii) Entrance width no higher value is permitted.
   (iii) Entrance width on lower side is permitted upto 100mm except in minimum car width.
4. Dimensions of pit depth and overhead may differ in practice as per the actual manufacturer's design depending upon load, speed and duty. However, the pit depth and overhead shall be such as to conform to the requirements of lifting clearance and top clearance of IS 14665(Part 2/Sec.1)

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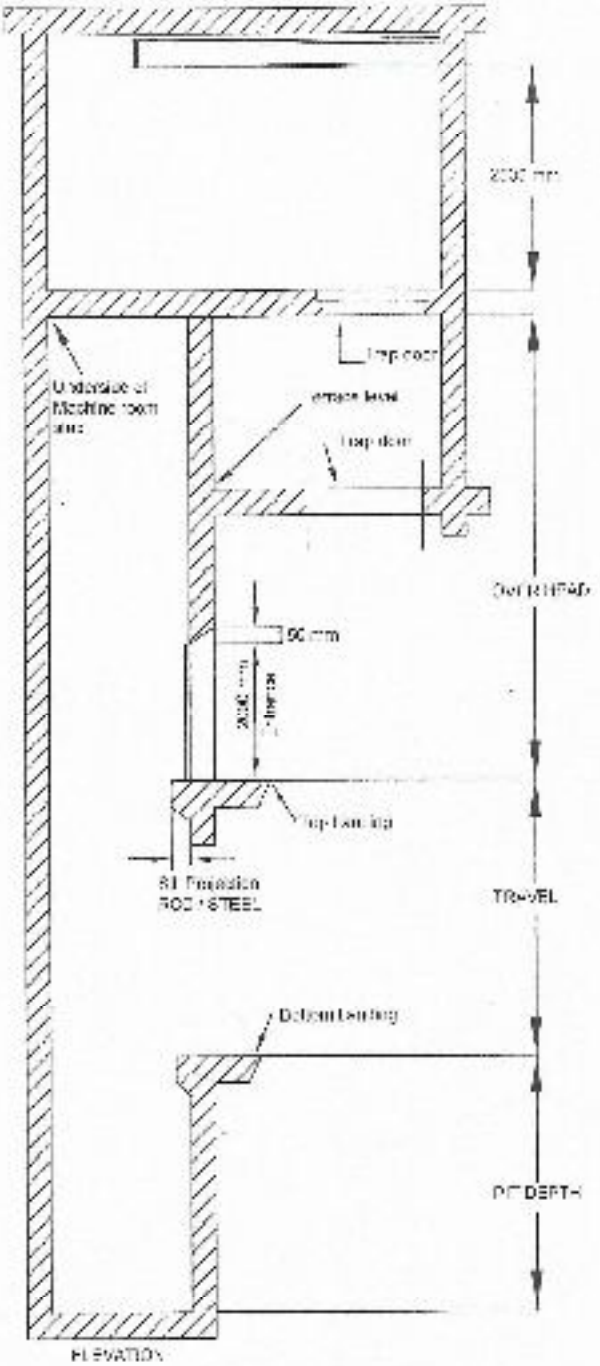
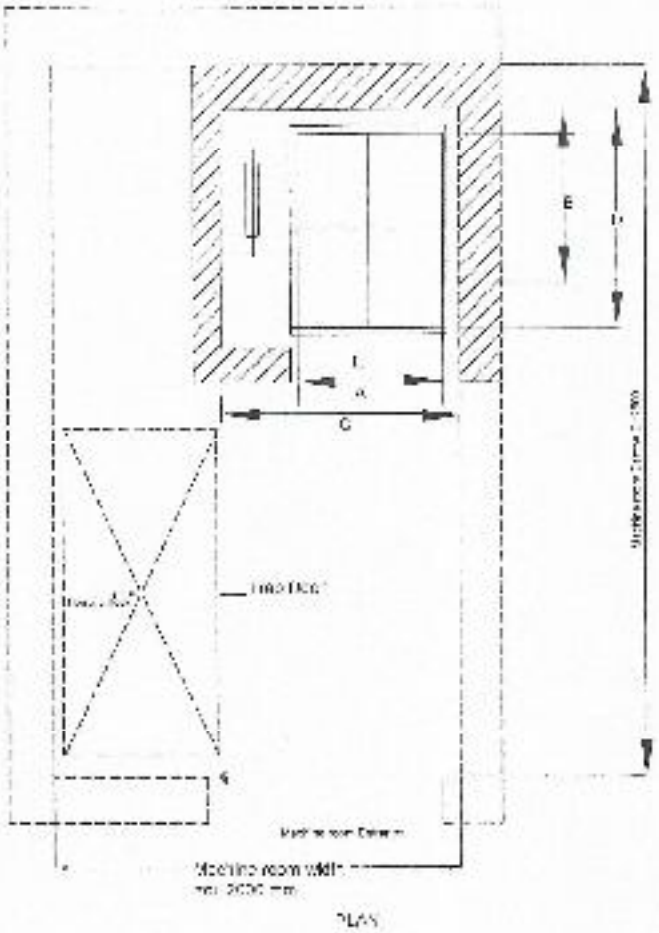
					30/6/16	

