भारत सरकार

GOVERNMENT OF INDIA

केन्द्रीय लोक निर्माण विभाग

CENTRAL PUBLIC WORKS DEPARTMENT

विद्युत कार्यों के लिए सामान्य विनिर्देश

भाग II - बाहरी

GENERAL SPECIFICATIONS FOR ELECTRICAL WORKS

PART II - EXTERNAL

1994

निर्माण महानिदेशक, के. लो. नि. वि., नई दिल्ली के प्राधिकार से प्रकाशित

PUBLISHED UNDER THE AUTHORITY OF DIRECTOR GENERAL OF WORKS, C.P.W.D., NEW DELHI

सत्यमेव जयते

K. K. MADAN

निर्माण महानिदेशक
DIRECTOR GENERAL OF WORKS
केन्द्रीय लोक निर्माण विभाग
CENTRAL PUBLIC WORKS DEPARTMENT
निर्माण भवन
NIRMAN BHAWAN

नई दिल्ली-110011
New Delhi-110011

28th Dec., 1994
the

FOREWORD

I am happy that the CPWD has brought out this revised edition of the General Specifications for Electrical Works (Part II-External), 1994. The last revision of these Specifications was done in 1974. The country has advanced substantially in the field of electrical technology in the intervening period, and these technological changes and improvements are reflected in this revised edition. I am sure that this edition would be very useful not only to the engineers of the CPWD, but also to other Government Departments and Undertakings who follow the CPWD Specifications for their works.

I acknowledge the hard work put in by members of the Drafting Committee under the able guidance of Shri N. Krishnamoorthi, Chief Engineer(E) I for bringing out these Specifications.

Sd/-
(K.K. Madan)
Director General of Works,
CPWD, New Delhi-110011.

New Delhi,
Dated: 28/12/94

Members of the Specifications Committee (Electrical)

S/Shri

1. N. Krishnamoorthi, Chief Engineer(E) I ... Chairman
2. M. K. Mathur, Chief Engineer(E) II ..... Member
3. Chief Tech. Examiner(CVC) ..... Member
4. M. B. Saxena, Chief Architect I ..... Member
5. S. R. Subramanian, SSW(E) II ..... Member
6. Mohan Swarup, SSW(E) (SWZ),Bombay ..... Member
7. Asim Sinha, SSW(E) (EZ), Calcutta ..... Member
8. Jose Kurien, SE(D), CDO ..... Member
9. J. K. Choudhury, SSW(E) I ..... Member Secretary

Those involved in the drafting of the Specifications

S/Shri

1. T. S. Varadarajan, Chief Engineer(E) (East)
2. J. M. Raj, Superintending Engineer(E)(Coord.),Madras
3. J. K. Choudhury, SSW(E) I
4. J. N. Ram, Surveyor of Works(E)I
5. A. K. Bhatnagar, Assistant Surveyor of Works(E)
6. P.R.S. Nair, Assistant Engineer(E)

PREFACE

The General Specifications for Electrical works in Central Govt. Buildings were first issued in 1949. In 1956, the Indian Electricity Rules were amended and the General Specifications for Electrical Works in Central Govt. Buildings were revised in 1960. General Specification 1960 included 8 sections on Internal Electrification and 2 section on External Specification. The sections on Internal Specification alone were upto date and issued as General Specifications for Electrical Works (Part I-Internal),1972 for adoption with effect from 1.9.73. The section on External Electrification viz. UG Cables and overhead lines were revised and issued as Part II of the General Specification in 1974.

2. Since the issue of the above General Specification in 1974, various amendments have been issued concerning cable and overhead line work. The section on UG cable and overhead line work have now been revised brining them upto date and have been made more exhaustive. The scope has been widened to include cable tray, heat shrinkable joints, XLPE cable joints and over head line works upto the voltage of the 33 KV. Charts for short circuit rating of various cables as well as length of the cable for 8 volt drops with various load have been added. A chapter on street light and feeder pillar has also been included. These revised sections on External Electrification are now being issued as General Specifications(Part II-External),1994.

3. It is appreciated that a uniform standard cannot be rigidly adhered to for all variety of installations in different localities, but it is hoped that these General Specifications would provide a general basis, and specific variations required to suit local conditions can be catered for specific works by the Superintending Engineers concerned. Care should, however, be taken, as far as possible, not to over-ride the basic provisions of these General Specifications for Electrical Works, 1994.

4. I am extremely thankful to Central Translation Bureau for their untiring effort for translating these specifications in Hindi.

5. Errors or omissions, and suggestions for improvement, if any, may kindly be brought to the notice of the Suptdg. Surveyor of Works (E)I, Office of the Chief Engineer(E)I, C.P.W.D., New Delhi - 110001 (Telephone No. 3314982).

Sd/-
N. KRISHNAMOORTHI
Chief Engineer(E) I, CPWD,
Vidyut Bhawan, New Delhi-110001
(Tel no. 3314046)

New Delhi,
Dated:26/12/94

CONTENTS

LIST OF TABLES

LIST OF APPENDICES

Appendix	Clause	Heading
A	1.3	Terminology
B	1.21.1	List of IE Rules relevant for UG cable/overhead line works.
C	1.21.2 &1.21.3	Important Indian Standards
D	1.24 &1.26.1	Completion Certificate.
E	1.28	Maintenance requirements.
F	2.7.8	Jointing of power cable.
G	3.2.3.1(iii)	Selection of stay sets.

LIST OF FIGURES

REFERENCE TO AMENDMENTS

Sl.No.	Reference under which issued	Clause No.	Page

Sl.No.	Reference under which issued	Clause No.	Page

CHAPTER 1

GENERAL

1.1 SCOPE

(i) These General Specifications indicate the requirements and precautions to be taken during the execution of Electrical Installation works involving power cables and/or overhead lines, to ensure efficient, safe, economical and practical use of materials and equipments including prevention of risks and fire hazards.

(ii) These General Specifications are subject to revision from time to time.

(iii) This Chapter covers the general requirements applicable to works contracts for such External Electrical Installation works.

1.2 RELATED DOCUMENTS.

Each work has its own particular requirements. Therefore, in addition to the General Specifications, governing ISS, I.E. Rules, Standard Contract Conditions etc. there would be necessity of Additional conditions/ Specifications for a particular work. In case of any discrepancy such additional conditions/ specifications will override these General Specifications.

1.3 TERMINOLOGY

The definition of terms shall be in accordance with relevant Indian Standards. Some of the commonly used terms are indicated in Appendix A..

1.4 SUBMISSION OF TENDERS

1.4.1 The tender shall be submitted complete with the following:-

(i) Complete tender documents as purchased from CPWD duly filled in and signed. The price part of the tender shall be indicated only on the tender schedule of work.

(ii) Earnest Money deposit in one of the specified forms.

(iii) Any other supplementary details required for the evaluation of the tenders such as drawings, technical literature/ catalogues, data etc.

(iv) Deviations, if any, from tender specifications and/or tender conditions, with reasons thereof. It is open to the Department whether or not to accept them.

1.4.2 Where two part tendering system is proposed to be adopted in any particular work, the procedure for submission and opening of tenders shall be indicated in tender documents for that work.

1.5 RATES

1.5.1 The work shall be treated as on works contract basis and the rates tendered shall be for complete items of work (except the materials, if any, stipulated for supply by the department) inclusive of all taxes

(including works contract tax, if any), duties, and levies etc. and all charges for items contingent to the work, such as, packing, forwarding, insurance, freight and delivery at site for the materials to be supplied by the contractor, watch and ward of all materials (including those, if any, supplied by the department) for the work at site etc.

1.5.2 Prices quoted shall be firm. Price adjustments shall however be governed by Clause 10C/10CC of the Conditions of Contract given in form CPWD 7or8 of the tender documents, for works executed under these forms. All relevant documents shall be produced by the contractor to the Engineer-in-charge, whenever called upon by him to do so, for working out such adjustments in rates.

1.6 TAXES AND DUTIES

1.6.1 Being an indivisible works contract, Sales Tax, Excise Duty etc. are not payable separately.

1.6.2 The works contract tax shall be deducted from the bills of the contractor as applicable in the State in which the work is carried out, at the time of payments.

1.6.3 Octroi shall not be paid separately for the materials supplied by the contractor, but octroi exemption certificate can be furnished by the Department, on demand. However, the Department is not liable to reimburse the octroi duty in case such exemption certificates are not honoured by the concerned authorities.

1.7 MOBILISATION ADVANCE

No mobilisation advance shall be paid for the work, unless otherwise stipulated in tender papers for any individual works.

1.8 COMPLETENESS OF TENDER

All sundry fittings, assemblies, accessories, hardware items, foundation bolts,termination lugs for electrical connections as required, and all other sundry items which are useful and necessary for proper assembly and efficient working of the various components of the work shall be deemed to have been included in the tender, whether such items are specifically mentioned in the tender documents or not.

1.9 WORKS TO BE ARRANGED BY THE DEPARTMENT

Unless and otherwise specified in the tender documents, the following works shall be arranged by the Department:

i) Covered storage Space for accommodation of all the equipments, components and materials involved in the work, till they are installed and commissioned.

ii) Power supply as per 1.12.

iii) Masonary ducts within and outside the buildings for the cables.

1.10 WORKS TO BE DONE BY THE CONTRACTOR

Unless and otherwise mentioned in the tender documents, the following works shall be done by the contractor, and therefore their cost shall be deemed to be included in their tendered cost:-

1) Foundation and brackets and components wherever required, including foundation bolts.

2) Suspenders and brackets for suspending/supporting cables, as required.

3) Suspenders for cable trays for laying the cables, where required.

4) Excavation and refilling of trenches in soil wherever the pipes/ cables are to be laid directly in ground, including necessary base treatment and supports for pipes as specified.

5) Sealing of all opening provided by the Department for pipes and cables, from fire safety point of view, after laying of the same.

6) Painting of all exposed metal surfaces of equipments and components with appropriate colour.

7) Making good all damages caused to the structure during installation and restoring the same to their original finish.

8) Testing and commissioning of the completed installation.

1.11 STORAGE AND CUSTODY OF MATERIALS

Suitable and lockable storage accommodation shall be provided by the Department free of cost to the contractor. However, the watch and ward of the stores and their safe custody shall be his responsibility till the final taking over of the installation by the Department.

1.12 ELECTRIC POWER SUPPLY

1.12.1 The power supply to the required extent for the erection, testing and commissioning of the installation shall be made available free of charge to the contractor within 25 M of the site of actual consumption at one or more places as required. Further power distribution to the various locations shall be done by the contractor at his own cost.

1.12.2 The contractor shall not misuse the power supply for any purpose other than which it is intended for. The power supply shall be forthwith disconnected in case of such a default and the contractor shall then have to arrange for the required power supply at his cost.

1.13 MACHINERY FOR ERECTION

All tools and tackles required for unloading of equipments and erection at site shall be the responsibility of the contractor.

1.14 PAYMENT TERMS

1.14.1 Unless otherwise specified in the additional conditions of the contact, the payment shall be made as per the relevant clauses of form PWD 7/8 forming a part of the tender documents.

1.14.2 Security deposit shall be deducted from each running bill and the final bill to the extent of 10% of the gross amount payable subject to the maximum limit specified. The earnest money deposit shall be adjusted against this security deposit. The security deposit shall be released on the expiry of guarantee/ maintenance period stipulated in the contract. However, the contractor can furnish a bank guarantee in the specified format from a schedule bank for the full value of the security deposit, in which event no recovery shall be made towards security deposit from his bills. The bank guarantee shall be kept valid till the expiry of the above guarantee/maintenance period.

1.15 COORDINATION WITH OTHER AGENCIES

The contractor shall coordinate with all other agencies involved in the site of work so that the works of other agencies are not hampered due to delay in his work, security or other reasons.

1.16 CARE OF BUILDINGS

1.16.1 Care shall be taken by the contractor to avoid damage to the building during execution of his part of the work. He shall be responsible for repairing all damages and restoring the same to their original finish at his cost. He shall also remove at his cost all unwanted and waste materials arising out of his work from the site.

1.16.2 As far as possible, cutting of roads, lawns etc. should be avoided. Where it becomes inescapable to cut them, these shall be repaired immediately. [See also clause 2.6.7.4].

1.17 STRUCTURAL ALTERATIONS TO BUILDINGS

1.17.1 No structural member in the building shall be damaged/altered, without prior approval from the competent authority through the Engineer-in-charge.

1.17.2 Structural provisions like openings, pipes, if any, provided by the department for the work, shall be used. Where these require modifications, such contingent works shall be carried out by the contractor, at his cost.

1.17.3 All cut out openings in floors provided by the Department shall be closed, after installing the cables, in accordance with the item therefor in the Schedule of work.

1.17.4 All cuttings made by the contractor in connection with the works shall be filled by him at his cost to the original finish.

1.18 ADDITION TO AN INSTALLATION

An addition, temporary or permanent, shall not be made to the authorised load of an existing installation until it has been definitely ascertained that the current carrying capacity and the condition of the existing accessories, conductors, switches etc. affected, including those of the Supply Authorities are adequate for the increased load.

1.19 WORK IN OCCUPIED BUILDINGS

1.19.1 When work is executed in occupied buildings, there should be minimum inconvenience to the occupants. The work shall be programmed in consultation with the Engineer-in-charge and the occupying department. If so required, the work may have to be done even before and after office hours.

1.19.2 The contractor shall be responsible to abide by the Regulations or restrictions set in regard to entry into and movement within the premises of the site of work.

1.19.3 The contractor shall not tamper with any of the existing installations, including their switching operations or connections there to, without specific approval from the Engineer-in-charge.

1.20 DRAWINGS

1.20.1 The work shall be carried out in accordance with the drawing(s) if any, enclosed with the tender and also in accordance with modification(s) if any thereto from time to time approved by the Engineer-in-charge, and also instructions from him in the course of execution of the works .

1.20.2 All schematics, layout diagrams etc. shall be deemed to be 'Drawings' within the meaning of the terms as used in Clause 11 of the Conditions of Contract (PWD 7 or PWD 8).

1.20.3 All circuits, poles, feeder pillars etc. shall be indicated and numbered in the layout diagram(s).

1.21 CONFORMITY TO IE ACT, IE RULES, AND STANDARDS

1.21.1 All Electrical works shall be carried out in accordance with the provisions of Indian Electricity Act, 1910 and Indian Electricity Rules, 1956 amended upto date (Date of call of tender unless specified otherwise). List of Rules of particular importance to Electrical Installations under these General Specifications is given in Appendix B for reference.

1.21.2 The works shall also conform to relevant Indian Standard Codes of practice (COP) for the type of work involved. (See Appendix C for the list of such Codes).

1.21.3 Materials to be used in work shall be ISI marked, whenever such ISI marked materials are available.

1.21.4 In all electrical installation works, relevant Safety codes of practices shall be followed. Guidelines on Safety procedure as outlined in Appendix E to the General Specifications for Electrical works - Part I (Internal), 1994 shall be followed.

1.22 GENERAL REQUIREMENTS OF COMPONENTS

1.22.1 Quality of materials

All materials and equipments supplied by the contractor shall be new. They shall be of such design, size and material as to satisfactorily function under the rated conditions of operation and to withstand the environmental conditions at site.

1.22.2 Inspection of materials and Equipments

Materials and equipments to be used in the work shall be inspected by the Departmental officers. Such inspection will of following categories:

1. Inspection of materials/ Equipments to be witnessed at the Manufacturer's premises in accordance with relevant BIS/ Agreement Inspection Procedure.

2. To receive materials at site with Manufacturer's Test Certificate(s).

3. To inspect materials at the Authorised Dealer's Godowns to ensure delivery of genuine materials at site.

4. To receive materials after physical inspection at site.

The Departmental officers will take adequate care to ensure that only tested and genuine materials of proper quality are used in work.

Similarly, for fabricated equipments, the contractor will first submit dimensional detailed drawings for approval before fabrication is taken up in the factory. Suitable stage inspection at factory also will be made to ensure proper use of materials, workmanship and quality control.

The tender specifications will stipulate the Inspection requirements or their waival for various materials/ equipments including norms of inspection in specific cases.

1.22.3 Ratings of components

All current carrying components in an installation shall be of appropriate ratings of voltage, current, and frequency, as required at the respective sections of the electrical installation in which they are used, without their respective ratings being exceeded.

1.23 WORKMANSHIP

1.23.1 Good workmanship is an essential requirement to be complied with. The entire work of manufacture/ fabrication, assembly and installation shall conform to sound engineering practice.

1.23.2 The work shall be carried out under the direct supervision of a first class licensed foreman or of a person holding a certificate of competency issued by the State Govt. for the type of work involved, employed by the contractor, who shall rectify then and there the defects pointed out by the Engineer-in-Charge during the progress of work.

1.23.3 **Fabrication of panels in a CPRI approved workshop.**

Unless otherwise specified, switch boards/ LT panels etc. will be fabricated by a fabricating workshop having CPRI Certificate for short circuit withstand capability for manufacture/ fabrication for the rating of Switch Boards specified. The workshop also should have reasonable quality control, and testing facilities, besides having a proper 7-tank process for proper treatment and painting of metal parts.

1.24 TESTING

All tests prescribed in these General Specifications, to be done before, during and after installation, shall be carried out, and the test results shall be submitted to the Engineer-in-charge in prescribed proforma, forming part of the Completion Certificate. (See Appendix D).

1.25 COMMISSIONING ON COMPLETION

After the work is completed, it shall be ensured that the installation is tested and commissioned.

1.26 COMPLETION PLAN AND COMPLETION CERTIFICATE

1.26.1 For all works costing more than Rs.1,00,000 completion certificate as given in Appendix D including the proforma for test results shall be submitted to the Engineer-in-charge, after completion of work.

1.26.2 Completion plan drawn to a suitable scale in tracing cloth with ink indicating the following along with three blue print copies of the same shall also be submitted.

(a) General layout of the site showing therein routes of cables and overhead lines.

(b) Schedule of lengths, types and sizes of cables and overhead conductors.

(c) Positions of all cable joints typewise, supports, stays, struts, lightning arresters, feeder pillars, and pipes or closed ducts .

(d) Positions of cable route markers and joint markers with respect to permanent land marks available at site.

(e) Types of street light fittings

(f) Name of work, job number, accepted tender reference, actual date of completion, names of Division/Sub-Divison, and name of the firm who executed the work with their signature(s).

1.26.3 In the case of works costing less than Rs.1,00,000 the completion plan shall be prepared by the Department and signed by the contractor before final payment is made.

1.27 Guarantee

The installation will be handed over to the Department after necessary testing and commissioning. The installation will Similarly, the materials supplied by the contractor will be guaranteed against any manufacturing defect, inferior quality. The guarantee period will be for a period of 12 months from the date of handing over to the Department. Installation/ equipments or components thereof shall be rectified/ repaired at the discretion of the Engineer-in-Charge.

1.28 MAINTENANCE

The periodicity of important maintenance activities are indicated in the Appendix E for guidance.

CHAPTER 2

CABLE WORK

2.1 SCOPE

This chapter covers the requirements for the selection, installation and jointing of power cables for low, medium and high voltage applications upto and including 33KV. For details not covered in these Specifications, IS:1255-1983 shall be referred to. All references to BIS- Specifications and codes are for codes with amendments issued upto date i.e. till the date of call of tender.

2.2 TYPES OF CABLES

2.2.1 The cables for applications for low and medium voltage (upto and including 1.1KV) supply shall be one of the following :-

(i) PVC insulated and PVC sheathed, conforming to IS:1554 (Part-1) - 1988.

(ii) Cross linked polyethylene insulated, PVC sheathed (XLPE), conforming to IS:7098 (Part-1) - 1988.

2.2.2 The cables for applications for high voltage (above 1.1KV but upto and including 11KV supply) supply shall be one of the following :-

(i) PVC insulated and PVC sheathed, conforming to IS:1554 (Part-2) - 1988.

(ii) Paper insulated, lead sheathed (PILCA) conforming to IS:692-1973.

(iii) Cross linked polyethylene (XLPE) insulated, PVC sheathed conforming to IS:7098 (Part-2) - 1985.

2.2.3 The cables for applications above 11KV but upto and including 33KV supply shall be one of the following:-

(i) Paper insulated lead sheathed (PILCA) conforming to IS:692-1973.

(ii) Cross linked, polyethylene insulated (XLPE) conforming to IS:7098 (Part-2) - 1985.

2.2.4 The cables shall be with solid or stranded aluminium conductors, as specified. Copper conductors may be used, only in special applications, where use of aluminium conductors is not technically acceptable.

2.2.5 Where paper insulated cables are used in predominantly vertical situation,these shall be of non-draining type.

2.3 ARMOURING AND SERVING

2.3.1 All multicore cables liable for mechanical damage and all HV cables (irrespective of the situation of installation) shall be armoured. Where armouring is unavoidable in single core cables, either the armour should be made of nonmagnetic material, or it should be ensured that,the armouring is not shorted at terminations, thus preventing the flow of circulating currents therein.

2.3.2 Short runs of cables laid in pipes, closed masonary trenches and similar protected or secured enclosures need not be armoured.

2.3.3 PVC and XLPE cables, when armoured, shall have galvanised steel wires (flat or round) for armouring.

2.3.4 Paper insulated cables shall have for armouring, a double layer of steel tape for normal applications. Steel wire armouring is preferred where the cables are liable to tensile stresses in applications such as vertical runs, suspended on brackets or laid in soil that is likely to subside.

2.3.5 Serving over armouring in paper insulated cables shall consist of a complete layer or layers of suitable compounded hessian materials.

2.4 SELECTION OF CABLE SIZES

2.4.1 The cable sizes shall be selected by considering the voltage drop in the case of MV (distribution) cables and Current carrying capacity in the case of HV (feeder) cables. Due consideration should be given for the Prospective short circuit current and the period of its flow, especially in the case of HV cables.

2.4.2 While deciding upon the cable sizes, derating factors for the type of cable and depth of laying, grouping, ambient temperature, ground temperature, and soil resistivity shall be taken into account.

2.4.3 Guidance for the selection of cables shall be derived from relevant Indian Standards such as IS:3961 (Part 1)-1967 for paper insulated lead sheathed cables, IS:3961 (Part-2)-1967 for PVC insulated and PVC sheathed heavy duty cables, IS:5819-1970 for recommended short circuit ratings of high voltage PVC cables, IS:1255-1983 on code of practice for installation and maintenance of power cables upto and including 33 KV rating etc. [See Table No. I(A) to I(E) for M.V. and H.V. selection.]

2.5 STORAGE AND HANDLING

2.5.1. Storage

(i) The cable drums shall be stored on a well drained, hard surface, so that the drums do not sink in the ground causing rot and damage to the cable drums. Paved surface is preferred, particularly for long term storage.

(ii) The drums shall always be stored on their flanges, and not on their flat sides.

(iii) Both ends of the cables especially of PILCA cables should be properly sealed to prevent ingress/ absorption of moisture by the insulation during storage.

(iv) Protection from rain and sun is preferable for longterm storage for all types of cables. There should also ventilation between cable drums.

(v) During storage, periodical rolling of drums once in, say, 3 months through 90 degrees shall be done, in the case of paper insulated cables. Rolling shall be done in the direction of the arrow marked on the drum.

(vi) Damaged battens of drums etc. should be replaced, as may be necessary.

2.5.2. Handling

(i) When the cable drums have to be moved over short distances, they should be rolled in the direction of the arrow marked on the drum.

(ii) For manual transportation over long distances, the drum should be mounted on cable drum wheels, strong enough to carry the weight of the drum, and pulled by means of ropes. Alternatively, they may be mounted on a trailer or on a suitable mechanical transport.

(iii) For loading into and unloading from vehicles, a crane or a suitable lifting tackle should be used. Small sized cable drums can also be rolled down carefully on a suitable ramp or rails, for unloading, provided no damage is likely to be caused to the cable or to the drum.

2.6 INSTALLATION

2.6.1 General

(i) Cables with kinks, straightened kinks or any other apparent defects like defective armouring etc. shall not be installed.

(ii) Cables shall not be bent sharp to a small radius either while handling or in installation. The minimum safe bending radius for PVC/XLPE (MV) cables shall be 12 times the overall diameter of the cable. The minimum safe bending radius for PILC/XLPE (HV) cables shall be as given in Table-II. At joints and terminations, the bending radius of individual cores of a multicore cable of any type shall not be less than 15 times its overall diameter.

(iii) The ends of lead sheathed cables shall be sealed with solder immediately after cutting the cables. In case of PVC cables, suitable sealing compound/tape shall be used for this purpose, if likely exposed to rain in transit storage. Suitable heat shrinkable caps may also be used for the purpose.

2.6.2 Route

Before the cable laying work is undertaken, the route of the cable shall be decided by the Engineer-in-Charge considering the following.

(i) While the shortest practicable route should be preferred, the cable route shall generally follow fixed developments such as roads, foot paths etc. with proper offsets so that future maintenance, identification etc. are rendered easy. Cross country run merely to shorten the route length shall not be adopted.

(ii) Cable route shall be planned away from drains and near the property, especially in the case of LV/MV cables, subject to any special local requirements that may have to be necessarily complied with.

(iii) As far as possible, the alignment of the cable route shall be decided after taking into consideration the present and likely future requirements of other services including cables enroute, possibility of widening of roads/lanes etc.

(iv) Corrosive soils, ground surrounding sewage effluent etc. shall be avoided for the routes.

(v) **Route of cables of different voltages.**

(a) Whenever cables are laid along well demarcated or established roads, the LV/MV cables shall be laid farther from the kerb line than HV cables.

(b) Cables of different voltages, and also power and control cables shall be kept in different trenches with adequate separation. Where available space is restricted such that this requirement cannot be met, LV/MV cables shall be laid above HV cables.

(c) Where cables cross one another , the cable of higher voltage shall be laid at a lower level than the cable of lower voltage.

2.6.3 Proximity to communication cables

Power and communication cables shall as far as possible cross each other at right angles. The horizontal and vertical clearances between them shall not be less than 60cm.

2.6.4 Railway crossing

Cables under railway tracks, shall be laid in spun reinforced concrete, or cast iron or steel pipes at such depths as may be specified by the railway authorities, but not less than 1m, measured from the bottom of the sleepers to the top of the pipe. Inside railway station limits , pipes shall be laid upto the point of the railway boundary or to a point to be decided by the railway authorities. Outside the railway station limits, pipes shall be laid upto a minimum distance of 3m from the center of the nearest track on either side.

2.6.5 Way Leave

Way leave for the cable route shall be obtained as necessary, from the appropriate authorities, such as, Municipal authorities, Department of telecommunication, Gas Works, Railways, Civil Aviation authorities, Owners of properties etc. In case of private property, Section 12/51 of the Indian Electricity Act shall be complied with.

2.6.6 Methods of laying

The cables shall be laid direct in ground, pipe, closed or open ducts, cable trays or on surface of wall etc. The method(s) of laying required shall be specified in the tender schedule of work.

2.6.7 Laying direct in ground

2.6.7.1 General

This method shall be adopted where the cable route is through open ground, along roads/ lanes, etc., and where no frequent excavations are likely to be encountered and where re-excavation is easily possible without affecting other services.

2.6.7.2 Trenching

(i) **Width of trench**

The width of the trench shall first be determined on the following basis (Refer figure 1).

(a) The minimum width of the trench for laying a single cable shall be 35cm.

(b) Where more than one cable is to be laid in the same trench in horizontal formation, the width of the trench shall be increased such that the inter-axial spacing between the cables, except where otherwise specified, shall be at least 20cm.

(c) There shall be a clearance of at least 15cm between axis of the end cables and the sides of the trench.

(ii) **Depth of trench**

The depth of the trench shall be determined on the following basis (Refer figure 1) :-

(a) Where the cables are laid in a single tier formation, the total depth of trench shall not be less than 75cm for cables upto 1.1KV and 1.2m for cables above 1.1KV.

(b) When more than one tier of cables is unavoidable and vertical formation of laying is adopted, the depth of the trench in (ii)a above shall be increased by 30cm for each additional tier to be formed.

(c) Where no sand cushioning and protective covering are provided for the cables as per 2.6.7.3(i)(b), 2.6.7.3(vii)(c) and 2.6.7.3(ix)(d) below, the depth of the trench as per (ii)(a) and (b) above shall be increased by 25cm.

(iii) **Excavation of trenches**

(a) The trenches shall be excavated in reasonably straight lines. Wherever there is a change in the direction, a suitable curvature shall be adopted complying with the requirements of clause 2.6.1(ii).

(b) Where gradients and changes in depth are unavoidable, these shall be gradual.

(c) The bottom of the trench shall be level and free from stones, brick bats etc.

(d) The excavation should be done by suitable means - manual or mechanical. The excavated soil shall be stacked firmly by the side of the trench such that it may not fall back into the trench.

(e) Adequate precautions should be taken not to damage any existing cable(s), pipes or any other such installations in the route during excavation. Wherever bricks, tiles or protective covers or bare cables are encountered, further excavation shall not be carried out without the approval of the Engineer-in-Charge.

(f) Existing property, if any, exposed during trenching shall be temporarily supported adequately as directed by the Engineer-in-Charge. The trenching in such cases shall be done in short lengths, necessary pipes laid for passing cables therein and the trench refilled in accordance with clause 2.6.7.4.

(g) If there is any danger of a trench collapsing or endangering adjacent structures, the sides should be well shored up with sheeting as the excavation proceeds. Where necessary, these may even be left in place when back filling the trench.

(h) Excavation through lawns shall be done in consultation with the Department concerned.

2.6.7.3 Laying of cable in trench

(i) **Sand cushioning**

(a) The trench shall then be provided with a layer of clean, dry sand cushion of not less than 8cm in depth, before laying the cables therein.

(b) However, sand cushioning as per (a) above need not be provided for MV cables, where there is no possibility of any mechanical damage to the cables due to heavy or shock loading on the soil above. Such stretches shall be clearly specified in the tender documents.

(c) Sand cushioning as per (a) above shall however be invariably provided in the case of HV cables.

(ii) **Testing before laying**

At the time of issue of cables for laying, the cables shall be tested for continuity and insulation resistance (See also clause 2.8.1).

(iii) The cable drum shall be properly mounted on jacks, or on a cable wheel at a suitable location, making sure that the spindle, jack etc. are strong enough to carry the weight of the drum without failure, and that the spindle is horizontal in the bearings so as to prevent the drum creeping to one side while rotating.

(iv) The cable shall be pulled over on rollers in the trench steadily and uniformly without jerks and strain. The entire cable length shall as far as possible be laid off in one stretch. PVC/XLPE cables less than 120sqmm size may be removed by "Flaking" i.e. by making one long loop in the reverse direction.

Note:- For short runs and sizes upto 50sq mm of MV cables, any other suitable method of direct handling and laying can be adopted without strain or excess bending of the cables.

(v) After the cable has been so uncoiled, it shall be lifted slightly over the rollers beginning from one end by helpers standing about 10m apart and drawn straight. The cable shall then be lifted off the rollers and laid in a reasonably straight line.

(vi) **Testing before covering**

The cables shall be tested for continuity of cores and insulation resistance (Refer clause 2.8.1) and the cable length shall be measured, before closing the trench. The cable end shall be sealed/covered as per clause 2.6.1(iii)

(vii) **Sand covering**

Cables laid in trenches in a single tier formation shall have a covering of dry sand of not less than 17cm above the base cushion of sand before the protective cover is laid.

In the case of vertical multi-tier formation, after the first cable has been laid, a sand cushion of 30cm shall be provided over the base cushion before the second tier is laid. If additional tiers are formed , each of the subsequent tiers also shall have a sand cushion of 30cm as stated above. Cables in the top most tier shall have a final sand covering not less than 17cm before the protective cover is laid.