RECOMENDED DIMENSIONS OF HOSPITAL LIFTS FOR SPEED UPTO 1.5 m/s





Capacity	Car size			Lift well		Entrance
Kg	A	B	H	C	D	F
450	1100	1400	2200	1400	1600	700
630	1100	1400	2200	1400	1600	800
800	1100	1400	2200	1400	1600	900
1000	1100	1500	2200	1400	1600	1000

All dimensions are in millimeters

NOTE:

1. The total travel is calculated on the basis of car height of 2.2m
2. In the case of centrally opening doors, clear entrance will be reduced by the amount of projection of the leaves / panels.
3. Although 16 persons capacity is most economical one, this can be used to cover floor area for capacity which can be used in hospital.
4. All dimensions given above are recommended dimensions primarily for architects and building purposes. Any variation mutually agreed between manufacturers and purchasers are permitted. However, variation in car inside dimensions shall be within the maximum areas limits specified in IS:14665(part 2/Sec1).
5. Dimensions of overhead and pit may differ in practice as per individual manufacturer's design depending upon load, speed and duty. However the pit depth and overhead shall be such as to maintain the requirements of bottom clearance and top clearance of 0.1+0.05(per V)mm.

N. F. RAILWAY CONSTRUCTIONS

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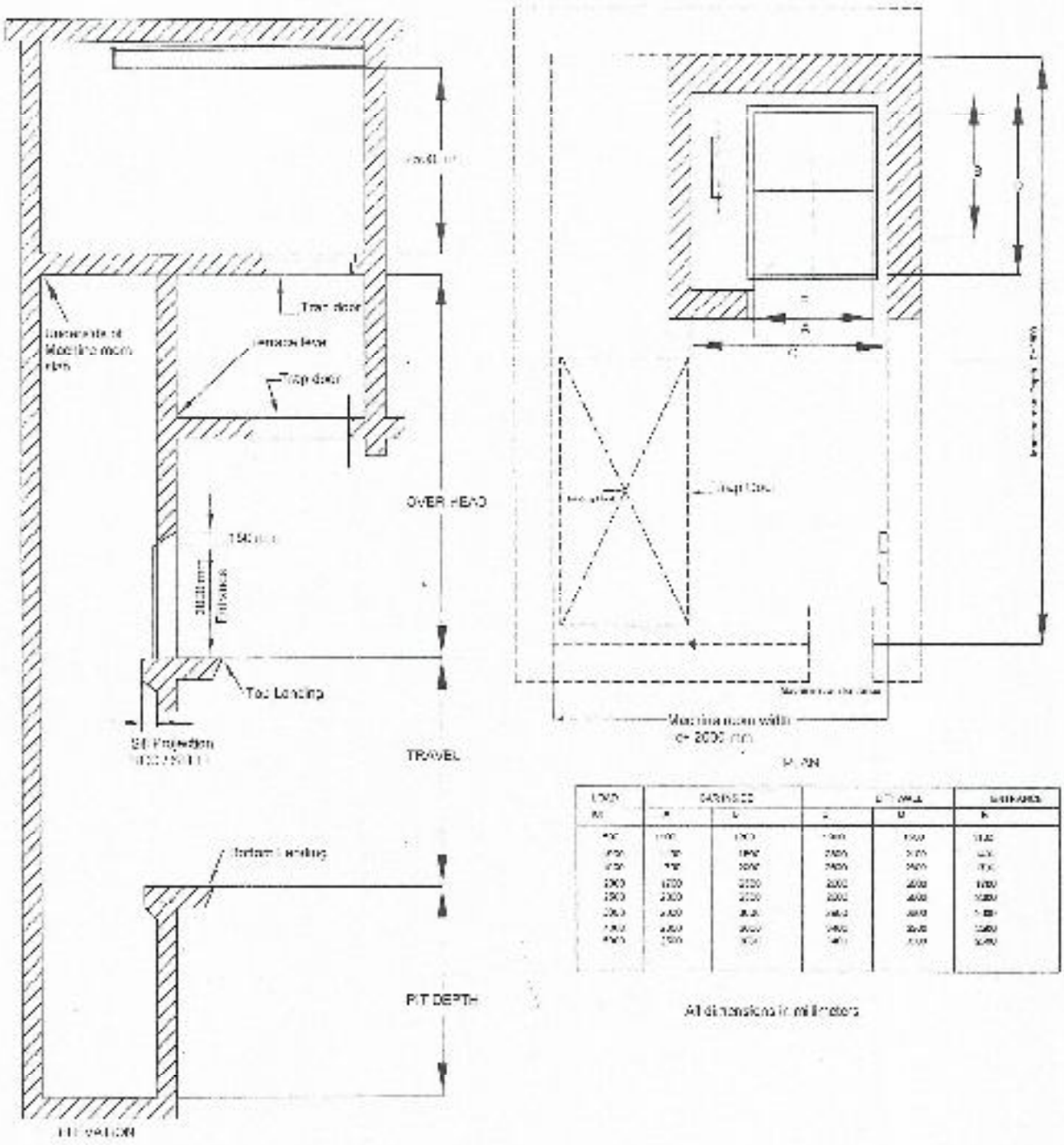
RECOMENDED DIMENSIONS OF GOODS LIFTS FOR SPEED UPTO 1.5 m/s