Sand covering as per (a) and (b) above need not be provided for MV cables where a decision is taken by the Engineer-in-charge as per subclause (i)(b) above, but the inter tier spacing should be maintained as in (b) above with soft soil instead of sand between tiers and for covering.

Sand cushioning as per (a) and (b) above shall however be invariably provided in the case of HV cables.

(viii) **Extra loop cable**

At the time of original installation , approximately 3m of surplus cable shall be left on each terminal end of the cable and on each side of the underground joints. The surplus cable shall be left in the form of a loop. Where there are long runs of cables such loose cable may be left at suitable intervals as specified by the Engineer- in-Charge.

(b) Where it may not be practically possible to provide separation between cables when forming loops of a number of cables as in the case of cables emanating from a substation, measurement shall be made only to the extent of actual volume of excavation, sand filling etc. and paid for accordingly.

(ix) **Mechanical protection over the covering**

(a) Mechanical protection to cables shall be laid over the covering in accordance with (b) and (c) below to provide warning to future excavators of the presence of the cable and also to protect the cable against accidental mechanical damage by pick-axe blows etc.

(b) Unless otherwise specified, the cables shall be protected by second class brick of nominal size 22cmx11.4cmx7cm or locally available size, placed on top of the sand (or, soil as the case may be). The bricks shall be placed breadth-wise for the full length of the cable. Where more than one cable is to be laid in the same trench, this protective covering shall cover all the cables and project at least 5cm over the sides of the end cables.

(c) Where bricks are not easily available, or are comparatively costly, there is no objection to use locally available material such as tiles or slates or stone/cement concrete slabs. Where such an alternative is acceptable, the same shall be clearly specified in the tender specifications.

(d) Protective covering as per (b) and (c) above need not be provided only for MV cables, in exceptional cases where there is normally no possibility of subsequent excavation. Such cases shall be particularly specified in the Tender specifications.

(e) The protective covering as per (b) and (c) above shall, however invariably be provided in the case of HV cables.

2.6.7.4 **Back filling**

(i) The trenches shall be then back-filled with excavated earth, free from stones or other sharp edged debris and shall be rammed and watered, if necessary in successive layers not exceeding 30 cm depth.

(ii) Unless otherwise specified, a crown of earth not less than 50mm and not exceeding 100mm in the center and tapering towards the sides of the trench shall be left to allow for subsidence. The crown of the earth however, should not exceed 10 Cms. so as not to be a hazard to vehicular traffic.

(iii) The temporary re-statements of roadways should be inspected at regular intervals, particularly during wet weather and settlements should be made good by further filling as may be required.

(iv) After the subsidence has ceased, trenches cut through roadways or other paved areas shall be restored to the same density and materials as the surrounding area and re-paved in accordance with the relevant building specifications to the satisfaction of the Engineer-in-Charge.

(v) Where road berms or lawns have been cut out of necessity, or kerb stones displaced, the same shall be repaired and made good, except for turfing/asphalting, to the satisfaction of the Engineer-in-Charge, and all the surplus earth or rock shall be removed to places as specified.

2.6.7.5 Laying of single core cables

(i) Three single core cables forming one three phase circuit shall normally be laid in close trefoil formation and shall be bound together at intervals of approximately 1m.

(ii) The relative position of the three cables shall be changed at each joint at the time of original installation, complete transposition being effected in every three consecutive cable lengths.

2.6.7.6 Route markers

(i) **Location**

Route markers shall be provided along the runs of cables at locations approved by the Engineer-in- Charge and generally at intervals not exceeding 100m. Markers shall also be provided to identify change in the direction of the cable route and at locations of underground joints.

(ii) (a) **Plate type marker**

Route markers shall be made out of 100mm x 5mm GI/aluminium plate welded/bolted on 35mm x 35mm x 6mm angle iron, 60cm long. Such plate markers shall be mounted parallel to and at about 0.5m away from the edge of the trench.

(b) **CC marker**

Alternatively, cement concrete 1:2:4 (1cement: 2coarse sand: 4graded stone aggregate of 20mm in size) as shown in figure2 shall be laid flat and centered over the cable. The concrete markers, unless otherwise instructed by the Engineer-in-Charge, shall project over the surrounding surface so as to make the cable route easily identifiable.

(c) **Inscription**

The words 'CPWD-MV/HV CABLE' as the case may be, shall be inscribed on the marker.

2.6.8 Laying in pipes / closed ducts

2.6.8.1 In locations such as road crossing, entry in to buildings, paved areas etc., cables shall be laid in pipes or closed ducts. Metallic pipe shall be used as protection pipe for cables fixed on poles of overhead lines.

2.6.8.2 (i) Stone ware pipes, GI, CI or spun reinforced concrete pipes shall be used for cables in general; however only GI pipe shall be used as protection pipe on poles.

(ii) The size of the pipe shall not be less than 10cm in diameter for a single cable and not less than 15cm for more than one cable.

(iii) Where steel pipes are employed for protection of single core cable feeding AC load, the pipe should be large enough to contain both cables in the case of single phase system and all cables in the case of poly phase system.

(iv) Pipes for MV and HV cables shall be independent ones.

2.6.8.3 (i) In the case of new construction, pipes as required (including for anticipated future requirements) shall be laid alongwith the civil works and jointed according to the CPWD Building Specifications.

(ii) Pipes shall be continuous and clear of debris or concrete before cables are drawn. Sharp edges if any, at ends shall be smoothened to prevent damage to cable sheathing.

(iii) These pipes shall be laid directly in ground without any special bed except for SW pipe which shall be laid over 10cm thick cement concrete 1:5:10 (1 cement: 5coarse sand: 10 graded stone aggregate of 40mm nominal size) bed. No sand cushioning or tiles need be used in such situations.

2.6.8.4 **Road crossings**

(i) The top surface of pipes shall be at a minimum depth of 1m from the pavement level when laid under roads, pavements etc.

(ii) The pipes shall be laid preferably askew to reduce the angle of bend as the cable enters and leaves the crossing .This is particularly important for HV cables.

(iii) When pipes are laid cutting an existing road, care shall be taken so that the soil filled up after laying the pipes is rammed well in layers with watering as required to ensure proper compaction. A crown of earth not exceeding 10cm should be left at the top.

(iv) The temporary re-instatements of roadways should be inspected at regular intervals, particularly after a rain, and any settlement should be made good by further filling as may be required.

(v) After the subsidence has ceased, the top of the filled up trenches in roadways or other paved areas shall be restored to the same density and material as the surrounding area in accordance with the relevant CPWD Building Specifications to the satisfaction of the Engineer-in-charge.

2.6.8.5 Manholes shall be provided to facilitate feeding/ drawing in of cables with sufficient working space for the purpose. They shall be covered by suitable manhole covers. Sizes and other details shall be indicated in the Schedule of work.

2.6.8.6 **Cable entry into the building**

Pipes for cable entries to the building shall slope downwards from the building. The pipes at the building end shall be suitably sealed to avoid entry of water, after the cables are laid.

2.6.8.7 Cable-grip / draw-wires, winches etc. may be employed for drawing cables through pipes / closed ducts.

2.6.8.8 Measurement for drawing/ laying cables in pipes/ closed duct shall be on the basis of the actual length of the pipe / duct for each run of the cable, irrespective of the length of cable drawn through.

2.6.9 **Laying in open ducts**

2.6.9.1 Open ducts with suitable removable covers (RCC slabs or chequered plates) are generally provided in sub-stations, switch rooms, plant rooms, workshops etc, for taking the cables. The cable ducts should be of suitable dimensions for the number of cables involved.

2.6.9.2 (i) Laying of cables with different voltage ratings in the same duct shall be avoided. Where it is inescapable to take HV & MV cables same trench, they shall be laid with a barrier between them or alternatively, one of the two (HV/MV) cables may be taken through pipe(s).

(ii) Splices or joints of any type shall not be permitted inside the ducts.

2.6.9.3 (i) The cables shall be laid directly in the duct such that unnecessary crossing of cables is avoided.

(ii) Where specified, cables may be fixed with clamps on the walls of the duct or taken in hooks/ brackets/ troughs in ducts.

2.6.9.4 Where specified, ducts may be filled with dry sand after the cables are laid and covered as above, or finished with cement plaster, specially in high voltage applications.

2.6.10 **Laying on surface**

2.6.10.1 This method may be adopted in places like switch rooms, workshops, tunnels, rising (distribution) mains in buildings etc. This may also be necessitated in the works of additions and/or alterations to the existing

installation, where other methods of laying may not be feasible.

2.6.10.2 Cables may be laid in surface by any of the following methods as specified:

(a) Directly clamped by saddles or clamps,
(b) Supported on cradles,
(c) Laid on troughs/trays, duly clamped.

2.6.10.3 (i) The saddles and clamps used for fixing the cables on surface shall comply with the requirements given in Table-III.

(ii) Saddles shall be secured with screws to suitable approved plugs. Clamps shall be secured with nuts on to the bolts, grouted in the supporting structure in an approved manner.

(iii) In the case of single core cables, the clamps shall be of non-magnetic material. A suitable non-corrosive packing shall be used for clamping unarmoured cables to prevent damage to the cable sheath.

(iv) Cables shall be fixed neatly without undue sag or kinks.

2.6.10.4 The arrangement of laying the cables in cradles is permitted only in the case of cables of 1.1KV grade of size exceeding 120sqmm. In such cases, the cables may be suspended on MS flat cradles of size 50mm x 5mm which in turn shall be fixed on the wall by bolts grouted into the wall in an approved manner at a spacing of not less than 60 cm.

2.6.10.5 All MS components used in fixing the cables shall be either galvanised or given a coat of red oxide primer and finished with 2 coats of approved paint.

2.6.11. Laying on cable tray

2.6.11.1 This method may be adopted in places like indoor sub-stations, airconditioning 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.

2.6.11.2 Perforated type cable tray

(i) 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. These may be galvanised or painted as specified. Alternatively, where specified, the cable tray may be fabricated by two angle irons of 50mmx50mmx6mm as two longitudinal members, with cross bracings between them by 50mmx5mm flats welded/bolted to the angles at 1 m spacing. 2mm thick MS perforated sheet shall be suitably welded/bolted to the base as well as on the two sides.

(ii) Typically, the dimensions, fabrication details etc. are shown in figure 3A,B, and C..

(iii) The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section. Two coupler plates, each of minimum 200mm length, shall be bolted on each of the two sides of the channel section with 8mm dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surfaces between the coupler plates and cable tray shall be scraped and removed before the installation.

(iv) The maximum permissible uniformly distributed load for various sizes of cables trays and for different supported span are given in Table IV. the sizes shall be specified considering the same.

(v) 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.

(vi) Factory fabricated bends, reducers, tee/cross junctions, etc. shall be provided as per good engineering practice. (Details are typically shown in figure 3). The radius of bends, junctions etc. shall not be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.

(vii) The cable tray shall be suspended from the ceiling slab with the help of 10mm dia MS rounds or 25mmx5mm flats at specified spacing (based on Table III). Flat type suspenders may be used for channels upto 450mm width bolted to cable trays. Round suspenders shall be threaded and bolted to the cable trays or to independent support angles 50mmx50mmx5mm at the bottom end as specified. These shall be grouted to the ceiling slab at the other end through an effective means, as approved by the Engineer-in-Charge, to take the weight of the cable tray with the cables.

(viii) The entire tray (except in the case of galvanised type) and the suspenders shall be painted with two coats of red oxide primer paint after removing the dirt and rust, and finished with two coats of spray paint of approved make synthetic enamel paint.

(ix) The cable tray shall be bonded to the earth Terminal of the switch bonds at both ends.

(x) 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.

2.6.11.3 Ladder type cable tray

(i) 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.

(ii) Alternatively, where specified, ladder type cable trays may be fabricated out of 50mmx50mmx6mm (minimum) angle iron for longitudinal members, and 30mmx6mm flat for rungs.

(iii) Typical details of fabrication and dimensions of both the types of trays are shown in figure 4A,B,C and D.

(iv) The maximum permissible loading, jointing of channel sections, width of the cable tray, provision of elbows, bends, reducers, horizontal tee/ cross junctions etc. suspension of cable tray from the ceiling slab, painting and measurement of the cable tray shall be as per sub-clauses (ii) to (x) below clause 2.6.11.2, except that the overall width of one cable tray may be limited to 800mm.

2.6.11.4 Cables laid on cable trays shall be clamped on to the tray at suitable intervals as per Table-III.

2.6.12 Cable identification tags

Whenever more than one cable is laid / run side by side, marker tags as approved, inscribed with cable identification details shall be permanently attached to all the cables in the manholes / pull pits / joint pits/ entry points in buildings/ open ducts etc. These shall also be attached to cables laid direct in ground at specified intervals, before the trenches are back-filled.

2.7 JOINTING

2.7.1 Location

(i) Before laying a cable, proper locations for the proposed cable joints, if any, shall be decided, so that when the cable is actually laid, the joints are made in the most suitable places. As far as possible, water logged locations, carriage ways, pavements, proximity to telephone cables, gas or water mains, inaccessible places, ducts, pipes, racks etc. shall be avoided for locating the cable joints.

(ii) Joints shall be staggered by 2m to 3m when joints are to be done for two or more cables laid together in the same trench.

2.7.2 Joints pits

(i) Joint pits shall be of sufficient dimensions as to allow easy and comfortable working. The sides of the pit shall be well protected from loose earth falling into it. It shall also be covered by a tarpaulin to prevent dust and other foreign matter being blown on the exposed joints and jointing materials.

(ii) Sufficient ventilation shall be provided during jointing operation in order to disperse fumes given out by fluxing.

2.7.3 Safety precaution

(i) A caution board indicating "CAUTION - CABLE JOINTING WORK IN PROGRESS" shall be displayed to warn the public and traffic where necessary.

(ii) Before jointing is commenced, all safety precautions like isolation, discharging, earthing, display of caution board on the controlling switchgear etc. shall be taken to ensure that the cable would not be inadvertently charged from live supply. Metallic armour and external metallic bonding shall be connected to earth. Where "Permit to work" system is in vogue, safety procedures prescribed shall be complied with.

2.7.4 Jointing materials

(i) Jointing materials and accessories like conductor ferrules, solder, flux, insulating and protective tapes, filling compound, jointing boxes, heat shrinking joint kit etc. of right quality and correct sizes, conforming to relevant Indian Standards, wherever they exist, shall be used.

(ii) The design of the joint box and the composition of the filling compound shall be such as to provide an effective sealing against entry of moisture in addition to affording proper electrical characteristic to joints.

(iii) Where special type of splicing connector kits or epoxy resin spliced joints or heat shrinkable jointing kits are specified, materials approved for such application shall be used. Storing as well as jointing instructions of the manufacturer of such materials shall be strictly followed.

2.7.5 Jointer

Jointing work shall be carried out by a licensed/experienced (where there is no licensing system for jointers) cable jointer.

2.7.6 Cable work with joints

(i) About 3m long surplus cable shall be left on each side of joints as laid down in clause 2.6.7.3 (viii).

(ii) Insulation resistance of cables to be jointed shall be tested as per clause 2.8.1. Unless the insulation resistance values are satisfactory, jointing shall not be done.

(iii) Cores of the cables must be properly identified before jointing.

(iv) Where a cable is to be jointed with the existing cable, the sequence should be so arranged as to avoid crossing of cores while jointing.

(v) Whenever the aluminium conductor is exposed to outside atmosphere , a highly tenacious oxide film is formed which makes the soldering of aluminium conductor difficult. This oxide film should be removed by using appropriate type of flux.

(vi) The clamps for the armour shall be clean and tight.

2.7.7 Joint types

The type of joint shall be suitable for the type of cable as per Table V and shall be specified in the Tender Schedule of Work.

2.7.8 Jointing procedure

While it would be necessary to follow strictly the instructions for jointing furnished by the manufacturers of cables and joint kits, a brief on the jointing procedures is given for general guidance in Appendix F.