LOAD kg	CABIN SIZE		LIFT WELL		CLEARANCE
	A	B	C	D	E
500	1100	1400	1400	1700	1150
630	1100	1400	1400	1700	1150
750	1100	1400	1400	1700	1150
1000	1200	2100	2000	2600	1650
1250	1300	2100	2000	2600	1650
1500	1400	2100	2000	2600	1650
1750	1500	2100	2000	2600	1650
2000	1600	2100	2000	2600	1650
2500	1800	2100	2000	2600	1650

All dimensions in millimeters

NOTE :

1. The width of the machine room shall be equal to the lift well width 'D' subject to minimum of 2000 mm.
2. The total travel has been calculated on the basis of car height of 2.3m
3. Clear entrance width : This is based on vertical sliding car door and vertical biparting landing doors. For other entrance combination clear entrance width will be reduced by 200 mm (minimum 1800 mm).
4. All dimensions given above are recommended dimensions primarily for architects and building planners. Any variation mutually agreed between manufacturer and purchaser are permitted. However variation in car inside dimensions shall be within the maximum areas limits specified in IS 14665(part 1/Sec1).
5. Dimensions of pit and overhead may alter in actual practice as per individual manufacturers design depending upon load, speed and duty. However the pit depth and overhead shall be such as to conform to the requirements of bottom clearance and top clearance of IS 14665(part 2/Sec1).

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NORTH EAST FRONTIER RAILWAY
CONSTRUCTION ORGANISATION

List of Preferred likely makes of equipments & Materials
(List of likely sources)

1. All Equipments & Materials should conform to latest version of BIS or other indicated specification. All energy consuming equipments should have minimum 3 star rating given by BEE, wherever applicable.

SN	Equipment / Material	Name of Manufacturer/ Brand Name
1	PVC Conduit	Finolex Polycab, Precia, LARSEN Precision Prime plast, CROWN AKU, SUDHAKAR, ANDI, LAXMI, RICHA
2	1.1kv PVC insulated, multistrand Copper conductor Cable for wiring (ISI Marked)	KEI Industries Ltd., Havells, Finolex, RPG, polycab Fort Gloster Industries Ltd The National Insulated Cable Co., Cable Corporation of India Ltd, Indian Cable Co. Kolkata Asian Cables Vijay Cables Industrials New Delhi Sun home Cables Industries New Delhi ICL Cable, Rajasthan Incab Torrent Skymine Vishal Brands of Deepmesh Cables Uniflex, PRIMECAB Unistar Universal Cable Ltd Gurunday Electricals (India)Delhi Trexton Cables(I) Atlanta cables, Rohtak Incheon Cables Excelite Wires & Cables Cabcorn Galaxy power cables Victor cables Tara Cables Deep Industries

(G.Ramaiah)
SE/CON/Engg/MLG

(R.K.Sahu)
AEN/CON/P.Way/MLG

(Rajesh Kumar)
BEE/CON/MLG

(Rajesh Kumar)
DY.CTE/CON/MLG/NJWL/MLG

(R.K.Aloria)
CBE/CON/NJWL

		Maxwell New Delhi
		Oriental Power cable
		Peekay Industries
		Lab corrd, New Delh
		Insucon cables & cond.
		Midland Electrical Pvt. Ltd.
		Bharat Cab plants of Vardhman cables
		Anchor, RR KABEL, LEADER, UNISTAR, Plazm, Paya', Richa,Silver,Prime Cab,Anchor,Finolex
3	Metal Box(enclosure for accessories)	L&T HAVELLS, C&S,Legrand, BCH Anchor, GM,MDS, CUNA,
		INDOASIAN, TOYOMA
		Standard, , PADAM, STD GOLD
4(i)	Electrical Accessories for wiring (ISI Marked)	Roger, Legrand, Havells HPL, CMS, ABB, Honsel
		Cona, Anchor, Ryder
		Sisk (topLine)
		Precision (Prime)
		Vinay (Clair30)
		Leader
		Flora, GM
4(i)	Electrical Accessories for wiring (Modular switches & Sockets) (ISI Marked)	LEGRAND,Finger, MK Electric ,Havell's - Crab Tree
		Anchor, Roma Woods ,Indo Asian-Fuseman,
		GM, KARU, LEADER, , TOYOMA
		Geco, Finesse, Richa
		OSRAM,BENTEC
5	Phenolic Laminated Sheets (ISI Marked)	Inkclive HylumLtd. Calcutta Formica India Ltd. Mohe Khan New Delhi, Super Hylan, Pvt Ltd. New Delhi, Surendra corporation Pvt. Ltd. Bhopal
6	Industrial Type Pin Tod Socket	L&T
		Siemens
		Control & Switchgear
		GE
		BCH,
		Crompton
		Havell's
		Standard Electronics
		HPL India Ltd
		OSRAM,BENTLY,SHIP,STD GOLD

(S.Nagaraj) SE/CON/TIRUVLR	(T.Jothi) AEE/CON/TIRUVLR	(S.Ganesh) EE/CON/MTU	(Mary Shylaja) DY.CEE/CO-ORD/CHENNAI

(K.N.Murthy) CEE/CON/CHE

7	i) MCB ii) RCBO iii) RCCB	Legrand Crompton L&T Control & Switchgear Hager ,Siemens Schneider ABB GEC Merlin BCH, Havells Standard Electricals Merlin Gerin Anchor MDS Indo Asian HPL India Iyoti Andrew Yule ,GEC,RIC IA
8	Call Bell	Anchor Cona. CN MAX Leader SSK, KOLORS
9	MCB Distribution Boards	Schneider, Legrand LEGRAND Control & Switchgears L&T Crompton Siemens GE Havells ,Standard HPL India Indo Asian, GMS GM ,APEL, ELEKTROKINGS, , KTKumar, STD Gold,
10	Electronic Regulator (ISI Marked)	Anchor Usha ERK, KIDER, ANSU TGL, UCL, GM Jay Engg. Mitchwel Elect Rama

[S.Chatterjee] SE/CON/NPRTI/MLG	[A.Das] AEE/CON/NPRTI/MLG	[R.C.Das] EE/CON/MLG	[Ravi Bhushan] DY.CHE/CON/NPRTI/MLG

[R.K.Mehta] CHE/CON/NPRTI

		Cona
		Plaza,
		Alstom,STD Gold, JILCO
11	Ceiling Fan/Air Circulating Fan (ISI Marked)	Khaitan
		Crompton
		Usha
		Orient
		Bajaj
		Havells
		Kepic e
		Polar
		GEC
		Almonard
		Philips
		Anchor
		ORTEM,JILCO, Orbem, Cona, Maya, Polar
12(i)	Exhaust Fan (ISI Marked)	Crompton
		GEC
		Almonard
		Usha,HAVELLS
		Bajaj
		Khaitan
		Polar
		Orient
		Philips
		ORTEM,ALSTOM
12(ii)	Exhaust Fan/Fresh Air fan with fibre body	Crompton
		GEC
		Usha ,HAVELLS
		Bajaj
		Khaitan
		Polar
		Orient
		ORTEM,ALSTOM
13	AC Units(Window & Split type),Cassette AC, Tower AC, Packaged AC, Battery Operated AC	VOLTAS
		Carrier, Voltem Lloyd
		Blue Star
		Ambrox Appliances
		Sidwal Refrigeration
		LG
		Toshiba
		Samsung, Hitachi
		Godrej, Panasonic
		Arcor, TROMYCOM

(K.Nafeery) MM/CON/HQ/MLG	(S.Das) AEE/CON/HQ/MLG	(S.C.Jas) EE/CON/MLG	(Ravi Bhushan) DY.CEE/CON/HQ/MLG

(K.K.Arora) CEE/CON/NFR

		Frick India Ltd.
		Shri Ram
		Unidir
		Videocon
		Daikin, Carrier
14	Water Cooler s/S Body	Voltas
		BlueStar
		Sidwal Refrigeration
		USHA, Bajaj
		Thermo Lloyd
		Kelvinator
		Sankrain, Eureka Forbes
15	Auto Voltage Corrector	As recommended by the OEM of AC Unit/Water Cooler
16	Geyser	Racold
		Bajaj Electricals
		Crompton, LG
		Venus, Godrej
		Johnson, SAMSUNG
		Superhot
		USHA
		SPHEREHOT, Havells.
		Jaco, Akshi, Pearl, Modi it
17(I)	Power Distribution Transformer (Oil type)	ARI VA T & D Ltd.,
		Kirloskar Electric Co. Ltd.,
		Bharat Heavy Electricals Ltd.,
		ABB
		ECE Industries
		CromptonGreaves
		Andrew Yule and Co.,
		Siemens
		Kanohar Electricals Ltd., Meerut, (UP)
		NGEF
		Bharat Bijlee Ltd., New Delhi
		Mirzapur Electrical Industries Ltd., Mirzapur,(U. P)
		Voltas
		Vet Amo.,
		Kerala Electric and Allied Engg. Co. Ltd.,
		Power Makes, Marsun, Standex, Basant, Calcutta
		Rama Krishna Transformers, Hyderabad
		Radhika Electricals
		Tesla, SHAKTI

(S.Chatterjee) SR.MANAGER/MM/WLG	(R.K.Dasgupta) AGM/CONSTRUCTION/WLG	(P.K.Das) CHIEF MANAGER/CONSTRUCTION/WLG	(Nawal Kishore) DY.GENERAL MANAGER/CONSTRUCTION/WLG