2.8 TESTING

2.8.1 Testing before laying

All cables, before laying, shall be tested with a 500V megger for cables of 1.1KV grade, or with a 2500/5000V megger for cables of higher voltage. The cable cores shall be tested for continuity, absence of cross phasing, insulation resistance from conductors to earth /armour and between conductors.

2.8.2 Testing before backfilling

All cables shall be subjected to the above mentioned tests, before covering the cables by protective covers and back filling and also before taking up any jointing operation.

2.8.3 Testing after laying

(i) After laying and jointing, the cable shall be subjected to a 15 minutes pressure test. The test pressure shall be as given in Table VI. DC pressure testing may normally be preferred to AC pressure testing.

(ii) In the absence of facilities for pressure testing as above, it is sufficient to test for one minute with 1,000V megger for cables of 1.1KV grade and with 2,500/5,000V megger for cables of higher voltages.

TABLE I(A)

(CLAUSE 2.4.3)

CHART SHOWING THE DISTANCE UPTO WHICH DIFFERENT SIZES OF U.G. ALUMINIUM CONDUCTOR CABLES CAN BE USED FOR DIFFERENT CURRENT RATINGS FOR 8 VOLTS DROP WHEN LAID IN GROUND (PVC INSULATED, PVC SHEATHED, 3 CORE OR 4 CORE) WHEN CABLE GRADING IS 1.1 KV)

(MAXIMUM CONDUCTOR TEMPERATURE- 70 DEGREE C)

S. No.	Current Amp.	Distance in Meters for the following cable sizes in Sq. mm.											
		6	10	16	25	35	50	70	95	120	150	185	240	300
1.	5	165	260	415	725	895	1300	1925	2360	3065	3555	4300	5770	6460
2.	10	80	130	205	360	450	650	960	1180	1530	1775	2150	2885	3230
3	15	55	85	140	240	300	430	640	785	1020	1185	1430	1920	2155
4.	20	40	65	100	180	225	325	480	590	765	890	1075	1440	1615
5.	25	30	50	80	145	180	260	385	470	610	710	860	1150	1290
6.	30	25	40	70	120	150	215	320	390	570	590	715	960	1075
7.	40	20	30	50	90	110	160	240	295	380	445	535	720	805
8.	50	-	25	40	70	90	130	190	235	305	355	430	575	645
9.	60	-	-	35	60	75	110	160	195	255	295	355	480	535
10.	70	-	-	30	50	65	90	135	165	215	255	305	410	460
11.	80	-	-	-	45	55	80	120	145	190	220	265	360	405
12.	90	-	-	-	40	50	70	105	130	170	195	235	320	360
13.	100	-	-	-	35	45	65	95	115	150	175	215	290	320
14.	110	-	-	-	-	40	60	85	105	140	160	195	260	290
15.	120	-	-	-	-	35	55	80	95	125	145	180	240	270
16.	130	-	-	-	-	-	50	75	90	115	135	165	220	250
17.	140	-	-	-	-	-	45	70	80	110	125	150	205	230
18.	150	-	-	-	-	-	-	65	75	100	115	140	190	215
19.	160	-	-	-	-	-	-	60	70	95	110	130	180	200
20.	170	-	-	-	-	-	-	55	70	90	105	125	170	190
21.	180	-	-	-	-	-	-	50	65	85	100	120	160	180
22.	190	-	-	-	-	-	-	-	60	80	90	110	150	170
23.	200	-	-	-	-	-	-	-	60	75	90	105	145	160
24.	225	-	-	-	-	-	-	-	-	65	80	95	125	145
25.	250	-	-	-	-	-	-	-	-	-	70	85	115	130
26.	275	-	-	-	-	-	-	-	-	-	-	80	105	115
27.	300	-	-	-	-	-	-	-	-	-	-	70	95	105

Note 1:- PVC Insulated electrical cable for voltage grade upto 1.1 KV is based on 8 volts drop

1. This table is based on current and resistance as given in M/S.Incab's Cable and table (April 1964. Table No. 17 and 33).
2. The distances are given in meters and after rounding
3. The conditions of installation of cable is ground temp. 15 degree C.

Note 2:-For Temperature correction please see as detailed below

1. When the voltage drop and length is constant then to find the size of cable for following temperatures multiply the respective current ratings of the chart to obtain the calculated load current by the following factors and then see the size according to that ratings which was multiplied by the temperature factor.

Ground Temp.:	20 Degree C	25 Degree C	30 Degree C	35 Degree C
Rating Factors:	0.95	0.90	0.85	0.80

TABLE I(B)
(CLAUSE 2.4.3)

SHORT CIRCUIT RATINGS IN KA FOR 11 KV (SCREENED) PAPER INSULATED ALUMINIUM CONDUCTOR CABLES TO IS:692-1973

NOM. AREA Sq.mm.	0.1 Sec.	0.2 Sec.	0.5 Sec.	1.0 Sec.	2.0 Sec.	5.0 Sec.
1.5	0.376	0.260	0.164	0.116	0.084	0.065
2.5	0.604	0.427	0.270	0.191	0.135	0.085
4	0.936	0.663	0.419	0.286	0.209	0.132
6	1.46	1.04	0.656	0.463	0.328	0.207
10	2.54	1.78	1.02	0.795	0.512	0.356
16	3.70	2.62	1.66	1.17	0.830	0.524
25	6.37	4.53	2.87	2.04	1.44	0.91
35	8.04	5.68	3.60	2.54	1.80	1.14
50	11.3	7.96	5.04	3.56	2.54	1.59
70	17.5	12.3	7.81	5.52	3.90	2.47
95	22.5	15.9	10.1	7.12	5.00	3.18
120	28.8	21.8	12.9	9.10	6.44	4.07
150	38.1	24.0	15.1	10.7	7.56	4.80
185	42.4	30.0	18.9	13.4	9.47	6.00
225	52.8	37.4	23.6	16.7	11.8	7.46
240	61.0	43.2	27.3	19.3	13.6	8.63
300	70.0	49.5	31.3	22.1	15.6	9.88
400	101.0	71.1	45.0	31.8	22.5	14.4
500	118.0	83.5	52.8	37.3	26.4	16.7
625	150.0	106.0	67.0	47.4	33.5	21.2
800	187.0	132.0	83.6	59.1	41.8	26.4
1000	239.0	169.0	107.0	75.5	53.4	33.8

Above short circuit ratings are based on the following assumptions:

1) Conductor temperature prior to short circuit - 70 Deg.C.
2) Conductor temperature at the termination of short circuit -160 Deg.C.

TABLE I(C)
(CLAUSE 2.4.3)

SHORT CIRCUIT RATINGS IN KA FOR 11 KV (BELTED), 22 KV & 33 KV PAPER INSULATED ALUMINIUM CONDUCTOR CABLES TO IS : 692-1973

NOM. AREA Sq.mm.	0.1 Sec.	0.2 Sec.	0.5 Sec.	1.0 Sec.	2.0 Sec.	5.0 Sec.
16	3.80	2.69	1.70	1.20	0.853	0.538
25	6.54	4.65	2.95	2.10	1.48	0.935
35	8.26	5.84	3.70	2.61	1.85	1.170
50	11.60	8.18	5.18	3.66	2.61	1.630
70	18.00	12.60	8.02	5.67	4.01	2.500
95	23.10	16.30	10.40	7.31	5.14	3.270
120	29.60	22.40	13.30	9.35	6.62	4.180
150	39.10	24.70	15.50	11.00	7.77	4.930
185	43.60	30.80	19.40	13.80	9.73	6.160
225	54.20	38.40	24.20	17.20	12.10	7.660
240	62.70	44.40	28.00	19.80	14.00	8.870
300	71.90	50.90	32.20	22.70	16.00	10.100
400	104.00	73.00	46.20	32.70	23.10	14.800
500	121.00	85.80	54.20	38.30	27.10	17.200
625	154.00	109.00	68.80	48.70	34.40	21.800
800	192.00	136.00	85.90	60.70	42.90	27.100
1000	246.00	174.00	110.00	77.60	54.90	34.700

Above short circuit ratings are based on the following assumptions:

1) Conductor temperature prior to short circuit - 65 Deg.C.
2) Conductor temperature at the termination of short circuit - 160 Deg.C.

TABLE - I(D)
(CLAUSE 2.4.3)

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	39900
500	74800	49800
630	92700	62000
800	--	78800
1000	--	97800

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-

$$I_{SC} = \frac{I}{\sqrt{t}}$$

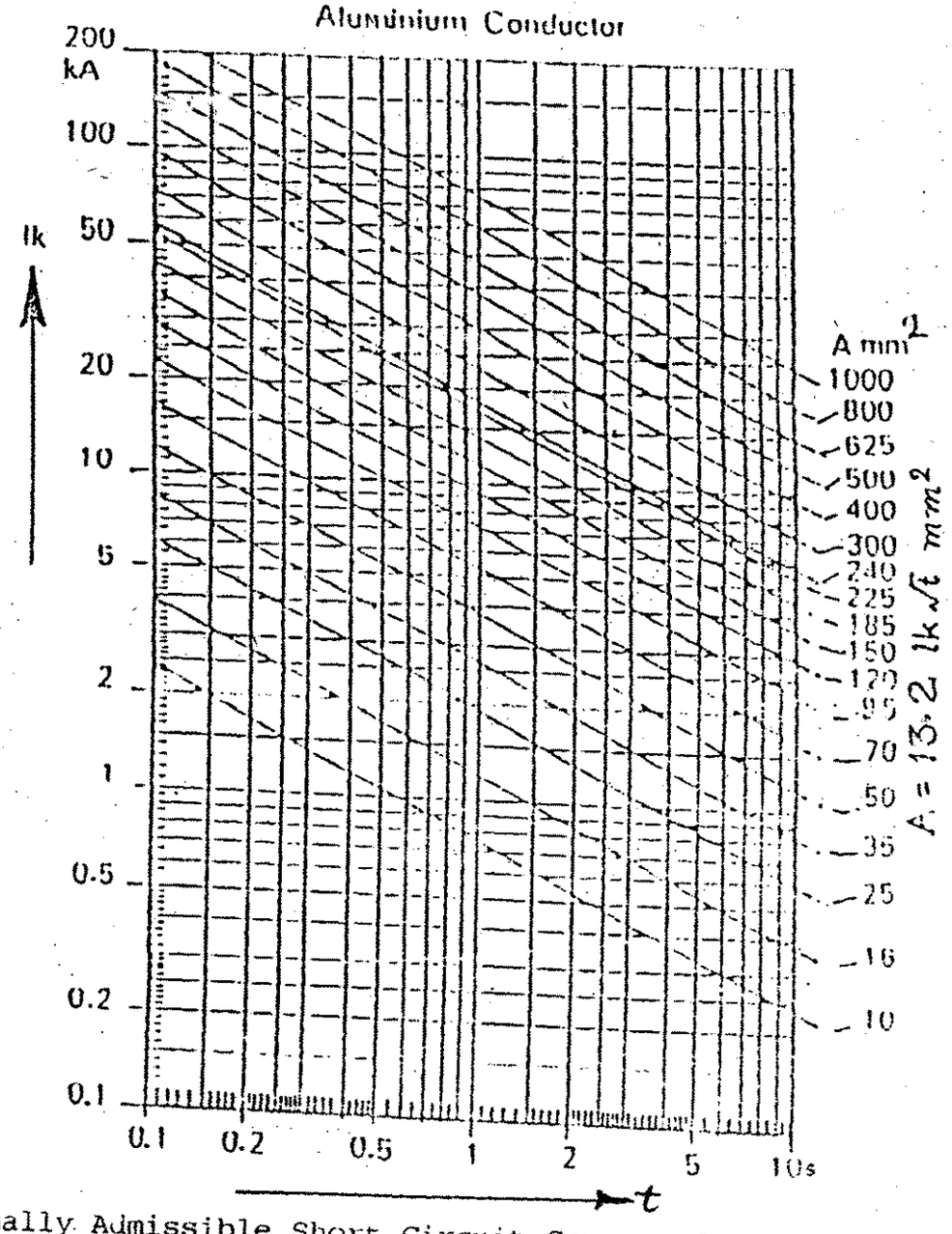
Where I_{SC} - Short circuit current during time t, amperes
I - Short circuit current during the time one second as given in above table.
t - Short circuit current duration, seconds.

Note For Large currents the force between the conductors must be considered especially when single core cable are used.

Table I(E)

Clause 2.4.3

SHORT CIRCUIT RATINGS FOR PVC INSULATED, PVC SHEATED POWER CABLES



Thermally Admissible Short Circuit Current for Cables 650/1100V to 6350/11000V grade cables.
For Full Load Conductor Temperature
Cond. Temp prior to Short Circuit - 70^0C
and
Max. S.C. Conductor Temperature - 160^0C
IK = Short Circuit Current in KA rms
t = Duration of Short Circuit in seconds
A = Area of Aluminium Conductor in mm^2

Table II

[Clause 2.6.1.(ii)]

Minimum Bending Radius - Paper Insulated Cables and XLPE cables.

System Voltage	Minimum Bending Radius		
	Single Core	Multi core	
		Unarmoured	Armoured
11 KV	20 D	15 D	12 D
22 KV	25 D	20 D	15 D
33 KV	30 D	25 D	20 D

"D" is the overall diameter of the cable.

Table III

(Clause 2.6.10.3(i) & 2.6.11.4)

Clamping of cables on surface

Type of cables	Size	Clamping by	Fixing Intervals
MV	Upto and including 25sqmm	Saddles 1mm thick	45cm
MV & HV	35sqmm to 120sqmm	Clamps 3mm thick 25mm wide	60cm
MV & HV	150sqmm and above	Clamps 3mm thick 40mm wide	60cm

Note : The fixing intervals specified apply to straight runs. In the case of bends, additional clamping shall be provided at 30cm from the center of the bend on both sides.

Table IV

[Clause 2.6.11.2(iv)]

Schedule of permissible loads for cable trays

The figures given below represent the maximum permissible uniformly distributed load in Kgs. per running meter for different unsupported free spans.

Channel Section Size			Unsupported Free Span			
Width (mm)	Depth (mm)	Thickness (mm)	800 mm	1200 mm	1800 mm	2500 mm
100	50	1.6	1430	355	156	87
150	50	1.6	1458	362	159	88
225	50	1.6	1498	371	160	89.4
300	50	1.6	1540	380	162	91.3
375	50	2.0	1955	483	210	116.7
450	50	2.0	1958	483	210	110.7
600	50	2.0	1964	481	208	110.4
300	62.5	2.0	2680	664	290	161.3
375	62.5	2.0	2685	664	290	158.9
450	62.5	2.0	2689	664	289	161.3
600	62.5	2.0	2698	664	289	157.1
750	62.5	2.0	2707	666	287	155.7
900	62.5	2.0	2716	667	287	153.7
600	75.0	2.0	3491	861	377	206.5
750	75.0	2.0	3513	868	377	205.02
900	75.0	2.0	3535	874	378	205.02

Note :-(i) The maximum permissible load at mid-span may be obtained from the formula

$$P = (1/2) \times U \times S$$

Where, P= Maximum permissible point load in Kgs. at mid-span.
U= Maximum permissible uniformly distributed load in Kg. per running meter, and ,
S= The particular free span in metre,

(ii) In case of a span not listed above, the corresponding maximum permissible uniformly distributed load may be found from the formula

$$U = 4x(U \text{ at } 2 \text{ m. span})/S^2$$

(iii) Free spans exceeding 16 ft. are not recommended.