(P.K.Adhikari) CHIEF MANAGER/CONSTRUCTION/WLG

		GEC TTTK Hart Transformers EMCO Mahindra Transformers Ghaziabad. VijayElectricals Indo Tech. Transformers Ltd., PN Engg. Power Master Electricals, Kolkata Automatic Electrocast, Kolkata Alfa Transformers, Bhubaneshwar Orissa Transformers, Pvt. Ltd., Bhubaneshwar United Machinery Corporation, Kolkata, Star Delta Transformers Pvt. Ltd. Bhopal. Trag (Upto 11KV/500 KVA, Fastran, Tencent (up to 2500KVA, 11/0.4 KV). Power Master
17(ii)	Power Distribution Transformer (Dry type)	Alstom, Schneider, KEC, ABB, CRS,BHEL,CGL,VOLTAMP
18	11kV Vacuum Circuit Breaker Panel	AKTVA T&D India Pvt., ABB, BHEL Schneider electric India Crompton Siemens India L&T Alstom GE Industries Andrew Yule Vatech Jyoti GEC GCH Kirloskar, Damodar Yamuna Power
19	HT 11kV and 33 kV XLPE(E Cable (ISI Marked)	KEI, Havells, Polycab, Finolex , Cable Corporation of India Fort Gloster Industries Ltd., Nicco Nicco Corporation Ltd., Industrial Cable India Ltd., Universal Cable Co. Asian Cables Torrent, Paramount, Sriram, Delton Incab Industries Oriental Power cable

(G.Nallaiyal) SSE/CON/ Hq/MLG	(T.Das) AEE/CON/T.JAI/G	(R.C.Das) EEE/CON/MLG	(Ravi Kishore) DY.CEE/CON/Hq/MLG

(R.L.Yadav) CEE/CON/ER

		Central cables Ltd.
		Indian cable
		Orient power Cables.
		Premier Cables.
		Shanlie Industries, Prime Cab
		Flexo, Krishna (upto 11 KV), Hindustan Vidyut (upto 11 KV)
20(i)	HT protection Relays (Over current, Earth) Earth and other protective relays for transformers & Panels (Introduction/ Static/ Numerical type)	AREVA T & D India Ltd
		L&T
		ABB
		Easun Rey Rolle
		Alind
		BHEL
		Jyoti
		GE
		MCP
		Minilec
		Siemens
20(ii)	LT Protection Relays	AREVA T&D India Ltd.
		L&T
		ABB
		Easun Rey Rolle
		Alind
		BHEL
		Jyoti
		GE
		Schneider
		BCH
		Enercon
		VXL
		Minilec, Inco Asian
21	D.G. Set	**Engine :**
		Kirloskar
		Cummins
		Jakson
		Greaves Ltd.
		Caterpillar
		Perkins Volvo
		Ashok Leyland
		Perkins
		Alternator :
		Kirloskar Electric Co. Hubli Jyoti
		Jyoti
		Stamford
		Kenalo
		Leroy Somer
		Kirloskar Green Crompton

(G.Nallaiyal) SM/CON/HQ/MLG	(P.Das) AM/CON/HQ/MLG	(S.C.Das) DGM/CON/MLG	(Ravi Prashant) DY.GM/CON/HQ/MLG

(K.Alaiyal) GM/CON/HQ/MLG

22	Cable Jointing/ Terminating Kit for 11 kV to 33 kV (3 cores)	Raychem RPG Ltd.,
		Yamuna Gases and Chemicals Ltd., New Delhi, Denson
		Raychem RPG Ltd., New Delhi
		DENSON Yamuna
		MS seal
		Sterlite Tic
		Safe Systems
		Mahindra Engg.& Chemical Product, New Delhi
		RCPL
		Elart Consolidated Pvt. Ltd., New Delhi, Compart International
		Super Seal Brand
		XICON
23(i)	Measuring & Recording Instruments (Electrical)	L&T
		AREVA
		Rishab,
		Motwani
		AutoElectric
		Toshniwal
		Siemens
		Meco Instruments
		NationalInstruments
		Sivananda Electronics
		IMP
		CIE
		Electric & Electronic devices.
		IMP
		IndustrialMotors
		Shark
		Moeller(L&T), Schneider
		Havells, V-AutomatLAE
23(ii)	Electric Energy Meter	L&T, Havell's
		ABB
		HPL(Electronic)
		Secure Meters
		Jaipur Metal Works
		Baroda Electric Meters
		Capital Power System
		ECE
		AREVA

(G.Lenora) SE(CON/Design/HQ	(P.Paul) AEE/CON/D/HQ	(S.Sahoo) EE/CON/D/HQ	(Hem Shukla) DY.CE/CON/COMM/G/HQ

(R.L.Arora) CE/CON/ANTS

		Meters & Instruments Industrial Meters Anchor Indo Asian Max Well IMP VXL India Ltd. Enermon, BENKO RICHA, Art Tech, Belkam
24	L.T. X.P.E. armoured Aluminium Conductor Cable (ISI Marked)	KEI Havells Finolex Polycab CCI NICCO Universal Cable Asian Cables Orient Power Cables India Cables KEC Incab Premier cables Ltd. Sterlite Industries Central Cables Ltd Sub Cab SDCI Finolex Bharat Cab Board of Vardhaman cables Vishal brand cable of Dash mesh cables, Paramount Communications Ltd, Sriram Cables Pvt. Ltd., Dolton cables Ltd, PRIMECAB SOLAR, RICHA, Plaza,
25(I)	APFC Panel	L&T Siemens ABB Schneider
25(II)	Capacitor	Indo Asian, Neptune Siemens ABB L&T BHEL Indian Capacitors EPCOS Khatau Junker Hind Rectifier HIRECT,