TABLE V
(CLAUSE 2.7.7)
TYPES OF CABLE JOINTS

	PVC cables 1.1 KV	XLPE cables 1.1 KV	PVC cables 11 KV	XLPE cables 11 KV &ABOVE	Pilca cables 11 KV &ABOVE
	1	2	3	4	5
1. Brass compression gland	Yes	No	Yes	No	No
2. Brass gland plumbing type with compound	No	No	No	No	Yes
3. Epoxy resin	Yes	Yes	Yes	Yes	Yes
4. Heat shrinkable	Yes	Yes	Yes	Yes	Yes

Table VI

(Clause 2.8.3)

Test pressure in KV

Working Volts in KV	AC 15 Minutes test		DC 15 Minutes test	
	Between conductors	Conductor to earth	Between conductors	Conductor to earth
Upto 1.1	2.0	2.0	3.0	3.0
3.3	6.0	3.5	9.0	5.0
6.6	12.0	7.0	18.0	10.5
11	20.0	11.5	30.0	17.5
22	40.0	23.0	60.0	35.0
33	-	-	-	60.0

CHAPTER 3

OVERHEAD LINE WORK

3.1 SCOPE

This chapter covers the requirements for installation, testing and commissioning of overhead lines for power supply upto and including 33KV, service connections, including the materials used therein.

3.2 MATERIALS AND CONSTRUCTION

3.2.1. Supports

3.2.1.1 Types of supports

(i) Supports for overhead lines shall be any of the following types, as specified in tender documents. (In particular cases, any other type of supports may also be specified)

(a) Steel tubular poles,
(b) Steel rail poles,
(c) Cement concrete (RCC/PCC) poles, and
(d) Fabricated poles.

(ii) Supports shall be of adequate strength and conform to Rule 76 of the Indian Electricity Rules. The sizes of pole sections shall be selected in accordance with relevant IS Specifications to suit the requirements of loading.

(iii) Length of supports shall be specified in tender papers, so as to satisfy the relevant functional requirements like the ground clearance of lines when installed, street lighting etc.

3.2.1.2. Steel tubular poles

(i) These shall conform to IS:2713 (Parts 1 to 3)-1980. These shall be of seamless/swaged and welded type in three stepped sections as specified.

(ii) The pole shall be complete with cap and base plate.

(iii) Unless otherwise specified, one sixth of the length of the pole plus 30cm from its base shall be coated with black bituminous paint, both internally and externally. The remaining portion of the pole shall be painted with one coat of red oxide primer on its external surface.

3.2.1.3 Steel rail poles

These shall conform to the standard specifications of the Indian Railways.

3.2.1.4 Cement concrete (RCC/PCC) poles

(i) Reinforced cement concrete (RCC) and pre-stressed cement concrete (PCC) poles shall conform to IS:785-1964 and IS:1678-1978 respectively. These shall carry an earth bond in accordance with Rule 90 of the Indian Electricity Rules.

(ii) The dimensions shall be as per designed conforming to local requirements.

(iii) Concrete poles shall be treated with suitable chemicals like silicate for the portion to be buried in ground where the subsoil water level is high and/or acidic as in coastal areas .

(iv) The selection of the poles shall be done in accordance with IS:7321-1974.

3.2.1.5 Fabricated poles

These shall be made from Galvanised Iron (GI) pipes or mild steel(MS) pipes (seamless or ERW), or fabricated from structural steel. Details of such supports shall be specified in tender papers.

3.2.2. Line materials

3.2.2.1. Cross arms

(i) (a) The cross arms for overhead lines shall be made either of MS angle iron of size not less than 50mmx50mmx6mm thick (4.5kg/m) for LV/MV lines and 65mmx65mmx6mm thick (5.8kg/m) for 11 KV lines, or of MS channel iron of size not less than 75mmx40mmx4.8mm thick (7.14Kg/m), (for LV/MV/11KV lines) as specified. The channel iron cross arms may be straight type for LV/MV, and straight or V-cross arms for 11KV, as specified.

(b) The cross arms for overhead lines for 22KV/33KV shall be fabricated either from 75mmx40mm (7.14Kg/m), or from 100mmx50mm (9.56 Kg/m) channel iron, as specified, fabricated as V-cross arms.

(ii) (a)The length of cross arms shall be suitable for accommodating the required number of insulators on them with the spacing of conductors in accordance with clause 3.3.3.1.

(b) Where guard wire cradle is specified to be fixed directly to the cross arms (without additional brackets), the length of cross arm supporting the cradle shall be such that the clearances specified in clause 3.3.3.7 is satisfied.

(c) The cross arms shall have holes for fixing on to the poles and for taking insulator pins,wire guards etc., as required. A minimum distance of 5cm for LV/MV lines and 10cm for HV lines shall be left from the center of the extreme insulator pin hole to the end of the cross arm.

(d) Table VII indicates the cross arm lengths based on the above requirements.

(iii) Unless otherwise specified, a triangular configuration shall be adopted for HV overhead lines. Where specified, the cross arm supporting the lower two conductors over pin insulators shall be provided with 50mmx50mmx6mm thick (4.5kg/m), angle iron bracket duly welded to it so that the cross arms are double clamped

to the poles for rigidity. However, such double clamping arrangement shall necessarily be provided in cases of HV overhead lines, where in-line configuration is adopted, whether or not so specified in tender papers.

(iv) Details of cross arms are illustrated in figure 5 for guidance.

(v) The cross arms shall be complete with pole clamps made of MS flat of size not less than 50mmx6mm with necessary bolts, nuts and washers.

3.2.2.2. D-Iron clamps

(i) Where vertical configuration is specified in tender documents for MV overhead lines, the conductors shall be supported on shackle insulators which shall be fixed to the poles by means of D-shaped clamps made of MS flat of size not less than 50mmx6mm and galvanised.

Note:- Vertical configuration shall not be adopted for HV lines.

(ii) The dimensions of D-iron clamp shall be such as to hold a 75mm high and 90mm (nominal) diameter shackle insulator. (as indicated in figure 6A).

(iii) The D-iron clamp shall be complete with pole clamp, made of 40mmx6mm flat iron and necessary GI bolts, nuts and washers and holes for fixing insulator pins.

3.2.2.3. GI straps

(i) Where D-iron clamps are not specified for shackle insulators, a pair of strap plates of hot dip galvanised iron of size 40mmx3mm thick and length 23 cm shall be used. (as indicated in figure 6B).

(ii) The fittings shall conform to IS:7935-1975.

3.2.2.4. Pole top bracket

The pole top bracket for supporting a single pin type insulator shall be made of flat iron 50mm x 8mm as shown in figure - 6C.

3.2.2.5. Cradle guard bracket

Where brackets are used for supporting cradle guards on cross arms, these shall be made of 50mm x 6mm flat iron, shaped such that clearance with the line conductors as specified in 3.3.3.7 is achieved. These shall be welded to the cross arms or fixed to them with double bolts nuts and washers, thus preventing its movement sideways .

3.2.2.6. The nuts bolts and washers used for fixing of hardware accessories shall be cadmium passivated or galvanised.

3.2.3. Stay sets

3.2.3.1. Locations and number

(i) Stays shall be provided on to the poles at locations where a pull from the conductors on one direction is likely to be experienced such as terminal poles, or at the deviation point(s) of the line from straight run etc. These shall be specified in the drawings.

(ii) The stays shall be provided on the side of the pole opposite to the likely direction of pull from the line i.e., opposite to where the shackle/disc insulators are provided. In the case of deviations from straight runs, the stays shall be provided opposite to the side of deviation and preferably on the bisection of the angle of deviation.

(iii) The number of stay sets to be provided shall be decided depending on the likely pull to be experienced on the pole, dictated by the length of span, number and size of conductors etc. Guidelines on the same are given in Appendix-G.

3.2.3.2. Construction

(i) A stay set shall consist of stay rod, anchor plate, bow tightener or turn buckle, thimbles, stay wire, strain insulator and stay clamp as per details shown in figs. 7A, 7B & 7C.

(ii) All components of the stay set assembly shall be of MS and galvanised.

(iii) The stay rod shall be not less than 1.80m long and 19mm dia. The stay rod shall be with stay clamp in case turn buckle is used instead of bow tightener.

(iv) The anchor plate shall be not less than 45cmx45cmx7.5mm thick.

(v) The stay wire shall be either 7/4mm dia or 7/3.15mm dia GI as specified and generally conform to grade 2 of IS:2141-1979 .

(vi) The strain insulator shall conform to IS:5300 -1969.

The recommended types of strain insulators for use on stay wires of overhead lines of different voltage levels are as follows.

Line voltage	Designation of Insulation
240V/415V	"A"
11KV/33KV	"C" (2 Insulators to be used/ line for 33KV)

3.2.4. Struts

3.2.4.1 Struts are provided wherever stays cannot be provided due to any obstruction, or where the stays themselves can cause an obstruction. A strut is normally provided opposite to the direction in which a stay would have been provided.

3.2.4.2 Normally, one strut would be adequate for each pole. However, where the angle of deviation is large, two struts may be required for each pole at the point of deviation.

3.2.4.3 A strut shall generally consist of a pole of the same section which it supports or slightly lighter as specified in the contract.

3.2.5. Insulators & insulator fittings

3.2.5.1. Insulators - general

(i) Porcelain insulators shall conform to IS:1445-1977 for lines below 1000V and to IS:731-1971 for lines with voltage greater than 1000V.

(ii) The insulators shall be vitreous throughout and non-absorbent. The exposed surface shall be glazed.

(iii) These shall have adequate mechanical strength, high degree of resistance to electrical puncture and to climate and atmospheric attack.

3.2.5.2. Types of Insulators

(i) The insulator shall be any of the following types, as specified.

(a) Pin/Shackle insulators for LV/MV overhead lines.
(b) Pin/Disc type insulators for HV overhead lines.

(ii) Shackle insulators shall be used when the configuration of conductors (in MV lines) is vertical. Shackle/disc insulators shall also be erected on cross arms of supports in case of long spans, deviation from straight line by more than 30 degrees, terminal positions, junction poles etc.

3.2.5.3. Size of insulators

(i) The minimum size of shackle insulator for LV/MV overhead lines shall be 90mm dia x 75mm high.

(ii) The minimum size of pin insulator for LV/MV overhead lines shall be 65mm dia x 100mm high.

(iii) The pin insulator shall be suitable for 12mm cordeau threaded GI pin, nuts and washers.

3.2.5.4. Insulator fittings

(i) The insulator fittings shall comply with IS:2486(Part-1)-1971 and IS:2486 (Part-2)-1989 for 11KV and 33KV insulators, and with IS:7935-1975 for LV/MV insulators.

(ii) **Pin insulator fittings**

(a) The pins suitable for the pin insulator for the LV and MV overhead lines shall have a stalk length 135 mm shank length of 125 mm and minimum failing load of 2 KN.

(b) The pins suitable for 11 KV pin insulators shall have stalk length of 165 mm and shank length of 150 mm and minimum failing load of 5 KN.

(c) The pins suitable for the 33 KV pin insulators shall be large steel head type L 300 N as per IS:2486 Part-II having stalk length of 300 mm and shank length of 150 mm and minimum failing load of 10 KN.

(d) The pins for pin insulators shall conform to the requirements in Table VII.

(e) The pins shall be of single piece MS without joints, obtained by the process of forging..

(f) The pins, nuts and washers, shall be galvanised.

(g) The threads of nuts and tapped holes shall be cut before galvanising and shall be well oiled or greased.

(iii) **Disc insulator fittings**

(a) The insulator fittings for disc insulators shall be either of ball and socket type or clevis and tongue type depending upon the type of disc insulators specified in the tender documents.

(b) The strain clamps for string insulators shall be suitable for ACSR conductors 7/3.55mm (50sqmm aluminium area), 7/4.09mm (80sqmm aluminium area) and 6/4.72mm and 7/1.52mm (100sqmm aluminium area)., as required. The ultimate strength of the clamps shall not be less than 41KN.

3.2.6. Conductors

3.2.6.1. Types of conductors

The conductors shall be any of the following types as specified.

(a) All aluminium stranded conductors, conforming to IS:398(Part-1)-1976.

(b) Aluminium conductors galvanized steel reinforced, conforming to IS:398(Part-2)-1976.

(c) Aluminium alloy stranded conductor, conforming to IS:398(Part-4)-1979.

Note:-Broad details of some conductors are given in Table VIII.

3.2.6.2. Choice of conductors

(i) The physical and electrical properties of different conductors shall be in accordance with relevant Indian Standards.

(ii) All conductors shall have a breaking strength of not less than 350Kg. However, for LV lines with spans less than 15m, conductors with breaking strength of not less than 140Kg may be used.

(iii) The size of conductors for a line shall be selected considering the power to be transmitted, length of line, line voltage, permissible voltage regulation etc. The size(s) shall be specified in contract.

(iv) No conductor of cross section smaller than the following shall be used for distribution lines.

Voltage of line	All aluminium stranded	ACSR	Aluminium Alloy Stranded
LV/MV	7/2.21mm	6/1/2.11mm	7/2.09mm (20 sqmm Al.area)
11KV/33KV	-----	6/1/2.11mm	7/2.56mm (30 sqmm Al.area)

3.2.7. Binding material

Binding of conductors with the insulators shall be done with 2.6mm (12SWG) soft aluminium conductors.

3.2.8. Guard wire

(i) Guard wire shall be of GI 4mm dia (8SWG), AAC(7/3.10mm) or ACSR (7/2.59mm). Crosslacings may be of GI wire (minimum 3.15mm dia) or scrap lengths of AAC or ACSR conductors used in the line. It shall have a minimum breaking strength of 635Kg, in accordance with Rule 88 of the Indian Electricity Rules.

(ii) It shall also be of sufficient current carrying capacity to ensure rendering the line dead without the risk of fusing the guard wire or wires, till the contact of the line wire has been removed.

(iii) Protective guarding of overhead lines shall comply with the requirements of Rule 88 of the Indian Electricity Rules.

3.2.9. Earth wire

The size of the continuous earth wire shall not be less than 4mm(8SWG) GI.

3.2.10. Lightning arresters

3.2.10.1. These shall conform to IS:3070(Part-1)-1985.

3.2.10.2. Types of lightning arresters

(i) Horn gap type arrester.

This type of arrester shall be used for LV/MV lines as specified.

(ii) Surge Diverter

Single pole units enclosed in GI case for outdoor mounting shall be used for system not exceeding 650V.

(iii) Non-linear Resister Type Lightning Arrester

(a) This type of arrester shall be used in an effectively earthed system with a nominal line voltage of 11KV/22KV/33KV.

(b) The rated voltage of the lightning arresters suitable for 33KV lines shall be 30KV (RMS) with nominal discharge current rating of 10KA (Station Class) in lines.

(c) The rated voltage of lightning arresters suitable for 11KV lines shall be 9KV (RMS) with a nominal discharge current rating of 5KA.

(d) The system shall be effectively earthed (Coefficient of earth not exceeding 80 percent as per IS:4004-1985) with the neutrals of all the transformers directly earthed.

3.2.10.3. The lightning arrester system shall conform to Rule92 of the Indian Electricity Rules.

3.2.11. Paint

(i) Only paints of approved make and shade conforming to relevant Indian Standards shall be used. These shall be in original containers of the manufacturers.

(ii) Primer coats shall be with red oxide paint.

3.3. LINE LAYOUT

3.3.1. Route

3.3.1.1 General

The route of overhead lines shall be adopted considering the following :-

(i) The route of LV/MV overhead lines shall generally follow the layout of roads except in particular stretches specified. However, HV lines can be routed through cross country also, especially in remote locations.

(ii) As far as possible, the present and future requirements of other agencies and utility services affected shall be considered, both for the line and for stays/struts.

(iii) Overhead lines shall not be erected in the vicinity of Aerodromes until the Aerodrome authorities have approved in writing the route of the proposed lines in accordance with Rule 84 of the Indian Electricity Rules.

(iv) The route shall be so chosen as to avoid use of struts and continuous curve in the overhead line as far as possible.

3.3.1.2. LV/MV lines

The following shall be considered for locating the poles of LV/MV overhead lines:-

(i) Poles shall be located alongside roads, on the road berm, a little away from the road edge and drain.

(ii) There shall be a pole located at each road junction.

(iii) Junction of main road and a service lane shall be preferred for location of pole so that the street light will benefit the service lane as well.

(iv) Front of entrance to building shall be avoided for locating poles. However, in the case of residential colonies, the street lighting poles shall be located such that the entrance to the blocks are lit up, as far as possible.