(C.Nataraj) ASP/CO/CONMLG	(S.Sasi) AD2/CO/CONMLG	(K.Sasi) dd2/CO/CONMLG	(Govindhsharan) DY.CHE/CO/CONMLG

(R.A.Aditya) CHE/CO/CONMLG

		SIEMENS Usha W.S. Insulators Shreem Voltas Surender Indian Condensors Havells Universal Cables, Nocturo, Jmaster
26	ACB & ACB Bus Coupler	Siemens ABB GEC (AREVA) ALSTOM L&T Crompton Jyoti English Electric Control & Switch Gear Schneider Electric India BCH Mysore Electric Industries BHEL Havells, Elecon NGEF Legrand Standard Kirloskar Power Boss N.N.Pharma Minda JSL Industries Ltd., New Delhi Andrew Yule, Indo Asian
27	MCCB	Siemens Control & Switch Gear ALSTOM L&T Crompton Jyoti Mysore Electric Industries GEC/ALSTOM Schneider Electric India BHEL ABB BCH Legrand HAVELLS Standard Minda Genin JSL Industries Ltd., New Delhi Indo Asian

(P.K.Nandan) GM/CC/HQ/NTPC/NOIDA	(S.K.Goel) AED/CC/HQ/NTPC/NOIDA	(S.K.Soni) GED/CC/HQ/NTPC	(Rajeev Bhushan) DGM/CC/HQ/NTPC/NOIDA

(D.K.Mukherjee)
CEE/CC/HQ/NTPC/NOIDA

		HPL/UCHA/SHP
28	Time switch(timer) Solid State	L&T Legrand C&S General Industrial Control Pvt. Ltd. MDS Havells Dyoti Bilti BCH GE ADH, InduAsian Siemens Minilec
29	Fuse Switch Unit, Switch Fuse Unit, Change Over Switch, HRC fuses, Cut Out	L&T Siemens Control & Switchgears Havells GE Schneider Electric ABB Legrand Crompton Jyoti Mysore Electric HPI Standard BCH Indo Asian Kenner GET (Areva) Indo Asian NGEF Andrew Yule Minilec Merlin Gerin
30	Cable Jointing/ Terminating Kit for LT cables	Sutech, Shub Raychem RPG Ltd , New Delhi DENSON Yamuna Polychem Engg.& Chemicals Products, New Delhi MS-Asia Hari Consolidated Pvt. Ltd., New Delhi Yaswant Industrial Works(P) Ltd Make: Super Seal
31	Current Transformers	L&T C&S

(D.Nichlani), SE/CON/HQ/WLG	(B.S.Rana) AEE/CON/HQ/WLG	(P.K.Das) SE/CON/WLG	(Ravi Bhushan), DY.CHF/CON/HQ/WLG

(S.K.Aleriya), CHF/CON/HQ

		Schneider
		AE
		MECO
		Siemens
		CGL
		Kappel,Riselli
		Havell's
		ISL Ind. Secure
		Alstom, Volta, Bentor Electricals,INTEC
32	Ferrules, Thimbles, Lugs	Dowells
		JAINSON
		Usha Martin
		Universal Machines
		Kemtosh Industries
		KSE Electrical
		JML Engg Ashok
		Bajaj
		Crompton
		GE
		Osram
		Ankita G.I. Metal Works
		Surya
		Sylvania
		Wipro
		Venture
		Bhagat, Multi, Multitec
33	High Mast Lighting Tower	Philips
		Bajaj
		Crompton
		Garware Electric, Valmont
		BPP
		L&T,KARSH
		Solar
		Nayone
34	Tubular Pole	BMW, Shiv steel Industries, North Eastern Tubin, J.K. Industries, Solar, Nayone and any other Reputed make with the approval of the Railway
35	GI Pipe (ISI Marked)	TATA
		Jindal
		Utkarsh
		PRAKASH-SURYA
		TT Swastik
		Hindustan, Aarti, Nayone
36	LT & HT Insulators	Jaya Shree Insulators
		BHEL,
		Bengal Potteries Ltd.
		W.S.Insulators
		Seshasayee Industries Ltd.