3.3.1.3. The route of overhead lines and pole locations shall be indicated in tender drawings. Modifications, if any, required to suit site conditions can be done only with the prior approval of the Engineer-in-charge.

3.3.1.4. Way leave

Way leave for the proposed route of overhead line shall be arranged by the Department from the appropriate authorities, such as State Public Works, Drainage, Public Health and Water Works/ Municipal authorities, Telephone and Telegraph, Gas Works, Railways, Director General of Civil Aviation, other Undertakings, owners of properties etc. as may be required.

3.3.1.5. Cutting of trees etc.

Where the route of overhead lines involves a need to cut branches of trees or clearing of other obstructions that may come in the way of the overhead lines, this may only be done with the prior approval of the Engineer-in-Charge and with the permission of the owners concerned.

3.3.2. Spacing of poles

Spans of over head lines shall be decided considering the following:-

(i) Clearances as laid down in clause 3.3.3 shall be satisfied, for the pole length and conductor sizes selected.

(ii) Requirements of Rule 85 of the Indian Electricity Rules shall be complied with.

(iii) Where street lighting is provided with overhead line system, the span shall be such that lighting is adequate, but the span may not exceed 45 m.

3.3.3 Clearances

3.3.3.1. The spacing of conductors depends on their disposition and is determined by the line voltage, sag, span, swing amplitude and type of structure. It shall comply with the requirements given in Table IX. Typical formation of conductors are indicated in figure 8(A) to 8(E).

3.3.3.2. The minimum clearance of the lowest conductor above ground level across a street, along a street and elsewhere for different voltage systems shall be in accordance with Rule 77 of the Indian Electricity Rules.

3.3.3.3. The minimum clearance of overhead lines and service lines for different voltage systems from buildings shall be in accordance with Rules 79 and 80 of the Indian Electricity Rules.

3.3.3.4. When conductors of different voltages are erected on the same support, Rule 81 of the Indian Electricity Rules shall be complied with. The clearance between LV/MV and 11KV lines shall be not less than 1m.

3.3.3.5. A clearance of not less than the height of the tallest support may be maintained between parallel overhead lines on different supports.

3.3.3.6. When two overhead lines cross, the crossing shall be made at right angles as far as possible. The vertical clearance between LV/MV lines and 11KV lines shall not be less than 1.25m. The clearance between LV/MV lines and 22KV/33KV lines shall not be less than 2m.

3.3.3.7. The minimum clearance between guard wire and LV/MV line shall be 10cm and between guard wire and 11KV/33KV line shall be 30cm.

3.3.3.8. Rules 86 and 87 of the Indian Electricity Rules shall be followed for clearance between power and telecommunication lines and shall not be less than 1.5m for lines upto 11KV, and 2m for lines above 11KV and upto 33KV.

3.3.3.9. Crossing of Railway lines shall be done as per Specifications for crossings and in consultation with the Railway authorities.

3.4. EXCAVATION FOR FOUNDATION

3.4.1. General

3.4.1.1. The locations of supports, stays and struts shall be pegged accurately before the excavation work is taken up.

3.4.1.2. Care shall be taken to see that the minimum amount of soil is disturbed so as to take advantage of the bearing capacity of the virgin ground, (and that the pits are not oversized) after taking into consideration the size of the foundation.

3.4.1.3. Pits shall not be left unfilled for unduly long periods so as to avoid accidents. While being kept open, protective measures such as suitable caution signs, caution lights, barricading etc. as necessary should be provided near the pit(s) to warn the pedestrians/ vehicular traffic, till such time the pit is back filled and surface leveled.

3.4.1.4. The pit for support/stay/strut shall be filled up or concreted only in the presence of the Engineer-in-Charge of the work.

3.4.2. Excavation for supports

3.4.2.1. The depth of pit shall be such that normally 1/6th of the length of the pole is buried in the ground. The size of the pit shall be suitable for the foundation of the supports as per clause 3.5.1.

3.4.2.2. The pits should be excavated in the direction of the lines.

3.4.3. Excavation for stays

3.4.3.1. The position of pit shall normally be such that the stay makes an angle of 30 to 60 degrees with the support.(Higher angle is preferred).

3.4.3.2. The depth of pit shall be such that normally a length of 45cm of stay rod shall project above the ground level.The size of the pit shall be suitable for the foundation of stay as per clause 3.5.2.2.

3.4.4. Excavation for struts

3.4.4.1. The pit for struts shall be located at a distance of not less than 1.8m from the pole.

3.4.4.2. The depth of pit shall be such that at least 1.2m of the strut is buried in the ground and the size of the pit shall be suitable for the fcundation of the struts.

3.5. ERECTION

3.5.1. Erection of supports

3.5.1.1. The supports shall be correctly aligned before concreting or the back filling of the pit, as the case may be.

3.5.1.2. All supports including RCC and PCC poles shall be erected over a cement concrete 1:3:6 (1 cement: 3 coarse sand: 6 graded stone aggregate of 40mm nominal size) bed of 15cm thick, either cast in situ or precast and laid in the excavated pit, irrespective of the provision of a base plate. The area of this cement concrete bed shall be 0.35sqm for steel tubular/rail and other steel poles and 0.5sqm for RCC/PCC poles.

3.5.1.3. The supports shall be erected in the following manner depending on the type of support.

(a) Steel tubular /steel rail/ other steel poles shall be fixed in cement concrete 1:3:6 (1 cement: 3 coarse sand: 6 graded stone aggregate of 40mm nominal size) foundation with not less than 20cm thick layer of the cement concrete all round the support, the foundation being continued upto 15cm above ground level and tapered suitably into a collar.

(b) RCC/PCC poles shall be erected with a filling of brick or stone ballast, with excavated earth as binder, well consolidated. The ramming shall be done in layers of 20cm. Water as necessary shall be used during this operation. The sectional area of the consolidated ballast foundation shall not be less than 0.5sqm including the area occupied by the support itself and shall be maintained upto the ground level.

RCC/PCC poles, except where specified otherwise, do not require any setting in concrete. No cement concrete collar is also necessary for such types of poles.

3.5.1.4. After concreting, the excavated earth shall be back filled and well consolidated in layers of 20cm.

3.5.1.5. Watering of concreted foundation above ground level and curing for at least two weeks shall be done by using moist gunny bags etc. before loading the pole.

3.5.2. Erection of stay sets and struts

3.5.2.1. The stay rod will be set in position in the excavated pit as shown in figure 7, the rod being straight or bent as laid down in clauses 3.5.2.2.(i) or (ii) as the case may be. The correct positioning and setting of stay set is essential.

3.5.2.2. (i) The straight stay rod with the anchor plate shall be embedded in cement concrete 1:3:6 (1 cement: 3 coarse sand: 6 graded stone aggregate of 40mm nominal size) not less than 0.28cum in content in such a way that the top of the concrete block is well below the ground level to prevent uprooting of the stay rod.

(ii) Alternatively, the bent stay rod shall be embedded vertically in cement concrete 1:3:6 (1cement: 3coarse sand: 6 graded stone aggregate of 40mm nominal size) foundation 42cmx42cm in section, the anchor plate lying over 15cm thick cement concrete. The bend in the stay rod shall be 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 damage to galvanisation .

3.5.2.3. After the concrete has set , back filling shall be done with excavated earth and ramming in layers of 20cm using water as required.

3.5.2.4. The top surface of concrete around the stay rod shall be cured by means of moist gunny bags etc. for at least 2 weeks before loading the stays.

3.5.2.5. The stay clamp shall be located just below the lowest cross arm on the pole so that it is as close to the center of gravity of the pull of the overhead conductors as possible. In the case of poles with vertical formation LV/MV line, special bracket as per detail in Figure 7B shall be used for the purpose.

3.5.2.6. One end of the stay wire shall be fixed to the bow tightener or the stay grip of the stay rod and the other end to the clamp fixed to the pole by means of well spliced joints using GI thimbles. A strain insulator shall be provided approximately at the middle of the stay wire. Turn buckle, when used, shall be installed at the top of the stay wire.

3.5.2.7. The stay wire shall be connected and bonded properly to the continuous earth wire.

3.5.2.8. Where Double sets are specified due to large pulling force, these shall as far as possible be set parallel to each other or shall be so placed that one does not reduce the strength of the other by suitable spacing between the two pits.

3.5.2.9. The stay rod, where so specified in tender documents, shall be protected with GI pipe, which shall not be less than 5cm dia and 1.5m long, placed so as to be 0.6m. below ground. The length of the stay rod shall accordingly be increased.

3.5.2.10. If the stay rod cannot be erected in accordance with the above clauses due to the existence of a road or an obstruction etc., bow stay, fly stay or strut, whichever is suitable to the location shall be used, as may be directed by the Engineer-in-charge.

3.5.2.11. **Bow stay**

(i) Bow stay shall consist of a brace made of 50mmx50mmx6mm thick angle iron with a 5cm pulley on the outer end or a hole, to allow for free motion of stay wire, in addition to other accessories required for stay set mentioned in clause 3.2.3.2. The arrangement shall conform to figure 7C.

(ii) The stay wire shall be clamped to the pole on the top and the other end to a stay rod, passing over the pulley or through the hole in the brace. The brace shall be clamped at about 2/3rd height of the pole from the ground level. This can be increased if so required, but in no case should the brace be closer to the lowest cross arm/D-Iron clamp by less than 1m. The stay rod shall be embedded in cement concrete foundation in the usual manner, as near as possible to the pole at about 1m from the pole.

(iii) Where the site condition does not permit allowing a space of 1m as above, the bottom end of the stay wire may be clamped to the pole near ground.

3.5.2.12. **Fly stay**

(i) The fly stay shall consist of a fly pole, stay wire running over the obstruction and the usual stay arrangement for the fly pole, as shown in figure 7C.

(ii) The stay wire crossing the obstruction shall be clamped at one end to the top of the fly pole with a turn buckle. The fly stay shall be taken at such a height as may be directed by the Engineer-in- Charge. When a fly stay is taken across a road, it shall conform to traffic regulations.

3.5.2.13 **Erection of struts**

The strut shall be buried in the ground as mentioned in clause 3.4.4. and erected in the same manner as the pole. It shall rest on the pole squarely and shall be firmly secured by GI clamp. A typical clamping arrangement is shown in figure 9.

3.5.3 Erection of Line materials

3.5.3.1 Cross arms

(i) Cross arms shall be clamped to the support properly, taking into consideration the orientation of the lines.

(ii) Double clamping shall be provided where required, as laid down in clause 3.2.2.1 (iii).

3.5.3.2. D-Iron clamps

(i) D-iron clamps shall be fixed to the support either by a through bolt and nut arrangement, or by a suitable GI pole- clamp, bolt and nut.

(ii) These shall be installed vertically on the supports complying with the required vertical clearance between conductors.

3.5.4. Erection of insulators

3.5.4.1. Pin insulators and shackle / disc insulators shall be erected on cross arms. Where D-iron clamps or GI straps are specified, shackle insulators shall be erected in them.

3.5.4.2. Where so directed by the Engineer-in-charge, pin insulators may be provided above in addition to disc/shackle insulators over the cross arm, so that the line conductors are properly routed with adequate clearances (see also 3.5.7.2).

3.5.4.3. Care shall be taken that insulators are not damaged during handling and erection. Damaged insulators shall not be used for any reason.

3.5.5. Stringing of conductors

3.5.5.1. Handling

(i) The general precautions during storage and handling shall be taken in accordance with the clause 2.5 of these General Specifications.

(ii) Particular attention is necessary when handling aluminium (AAC/ACSR) conductors because of their relative softness.

(iii) While paying off, the conductors shall be taken from the top of the drum and the drum shall be rotated in the direction of the arrow marked on it.

(iv) Care shall be taken during paying off to avoid damage due to contact with steel works, fence etc. by giving soft wood protection, using wooden rollers etc.

3.5.5.2. When the work is being carried out adjacent to and/or for connecting to an existing system in operation, adequate safety precautions for isolation, discharging, earthing etc. shall be taken on the existing line to ensure that the lines do not inadvertently get charged from live supply. Where "Permit to Work" system is in vogue, the prescribed safety procedure shall be complied with.

3.5.5.3 Appropriate tools only shall be used for the stringing work. All the strands of the conductor must be gripped securely when pulling the conductor.

3.5.5.4 During the stringing operation, standard sag tables or charts shall be followed.

3.5.5.5. Care shall be taken to see that there are no kinks in the conductors.

3.5.5.6. Angle or section points shall be selected while pulling the conductors. While stringing, conductors of sufficient length shall be kept at shackle terminations for making jumpers.

3.5.5.7. After stringing the conductor, it shall be clamped permanently with shackle or strain clamps.

3.5.5.8. Joints if any in conductors shall be staggered. Mid span joints in conductors shall however be generally avoided.

3.5.6. Binding of conductors

3.5.6.1. The binding of conductors to insulators shall be sufficiently firm and tight to ensure that no intermittent contacts develop.

3.5.6.2. The ends of the binding wire shall be twisted in a closely spaced spiral around the conductor to ensure good electrical contact and to strengthen the conductor.

3.5.7. Jumpers

3.5.7.1. Jumpers shall be neat and as far as possible symmetrical to the run of conductors. These shall be so made as to prevent occurance of fault due to wind or birds.

3.5.7.2. Where necessary, the jumpers shall be with insulated conductors or taken on intermediate pin insulators as specified. For HV lines, the jumpers should be so arranged that there is a minimum clearance of 30cm under maximum deflection condition due to wind between the live jumper and other metallic parts. Erection of intermediate pin insulators may be necessary for fixing these jumpers (see also 3.5.4.2).

3.5.7.3. Parallel groove (PG) clamps may be preferred to binding of conductors at jumper locations or service taps.

3.5.7.4. Jumpers used shall normally be of the same material as the line conductor and they shall be of adequate current carrying capacity. If the material of the jumper wire is different from that of the line conductor, suitable bimetallic clamps should be used. If copper to aluminium bimetallic clamps are to be used, it should be ensured that the aluminium conductor is situated above the copper conductor so that no copper contaminated water comes in contact with aluminium.

3.5.8. Earth wire

3.5.8.1. A continuous GI earth wire of size not less than 4mm(8SWG) shall be run all along the LV/MV distribution lines and service lines. This shall be securely fastened to the cross arms by means of cast iron cleats or by suitable clamps as directed by the Engineer-in-Charge.

3.5.8.2. Where a continuous carpet guard wire is provided, the same shall serve the purpose of continuous earth wire run mentioned above.

3.5.9. Erection of guard

3.5.9.1. A guard shall be provided at all road crossings of overhead lines, crossings with other lines and between HV and LV/MV lines carried on the same support.

3.5.9.2. A cage guard shall be provided for LV/MV over head lines of vertical configuration. Cradle guard shall be used for overhead lines of horizontal configuration. Where no guard of any of these types is provided, a ring guard supported from the pole shall be arranged (refer figure 10).

3.5.9.3 In case of cradle/ cage guards , at least 9 laces shall be provided for each span.

3.5.9.4 The guard wires shall be bonded to the earth wire.

3.5.9.5 Reel insulator shall be used to bind the cage guard to the neutral.

3.5.9.6 The guard wire shall always run not less than 30cm beyond the outer most bare conductor of the configuration in the case of 11KV/33KV lines, and 10cm in the case of LV/MV lines.

3.5.10. Earthing

3.5.10.1 Earthing installation shall conform to various clauses under Chapter 8 of the CPWD General Specifications for Electrical Works (Part I-Internal), 1994.

3.5.10.2. All metal supports and RCC/PCC supports of overhead line, and metallic fittings attached there-to shall be permanently and efficiently earthed, and for this purpose a continuous earth wire shall be run as per clause 3.5.8. In the case of RCC/PCC poles, all insulator pins, cross arms, stays, street light brackets and other metallic fittings shall be bonded to the continuous earth wire.