(Submitted) SSE/C&W/Engg/MLG	(Examined) AEN/C&W/Engg/MLG	(Checked) DY.CE/C&W/MLG	(Approved) 21/5/16 DY.CE(TC)/C&W/HQ/MLG

(Approved)
DY.CE/C&W/NTF

		Venkateshwara Ceramics
		Odium, Hipro, Kappa, Compact International
		Mahaloxin, RASTRIYA
		RRE,RM
37	ACSR Conductor (ISI Marked)	NICAB, Hemant, Fort Gloster, Hindustan Vidyut, Krishna, Lumino, Vinesh and any other Reputed make with the approval of the Railway
38	RCC Hume/HDPE Pipe/ DWC Pipe/CI Pipe	HDPE : Swastik, Ajanplus,JAIN CI Pipe: Kesoram Sons, Electrosteel Casting and any other Reputed make with the approval of the Railway
39	Battery Charger for Train Lighting	Sigmatron
		Intag
		Rectronsha
		Pyramid
		Automatic Elec.Inc.
		Delta Electric
		Universal Industrial products
		Trinity Electric
		Venus Engg
		R.S. Power
		Engineering Service Equipment centre
		NAYAR, NIPUN, Sehgal, Vetta, John Rectifier, Hind Rectifier, Suresh Electricals, Power Plus
40	i) H.S. Pump	Kirloskar
		KSB
		WATERMAN
		Worthington Pumps India Pvt. Ltd., Ghaziabad
		Beacon Weir Ltd., Chennai
		Mather & Platt Ltd., Pune
		Jyoti Ltd., New Delhi
		Mather Pumps India Ltd., Gurgaon Essmi Pumps
		Geeta Flow Pumps India Pvt. Ltd.
		Sulzer
		CCL, SHAKTI
	ii) Control Panel for Pump	Original as supplied with pump by OEM
41	i) Submersible Pump	KSB Pumps Ltd. Calama

(V.Nadhamuny) SSE/CON/Drg/Vn.G | (S.Kumar) ATT/CON/T/Vn.G | (B.Singh) FA/CON/Vn.G | (Ram Bhawan) Dy.CEE/CON/HQ/Vn.G

(R.A.Akhtar) CFA/CON/Vn.G

		Kirloskar
		India Electrical & Engg. Co. Ahemdabad
		Tyco Elec., New Delhi
		Crompton
		Waaaman
		TEXMO
		Lixo Hydraulics
		Shroff Engg.
		KK Pumps
		SB Pumps
		Flow Tech
		Sucuna
		Micky Industries(IC) Pvt. Ltd., New Delhi
		SAGH
	ii) Control Panel	Original as supplied with pump by OEM
42	11 kV Air break Gang operating Switch with Drop Out fuse 200A & 400A	ABB
		AEIMD
		Crompton Greaves
		Jyoti
		Mysore Electric
		Siemens
		RM, Vivekananda
		TimesElectricals
		Power Gears Pvt. Ltd., Hyderabad
		NGEF, BHEL, Elpro
		S&S Power Switch Gears Ltd.
		Kirloskar
		Alfanar Engg. Pvt. Ltd.
		ICE Industries
43	33 kV Air break Gang Operating Switch with Drop Out Fuse 200A to 1250A	DCH Industries
		ABB
		RM, VIVEKANANDA
		S&S Power Switch Gears Ltd.
		Alfanar Engg. Pvt. Ltd.
		H.M. Alpha
44	Rotary Switch & Selector Switch	Power Gears Pvt. Ltd., Hyderabad
		Kay Dee
		L&T
		Slazer
		GE
		Alfa

(C.Nataraj) SSE/CONST/BGM/IG | (D.Ravi) ADE/CONST/TVLG | (S.C.Das) EE/CONST/MTC | (Ravi Shankar) FA/CEE/CONST/CHN/IG

(N.N.Mohapatra) CEE/CONST/MTC

		C&S Siemens HPL
45	Connectors	Mentor, BCH, Tekno, Schneider, ABB L&T Jyoti GEC C & S Siemens Cromption MEL, Indo Asian NCEF Legrand BCH Schneider BHEL Mentor Enercon Andrew Yule MK Mentor Power Base Standard Mysore Electric
46	L.T. Panel	Firms having ISO:9001 certification & testing facilities as works as per IS:8623 Schneider, ABB, Siemens, L&T, BCH, Indo Asian
47	Solar lighting system for Crossing Gate	APSL, Electrokings TATA BP, BCL, TITAN, SSPL, ANDROMEDA, SUNWATT, JAIN SOLAR SYSTEM, CIRA, Nano Bright, Philips, MNR- approved sources with prior approval of Railway
48	Remote Energy Monitoring, Control and Data Acquisition System of Power, AMRs	AMI, Analogic, L&T, Vision Tech
49	Elevator, Escalator, Travelator and lifts (New Item)	Thyssen Krupp, Johnson, Schindler, OTIS, ONIDA, Kone, Kirloskr
50(i)	LED	Cree, Osram, Lumileds, Philips, Nichia, Cree/Seoul, GE
(ii)	LED Luminaire	Philips, Bajaj, HPL, Syska, Solar, Crompton, GE, Surya, Wipro, Jaquar, Comtelk
51	Solar Water Heater	Tata BP Solar, Racold Thermo Ltd., Kotak Urja, Accurate, Jain Irrigation or other