3.5.10.3. The continuous earth wire shall be connected to earth. There shall be not less than 3 connections with the earth per kilometer, spaced at equi-distance as far as possible. Where a continuous earth wire cannot be provided, every pole should be earthed and all the metal parts are to be bonded, with the concurrence of the Engineer-in-charge.

3.5.10.4. Junctions, end terminal locations, and all special structures may be selected for connecting to earth.

3.5.10.5. The lead from the earth electrode shall be suitably protected by a 15mm dia GI pipe upto a height of 3m from the ground level and shall be bonded to the continuous earth wire.

3.5.10.6. The protection pipe and the earth lead shall be suitably clamped to the support.

3.5.11 Safety and protective devices

3.5.11.1. Danger board

All supports carrying HV lines shall be fitted with danger plate conforming to IS:2551-1982 at a height of 3m from ground and it shall indicate the voltage of the line.

3.5.11.2. Anticlimbing devices

Necessary arrangement for preventing unauthorised persons from ascending any of the supports carrying HV lines without the aid of a ladder or special appliances shall be made. Unless otherwise specified, barbed wire conforming to IS:278-1978 having 4 point barbs, spaced 75mm ± 12mm apart and weighing 108/125gm/m, shall be wrapped helically with a pitch of 75mm around the limb of the support and tied firmly commencing from a height of 3.5m and upto a height of 5m or 6m as directed by the Engineer-in-Charge.

3.5.11.3. Lightning arresters

(i) Horn Gap type lightning arrester

(a) Horn gap type lightning arrester for LV/MV lines and surge diverter suitable for MV lines shall be employed with each phase at terminals and any other places where specified, depending upon the local climatic conditions. These shall be mounted on cross arms.

(b) A short and definite air gap not exceeding 2cm must be maintained between the horns.

(ii) Non-linear resistor type lightning arrester

(a) Non-linear resistor type lightning arrester suitable for HV lines shall be installed, one unit per phase, at the terminals, transformer stations etc. as specified.

(b) These devices shall be connected ahead of fuses, if any, provided.

(iii) Earthing for lightning arresters

(a) An independent earth electrode shall be provided for lightning arresters.

(b) The earth lead from the earth electrodes to the lightning arresters shall be continuous, and where specified, it shall be insulated throughout above the earth surface by an alkathene pipe.

3.5.12 Double / Triple / Four Pole Structure :-

3.5.12.1. Where a HT overhead line deviates by more than 10 degrees, a double pole, triple pole or four pole structure may be erected at the point of deviation depending upon the angle of deviation. Normally, a double pole structure should suffice for an angle of deviation upto about 30 degrees, a triple pole structure upto an angle of deviation upto 60 degrees, and a four pole structure beyond that angle of deviation.

3.5.12.2. The structure shall comprise of the same type of poles as used for the overhead lines unless otherwise specified.

3.5.12.3 A set of double channel iron cross-arms of the same length duly clamped by through bolts and nuts shall be provided for each double pole structure. Similar set of double channel iron cross-arm shall be likewise clamped to each side of the triple and four pole structures. The two channel iron lengths of the double channel iron cross arm shall be stepped to each other by 50 mm x 6 mm flat iron strips to prevent bulging of the cross arms during stringing of the lines. These flat iron strips shall be bolted to the two channel iron lengths adjacent to each strain/ disc insulator fittings supported by the cross arm.

3.5.12.4 A set of double channel iron cross-arms of the same length duly clamped to the poles by through bolts and nuts shall be provided for each double pole structure. Similar set of double channel iron cross-arms shall be likewise clamped to each side of the triple and four pole structures. The two channel iron lengths of the double channel iron cross arm shall be strapped to each other by 50 mm x 6 mm flat iron strips to prevent bulging of the cross arms during stringing of the lines. These flat iron strips shall be bolted to the two channel iron lengths adjacent to each strain/ disc insulator fitting supported by the cross arm.

3.5.12.5. Cross Bracings

(i) A set of cross bracings fabricated out of 50mmx50mmx6mm angle iron for 11KV lines , and out of 65mmx65mmx6mm for 33KV lines shall be provided for each double pole structure.

(ii) Three such sets of cross bracings shall be provided for each triple pole structure.

(iii) Four sets of such cross bracings shall be provided for each four pole structure.

(iv) The horizontal members of the bracings shall be fixed to the poles by means of clamps fabricated out of 50mmx6mm flat iron. The inclined members of the cross bracings shall be fixed to the horizontal members by suitable bolts and nuts, after pressing together by forging the two sides of the angle iron at either end of the inclined members.

(v) The cross bracings shall be so fixed as to form a rectangle of minimum size 1.4m width x 2.5m height in case of 11KV lines, and of 2.4m width x 2.8m height in case of 33KV lines.

(vi) The cross bracings shall be fixed more or less in the middle of the structure.

3.6. SERVICE CONNECTION LINE

3.6.1. No service connection shall be taken off an overhead line except at a point of support.

3.6.2. The service line shall be either through an overhead service or underground cable, as specified. In case of overhead services, the same may be provided with either (a) bare conductors, or, (b) insulated conductors.

3.6.3. Service line with bare conductors

3.6.3.1 Any of the following methods shall be adopted as specified:-

(i) First Method

(a) The bare conductors shall be strung with shackle insulators fixed to cross arms at both ends. The feeding end cross arm shall be fixed to the support and the one at receiving end shall be mounted on a GI pipe of minimum 5cm dia. The bare conductors shall be kept at a height of at least 2.5m from the top of the structure in accordance with Rule 79 of the Indian Electricity Rules.

(b) The GI pipe shall be provided with double bends at the top. The pipe shall be secured by atleast 2 clamps made of 50mmx6mm MS flats fixed firmly to the wall in the vertical position. It shall in addition be provided with a GI stay wire of 7/3.15mm size anchored to the building with an eye bolt.

(c) Service connection shall be given from the overhead service line, with weather proof/PVC insulated cable through this GI pipe. Well fitting PVC bushes shall be provided at both ends of this GI pipe.

(ii) Second method

(a) The bare conductors shall be strung with shackle insulators as above except at the receiving end, where the insulators shall be fixed to a bracket in a suitable form made of angle iron of size not less than 50mmx50mmx6mm. The ends of the bracket shall be cut and split and embedded in the wall with cement mortar.

(b) The bare conductor shall be kept at least 1.2m away from the edge of the structure in accordance with Rule 79 of the Indian Electricity Rules.

(c) The service connection shall be given with weather proof/ PVC insulated cable through GI pipe of minimum 4cm dia fixed to the wall. The GI pipe shall be bent downwards near the service entry. Well fitting PVC bushes shall be provided at both ends of the GI pipe.

3.6.3.2 The service line with bare conductors shall be guarded wherever required in accordance with the Indian Electricity Rules.

3.6.4. Service line with insulated conductors

(i) Service connection may be given by weather proof cable/PVC insulated PVC sheathed cable on GI bearer wire.

(ii) The cable shall be supported by the bearer wire by means of suitable link clips spaced 30cm apart, or by porcelain cleats 50cm apart.

(iii) The GI bearer wire shall be of minimum 3.2mm(10 SWG) size. One end of the GI bearer wire shall be attached to a clamp which is fastened to the nearest pole carrying the distribution lines from where the service connection is intended to be given. The other end of GI wire shall be fastened to a 5cm dia GI pipe for a span upto 4.5m which shall be fixed to the wall with guy etc.

(iv) The GI pipe shall be fixed to an angle iron of size 40mmx40mmx6mm thick with suitable guy for high supports and for a span exceeding 4.5m.

(v) Alternatively, when the height of the structure permits minimum ground clearance, the other end of this GI bearer wire may be fixed to a hook, eye-bolt or bracket embedded with cement mortar in the wall. The weather proof/PVC insulated and PVC sheathed cable shall pass through GI pipe of minimum dia 5cm which is bent downwards. Well fitting PVC bushes shall be provided at both ends of the GI pipe.

3.6.5 Service line by underground cable

(i) Service cables shall be PVC insulated PVC sheathed armoured UG cables to the specified size(s).

(ii) The service cable from an overhead distribution line shall be fixed to the support with 2 Nos. of clamp of MS flat of size 50mmx6mm. This shall be protected upto a height of 3m from ground level by a GI pipe of adequate size, clamped to the support with 2 Nos. of MS flat of size 50mmx6mm. The service cable shall be laid in accordance with chapter 2 of these Specifications.

(iii) The service cable shall be terminated to an outdoor cable termination box fixed to the support. The connection with the over head line shall be given either by the cores of the service cable directly or through separate insulated leads as specified.

3.6.6 Service fuses

Unless otherwise specified, an ICDB (with rewireable fuses) may be provided on the pole for the purpose.

3.7. PAINTING

3.7.1. Treatment of all supports and line materials before or at the time of erection shall be done in accordance with the relevant sub clauses of clause 3.2.11. The cross arms and the pole clamps 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.

3.7.2. After erection, the external surface of metal supports above ground level and all pole fittings shall be given finishing coats of painting.

3.7.3 The following procedure for painting/repainting works shall be adopted.

(i) In the case of line accessories, all rust and scale shall be removed by scraping, or by brushing with steel wire brush. All dust and dirt shall be carefully and thoroughly wiped away. Painting shall not be done when the surface is wet or covered with dirt/dust.

(ii) The primer coat shall be applied with red oxide paint. In the case of new supplies, this shall be done before supplying to the site.

(iii) Application of finishing coat at site shall be done with brushes and the paint shall be spread as evenly and as smooth as possible. The surface shall be given two or more coats as specified.

3.8. NUMBERING OF SUPPORTS

3.8.1. All supports shall be numbered after painting, as directed by the Engineer-in-Charge.

3.8.2. Separate number plates may be used, if so specified.

3.9. TESTING OF OVERHEAD LINE

3.9.1. Before connecting the services to transformer, equipments etc. a pressure test of appropriate standard shall be carried out on the line as directed by the Engineer-in-Charge.

3.9.2. Before charging the MV lines, the same shall be tested with a 500V megger for insulation resistance. Similar testing shall be done for 11KV lines with a 2500V megger and for 33KV lines with a 5000V megger.

3.9.3. Where pressure test is not done on a MV line, it shall be tested with a 2500 V/ 5000 V megger for insulation before charging.

3.9.4. All earth sets associated with the work shall be tested.

3.9.5. All test results including earth test results shall be recorded and submitted to the Engineer-in-charge.

3.10. COMMISSIONING

3.10.1. The distribution lines shall be charged only if the pressure/megger test and earth test results are satisfactory.

3.10.2. The lines shall be commissioned in the presence of the Engineer-in-Charge.

3.11. MEASUREMENT OF OVERHEAD CONDUCTORS AND EARTH WIRE

The weight of overhead conductors and earth wire shall be determined by measuring the distance from center of one pole to the center of another pole and computing the weight of the earth wire or conductor by using a standard table. 3% extra shall be allowed collectively for wastage, sag, jointing, binding, jumpers etc.

TABLE VII
(CLAUSE 3.3.2.1 (ii)(d))

CROSS ARM LENGTHS

Line Voltage	No. of horizontal conductors	Length of cross arm
LV/MV	2	55 cm
LV/MV	4	115 cm
LV/MV	4 + Guard	175 cm
11 KV	3	230 cm

Note : If cradle guard is proposed below the 11 KV line, additional Z clamps should be provided from the ends of cross arm, with horizontal conductors of 30 cm from the outer conductors.

TABLE VIII
(CLAUSE 3.3.6.1 (NOTE)
OVERHEAD CONDUCTOR DETAILS

CONDUCTOR	STRADING AND WIRE DIAMETER		CONDUCTOR AREA	APPX. EQUIV. COPPER AREA	CALCULATED RESISTANCE AT 20 Deg.C WHEN CORRECTED TO STANDARD WEIGHT	APP.CURRENT CARRYING CAPACITY		APP. WEIGHT	APP. ULTIMATE STRENGTH
1	2		3	4	5	6		7	8
CODE NAME	NO.OF STRANDS	DIA MM	SQ.MM.	SQ.MM.	OHM/KM	40DEG. C	45 DEG C	KG/KM AMB.TEMP	KG/KM AMB.TEMP
ALL ALUMINIUM (STRANDED) CONDUCTOR (A.A.C)									
GNAT	7	2.21	26.85	16	1.07100	--	---	73	485
LADY BIRD	7	2.79	42.80	25	0.67210	178	165	117	737
ANT	7	3.10	52.85	30.00	0.54440	204	189	144	892
FLY	7	3.40	63.55	40.00	0.45260	229	212	174	1051
BLUE BOTTLE	7	3.66	73.65	45.00	0.39360	252	234	201	1203
EARWIG	7	3.78	78.55	48.00	0.36620	264	245	215	1272
GRASS HOPPER	7	3.91	84.05	50.00	0.34220	275	255	230	1356
CLEGG	7	4.17	95.60	60.00	0.30090	298	276	261	1523
WASP	7	4.39	106.00	65.00	0.27150	318	295	290	1623
ALUMINIUM CONDUCTOR STEEL REINFORCED (A.C.S.R.)									
SQUIRREL	6/1	2.11	24.48	13.00	1.37400	115	107	85	771
GOPHER	6/1	2.36	30.62	16.00	1.09800	133	123	106	952
WEASEL	6/1	2.59	36.88	20.00	0.91160	150	139	128	1136
FERRET	6/1	3.00	49.48	25.00	0.67950	181	681	171	1503
RABBIT	6/1	3.35	61.70	30.00	0.54490	208	193	214	1860
MINK	6/1	3.66	73.65	40.00	0.45650	234	217	255	2207
BEAVER	6/1	3.99	87.53	45.00	0.38410	261	242	303	2613
RACOON	6/1	4.09	91.97	48.00	0.34340	270	259	318	2746

NOTE: Lower and higher sized conductors, which are not in normal use in C.P.W.D. have not been considered and cable charts and I.S 398 (Parts 1&2)-1976.

TABLE IX

(clause. 3.4.3.1)

MINIMUM CLEARANCE BETWEEN CONDUCTORS ON THE SAME SUPPORTS

(a) L.V. Lines

(i) Vertical configuration of conductors

Minimum clearance between earth and live conductors	30 cm.
Minimum clearance between live conductors	20 cm.

(ii) Horizontal configuration of conductors

Minimum clearance between live wires on either side of a support	45 cm.
Minimum clearance between live wires on the same side of a support	30 cm.
Minimum distance between the centre of insulator pin hole and end of cross arm	5 cm.

(b) **H.V. Lines**

Triangular configuration :-

(i) 11 KV Lines

The conductors shall be erected in such a way that they form an equilateral triangular pattern of side of 1 meter minimum.

(ii) 33 KV Lines

The conductors shall be erected in such a way that they form an equilateral triangular pattern of side of 1.5 meter minimum.

CHAPTER 4

OTHER EXTERNAL ELECTRICAL WORKS

4.1 SCOPE

This chapter covers the requirements of External Electrical Installation works, other than cable work and overhead line work. Works relating to street lighting, compound lighting and general lighting of open areas, and feeder pillars are covered. Functional flood lighting involving close design parameters, high mast lighting etc. are not covered here.

4.2 EXTERNAL LIGHTING WORKS

4.2.1 Materials

4.2.1.1. Supports

(i) The supports of overhead LV/MV distribution lines should, as far as possible, be used for street lighting for the corresponding streets.

(ii) Where underground cables are used for LV/MV distribution, the street lighting poles may be of RCC/PCC, or steel tubular type, as specified.

(iii) Street lighting poles shall be of appropriate length, after taking into account the bracket design to meet the lighting design. The stresses likely to be experienced due to wind, and weight of the bracket and luminaire shall be the guiding factor for the selecting the pole section as per relevant BIS.

4.2.1.2. Brackets

Brackets for taking the luminaries with fluorescent tubes shall be of GI pipe of size matching the fixing requirement of the luminaire. Brackets for luminaries with other types of discharge lamps shall be of GI or MS, with or without an extension pipe piece welded to the same, as may be required to fix the luminaire thereto.

4.2.1.3 Looping box

(i) A looping box shall be provided with every pole having underground cable connection.