(G.Narang)
SSE/TRD/N/Dig/WLG

(Rahul Gad)
ABE/CON/P.Way/WLG

(Rajesh)
AEE/CON/WLG

(Rahul Gahlot)
DY.CBE/CON/HQ/WLG

(R.K.Mallya)
CAO/CON/WLG

		MNRE approved sources with prior approval of Railway
52	GI Octagonal Poles	PHILIPS, BAJAJ, SURYA, Solar, Nozone and other reputed makes with prior approval of Railway
53	Battery for solar systems	EXIDE , TATA BP, PANASONIC, AMARRAJA, HITACHI
54	Street light controller and their management	BAJAJ, PHILIPS, Schneider ,CROMPTON GREAVES, HAVELLS,
55	Air Curtains	CROMPTON GREAVES, HAVELLS, POLAR
56	Cable Fault Locator	APLAB Thane, MRPC Hyderabad, ELTEL ROCON SYSTEM Bangalore, AISHWARYA TELECOM LTD., METRAVI
57	Cable Route Tracer	APLAB Thane, MRPC,Hyderabad.,ELECTROCON,SYSTEM,Bangalore ,AISHWARYA,TELECOM,LTD
58	Digital Megger	MOTWANI, KUSUM, MECO, METRAVI, MEGGER RISHAB, MEGGER
59	Digital Earth Tester Megger	MOTWANI , KUSUM, MECO, METRAVI, RISHAB, MEGGER
60	Cable Tray(GI)	Firms having ISO 9001 certification & testing facilities in works, Legrand, Cablofil, Bharat, Unitech, Steelways, MEM
61	Lamp	Philips, Bajaj, Osram, Crompton Greaves, Wipro,Sylvania,Surya,Venture, Myna
62	Luminaires/Fittings (FL, CFL, HPSV, Metal Halide, Mirror Optic fittings etc.)	Philips, Bajaj, Surya, Havells, Crompton Greaves, Anchor ,Havells,Surya, Myna,Ricna,JETC, Solar, KI Kumar, ENKAY, ANSU
63	Ballast (Electronic / Copper)	Philips, Bajaj, Kukreja, Sundeep, KI Kumar , Linsey, HPCO (Electronic), Shubh (Electronic), Avian (Electronic), Pocain (Conventional), Bentec (Electronic), Atos (Electronic), Ansu-HGL (Conventional), Sigma, Myna (Electronic), Ricna, JETC, Solar, ANSU
64	UPS, SERVO Line Voltage Corrector	Kirloskar, Volta, Powerware, Hitu, Seltgal, Dubas, Inmg, Tata Libert, Numeric, APC, Siemens, Piller, Schneider, , GE, Aros-PCI,NAYAR NIPUN,
65	Lightning arrestor	Obcm, Raychem, Elpro, Joyshree, Lemco, RRI, OBI

(S.Hariharan) SSE/CON/Drg/M.G	(B.Das) AEN/CON/HP/Dy.CE	(K.C.Bisi) DY/CON/HQ/LP	(Roy Bhushan) CE/CON/HQ/MG

(R.Mohanty) SSE/CON/Drg/HP

66	Inverter	Luha, Volta, Sengal, Dubas, Intex, Microtek, Sukam, RUN IDC, NAYAR NPUN, IECT
67	[illegible]	Alstom, C&S, Siemens, Denzel Electrical, Intec,ARHVA
68	Oil Circuit Breaker	Siemens, L&T, Alstom, Kirloskar Electric, Schneider Electric, MEI
69	Motor Starter	Havells, L&T, Siemens, Schneider Electric, C&S,BCH, Crompton
70	Bus-Bar	Schneider, Siemens, Indo Asian, GECO, Havells, L & T , C & S
71	ARC Welding Transformer	Kukreja,Indara
72	Welding Cable	Kukreja
73	UPS Battery	Exide, Panasonic, Amararaja, HBL, NIFE
74	Variable refrigerant volume of flow units	Blue star, Daikin, Mitsubishi, York, Hitachi
75	Sluice valve	Kirloskar, Leader
76	Gunmetal/ Stainless steel valve (Full way & Check	
	a) Class I	Zoloto, Leader
	b) Class II	Leader, Sant
77	Non Return valve	Kirloskar, Leader
78	Heat pipe (RKL type)	Jayashree, Nowaco, CRC, Jyoti, Narain, Kirloskar,
79	Branch pipe with nozzle	Minimax, Safex, Zenith Newage, Safeguard, Minimax
80	Foot valve with strainer	Kirloskar, Leader, Zoloto, Sankar
81	Cast iron Non-return double flanged	Kirloskar, Leader, Kalpana
82	Portable Fire Extinguisher	Minimax, Nirin, Safex, Zenith, Safeguard, CEASEFIRE
83	Welding Electrode	Advani Oerlikon, L & T
84	Indicating lamp and push buttons	L & T, BCH, Vaishno, Siemens, Teknik, Raas, Schneider

NOTE:

1. If any item/equipment is not included in the above list, good quality material/equipment shall be procured in accordance Railway policy as stipulated.
2. If any work requires coordination and acceptance of other department of Centre/State Government, the contractor shall follow approved vendor list and standards, specifications of that department and take their approval before procuring the material/equipment.

(G.Narayan) SE/CON/Dn/MLG	(Ashish) ACE/CON/T/MLG	(Sridhar) CE/CON/MLG	(Ravi Bhushan) Dy.CEE/CON/ IG/MLG

(Abhiyal) CET/CON/Hdqrs