(ii) The looping box shall be fabricated out of 1.6mm (16SWG) thick MS sheet, with hinged front cover having fixing/locking arrangement. The hinge should preferably be at the top to enable self closing of the cover.

(iii) The looping box shall be of minimum size 250mmx200mmx100mm where 2 core cables alone are involved, minimum 250mmx300mmx100mm where 4 core cables are involved, or any other specified size to suit the individual site requirements.

(iv) The box shall be complete with brass compression gland(s) of appropriate size(s) if specified, earth stud, two MS clamps of 25mmx3mm section for fixing to the pole, the required number of terminal blocks with brass connector strips and fuse carrier with base/MCB, as specified.

(v) The box shall be treated with anti-corrosive paint before erection.

(vi) Depending upon local uses, the control box of CI or some other materials, which will be specifically provided in the tender.

4.2.2. Selection of Compound / Street lighting luminaires

Such luminaires are available in one of the following forms :

(1) Incandescent
(2) Halogen
(3) Compact Fluorescent
(4) Fluorescent
(5) HP MV
(6) HP SV
(7) LP SV
(8) Metal Halide

Use of incandescent lamp should be avoided as far as possible due to very low lumen output and life. For other type table X gives the average lumen output, efficacy, colour rendering and life. Careful selection should be made for most suitable and economical application.

4.2.3. Installation

(i) The poles shall be erected as per relevant clauses in chapter 3.

(ii) Where the work involves provision of looping boxes for cables in street lighting works, these should be installed at 60cm from ground level or above high flood level whichever is more. The cables shall be routed from ground through GI pipes of suitable size to the looping box. These pipes shall be suitably bent outwards and embedded when the foundation work is done, thus avoiding any cutting later.

(iii) Looping boxes for compound lighting poles may be installed within the concrete pedestal for the poles (before casting of the pedestal) at such a height that rain water may not enter these boxes. Necessary cable entry pipe(s) shall be fixed to the box, properly bent outwards, when fixing the box to the pole. Necessary chamfering should be done on the pedestal to enable lifting the front cover of looping box and having proper access inside for maintenance.

(iv) Brackets for luminaries shall be fixed to the poles firmly so as not to be disturbed by wind or by manual pressures during maintenance. Clamps, locking studs or any other reliable means shall be adopted for this purpose. The luminaries shall be fixed to the brackets firmly such that they are not disturbed by wind, vibration due to traffic etc. Arrangement, if any recommended by the manufacturer, should be followed.

(v) Wiring of poles from looping box to the fittings should be done with specified size of copper conductor PVC insulated cables.

(vi) Where compression type glands are used with the boxes, the cables shall be terminated on to them. Where the cable entry pipes are terminated directly on to the boxes, without the provision of cable gland(s), suitable metallic clamp shall be provided with each cable end for earthing the cable armour through the earth terminal in the boxes.

(vi) The poles shall be painted in approved colour with 2 coats of approved paint suitable for outdoor applications. The interior of the looping boxes shall be painted with synthetic enamel paint. All poles shall be numbered with figure height of 30mm.

4.2.4. Earthing

(i) Earthing of poles shall be carried out as per clause 3.5.10. The earth terminal in the looping box shall be connected to this by bare GI wire.

(ii) Though earth continuity shall be ensured through cable armour, 4mm dia (8SWG) GI wire shall be run additionally along the cable route and looped at the poles by stud and washers arrangement.

(iii) The luminaire body shall be connected to the earth stud in the looping box by bare conductor of 4 sq. mm. Aluminium.

4.3 FEEDER PILLAR

4.3.1 General

(i) Feeder pillar shall be of floor mounting, free standing type, suitable for outdoor installation in dust, vermin and weather proof construction.

(ii) This shall be suitable for continuous operation on 415V(nominal) 3 phase 4 wire 50Hz supply. The number, type and capacities of protection gear forming part of the feeder pillar assembly shall be as specified.

(iii) The fabrication work should be taken up, only after the detailed and dimensioned drawing is prepared by the contractor and approved by the Engineer-in-charge.

4.3.2. Enclosure

(i) The enclosure shall be fabricated out of at least 2mm thick MS sheet, with suitable stiffeners.

(ii) Hinged double doors of the same material shall be provided on the front and rear sides, with necessary handles and inbuilt locks with double keys. Neoprene gaskets shall be provided for the doors.

Note: In the case of feeder pillars whose width may not exceed 60cm, single leafed doors may be permitted both on the front and the rear sides.

(iii) Suitable MS top cover of 2 mm thick with suitable slants/ over hang shall be provided for protection against rain/weather etc.

(iv) Detachable gland plate(s) shall be provided at the bottom, with compression type cable glands to the sizes as specified. Adequate space should be provided below the same for safe bending and termination of cables.

(v) The enclosure shall be provided with ventilation louver covered with wire mess, lifting hooks, supporting legs, and double earth terminals with double washers.

(vi) The internal design shall be such as to permit suitable arrangement of incoming and outgoing switchgears, busbars, incoming and outgoing cables. Due provision should be kept for routing of cables, their support and termination. Ample working space should be left for maintenance.

(vii) The metallic parts of the enclosure shall be subjected to seven tank process to include cleaning, derusting, rinsing, phosphatising etc.

(viii) All holes necessary for fixing the components shall be drilled before primer painting. Two coats of red lead anti corrosive primer shall be given on all sides internal as well external, before taking up stove enameled/ powder painting process.

4.3.3 Internals

(i) Bus bars and bus bar supports shall conform to relevant subclauses under 7.1.2 and 7.1.3 of CPWD General Specifications for Electrical work Part I Internal, 1994.

(ii) Adequate clearance should be maintained between phases and between phase and earth as per clause 7.1.3.3 of CPWD General Specification for Electrical Works Part I Internal, 1994. Bus bars shall be insulated with necessary sleeves/tapes of PVC or heat shrinkable insulating material.

(iii) An independent earth bus shall be provided, to which all earth connections (Incoming as well as outgoing, including body earth) will be terminated. This shall be complete with the required number of holes, bolts, nuts, double washers etc.

(iv) The protective gear may be rewireable/HRC fuses in fuse carriers and bases, MCB or MCCB, as specified. These may be bus bar mounted or supported independent of bus bars. In both cases, the supports, including intermediate supports, shall be substantial in construction, capable of withstanding the loads under fault conditions.

(v) There shall be a suitable incoming switch mounted inside at a convenient location.

(vi) Provision shall be available for lighting the interior, when the doors are opened.

(vii) Generally the internal arrangement and design of feeder pillar shall be one of the following categories:-

(a) Metal Clad incoming switch shall feed an enclosed bus bars chamber, Metal clad outgoing switches shall be connected to the busbars chamber.

(b) Metal clad incoming switch shall feed an enclosed busbars chamber. Fuse fittings will be mounted on busbars. The outgoing cables will be connected to the fuse fittings.

(c) The above incoming switch, busbars, outgoing switches, incoming and out going cables shall be accommodated in a cubicle panel, with switch bays, busbars bays and cable alleys. The cable entry can be from back or front side.

Note The design, depending upon the actual requirements will provide for a suitable schedule of work for the feeder pillar. If required suitable rupturing capacity in KA and weather protection as per IP54 will be specified, which may require suitable testing and test certificates.

(viii) The front openable/ lockable door shall act as a cover for the switch boards as above.

(ix) Illustrative sketches of different type of feeder pillars are enclosed (See fig. 21).

4.3.4. Installation

(i) The feeder pillar shall be installed on a suitable pedestal of masonary or RCC. The pedestal shall be built to appropriate dimensions, with provisions for cable entry through the pedestal, and cable bending from below into the feeder pillar. The minimum height of the pedestal above ground level shall be 45cm. This may be increased, where so specified, considering the local conditions (like high flood level) in individual cases.

(ii) The installation shall be done at locations approved by the Engineer-in-charge. The locations shall be at about 1m to 2m from any road berm, clear of any service pipes, ducts, cable routes etc. and convenient in taking the distribution cables.

(iii) Finishing coats (2 coats) of painting shall be given in approved colour, using approved makes and type of paint in original containers.

(iv) MV Danger board shall be provided on each door. Flexible earth connection with the body should be provided for each door.

(v) Each feeder pillar shall be earthed with 2 GI pipe electrodes.

(vi) All cable connections shall be made using appropriate accessories like crimped lugs, flat and spring washers, bolts and nuts etc., as suitable for the type of termination. In no case, any mechanical pull from cable connections shall be experienced at the terminations.

(vii) Circuit details should be indicated by painting on the back of one of the doors.

(viii) After all cable terminations no openings or unplugged holes shall be allowed, which may allow ingress of insect etc.

(ix) All incoming and outgoing switchgears shall be properly marked indicating the load connected, cable sizes and outgoing connection etc.

4.3.5. Testing

The feeder pillar shall be tested using a 500V DC megger before commissioning.

TABLE X
(Clause 4.2.2)

Selection of Luminaire

Lamp Type	Range	Luminious Flux (Lumens)	Efficacy Lm/W	Life Hours	Colour Rendering
GLS (Incandescent)	25W-1000W	230-18000	9- 18	1000	Excellent
Halogen	300W-1000W	5100-22000	17- 22	2000	Excellent
CFL	9W- 25W	450- 1200	59- 78	8000	Good
	5W- 11W	250- 900	50- 82	8000	Good
Fluorescent	18W- 65W	970- 4000	49- 77	5000	Good to moderate
ML	160W	2900	18	5000	Moderate
HP MV	80W-1000W	3500-58000	44- 58	5000	Moderate
HP SV	70W- 400W	5800-47500	83-119	12000-15000	Fair
LP SV	18W- 35W	1800- 4500	100-129	10000	Poor
<u>Metal Halide</u>					
i) a) HPI-T	250W	17000W	70- 90	10000	Good
b) HPI-T	400W	31500W	70- 90	10000	Good
c) HPI-T	1000W	81000W	70- 90	10000	Good
d) HPI-T	2000W	189000W	70- 90	10000	Good
ii) a) HPI-BU	250W	17500W	70	10000	Good
b) HPI-BU	400W	27600W	70	10000	Good
iii) a) MHNTD	70W	5500W	75-80	6000	Excellent
b) MHNTD	150W	11250W	75-80	6000	Excellent

APPENDIX-A
(CLAUSE 1.3)

TERMINOLOGY

1. **Sub-station**

An assemblage of equipment at one place including any neccesary housing for the conversion, transformation or control of electrical energy and for connection between two or more circuits.

2. **Distribution Sub-station:-**

A sub-station used for feeding a distribution network.

3. **Package (Unit) Sub-station:-**

A sub-station in which the switchgear, the busbars and the transformers are all contained in a single, robust metal enclosure.

4. **Distribution (feeder) Pillar:-**

A totally enclosed structure or cubicle containing bus bars connected to incoming and outgoing distribution feeders controlled through links or fuses.

5. **Isolated Neutral System:-**

A system which has no intentional connection to earth except through indicating, measuring, or protective devices of very high impedance.

6. **Earthed Neutral System:-**

A system in which the neutral is connected to earth, either solidly, or through a resistance or reactance of value low enough to reduce materially transient oscillations and to give a current sufficient for selective earth fault protection.

7. **System with Solidly Earthed Neutral:-**

A system with one or more transformers or generators having the neutral point(s) earthed in such a way that the voltage drop along the connection to earth is negligible compared with the nominal voltage of the system under all possible operating conditions.

8. **Radial Circuit:-**

A line emanating from a source of supply and terminating at a point to be supplied which, together with any other points to be supplied by the line, do not have a supply available to them in more than one direction.

9. **Ring Circuit:-**

A circuit emanating from a source of supply and terminating at the same or another source of supply, and with points to be supplied along the route of the circuit so connected that the supply is available to all of them from both directions along the circuit.

10. **Feed Point:-**

A point at which a network or a line receives energy.

11. **Supply Terminals:-**

The point at which a consumer receives energy.

12. **Electric Line:-**

A generic term of a set of conductors, with insulation and accessories, used for the transmission or distribution of electrical energy.

13. **Transmission (Distribution) Line:-**

Electric line forming part of an installation for transmitting electrical energy, normally restricted to overhead construction.

14. **Service Line:-**

A line connecting the consumer's installation to a distributor.

15. **Feeder:-**

A line which supplies a point of distribution network without being tapped at any intermediate point.

16. **Span:-**

The part of an overhead line between two consecutive supports.

17. **Length of a Span:-**

The horizontal distance between two consecutive supports of an overhead line.

18. **Sag:-**

Maximum vertical distance, in a span of an overhead line, between a conductor and the straight line passing through the two points of support of the conductor.

19. **Conductor Vibration:-**

Vibration, generally of small amplitude, of the conductors of overhead lines, which can be suppressed by means of appropriate dampers.

20. **Jumper:-**

A short length of conductor, not under mechanical tension, making an electrical connection between two sections of a conductor of an electric line.

21. **Pin Insulator:-**

An insulator consisting of a single piece of porcelain or of two or more porcelain components permanently connected together and intended to be mounted rigidly on a supporting structure by an insulator pin passing up inside the insula-

tor. Unless otherwise stated, this term excludes the insulator pin.

22. **Fittings:-**

The portions of an insulator provided for making a mechanical connection to it.

23. **Multiple Stranded Conductor:-**

A stranded conductor consisting of a number of groups of wires assembled together in one or more helical layers, the wires in each group being either bunched or stranded.

24. **Conductor Insulation:-**

Insulation applied on a conductor or a conductor screen.

25. **Lapped Insulation:-**

Insulation consisting of tapes applied helically in concentric layers.

26. **Screen (of a cable):-**

Conducting layer(s) having the function of control of the electric field within the insulation. It may also provide smooth surfaces at the boundaries of the insulation and assist in the elimination of spaces at these boundaries.

27. **Conductor Screen:-**

An electrical screen of non-metallic and/or metallic material covering the conductor.

28. **Mass-impregnated(paper) Insulation:-**

Impregnated paper insulation in which the paper tapes are impregnated after lapping.

29. **Mass-impregnated non-draining Insulation:-**

Mass-impregnated paper insulation in which the impregnate is not fluid at the maximum continuous operating temperature.

30. **Extruded Insulation:-**

Insulation consisting generally of one layer of a thermoplastic or thermosetting material and applied by an extrusion process.

31. **Mineral Insulation:-**

Insulation consisting of compressed mineral powder.

32. **Insulation Screen;Core Screen:-**

An electrical screen of non-metallic and/or metallic material covering the insulation.

33. **Shield(of a cable):-**

A surrounding earthed metallic layer to continue the electric field within the cable and or to protect the cable from external electrical influence.

34. **Core Insulated Conductor (North America):-**

An assembly comprising a conductor with its own insulation (and screens if any).

35. **Oversheath:-**

A non-metallic sheath applied over a metallic covering, constituting the outermost sheath of the cable.

36. **Filler:-**

The material used to fill the interstices between the cores of a multi-conductor cable.

37. **Armour:-**

A covering consisting of a metal tape(s) or wires, generally used to protect the cable from external mechanical effects.

38. **Serving:-**
One or more non-extruded layers applied to the exterior of a cable.

39. **Braid:-**

A covering formed from plaited metallic or non-metallic material.

40. **Aerial (insulated) Cable:-**

An insulated cable designed to be suspended overhead and outdoors.

41. **Shielding Conductor:-**

A separate conductor or single core cable laid parallel to a cable or cable circuit and itself forming part of a closed circuit in which induced currents may flow whose magnetic field will oppose the field caused by the current in the cable(s).

42. **Parallel Earth Continuity Conductor:-**

A conductor usually laid along the cable route to provide a continuous low impedance metallic earth connection between the earthing systems at the ends of the cable route.

APPENDIX - B
(Clause 1.21.1)

IMPORTANT RULES FOR EXTERNAL EI WORKS FROM I.E. RULES-1956
(As amended upto 1st July 1990)

2. Definition

(1)(av) "Voltage" means the difference of electric potential measured in volts between any two conductors or between any part of either conductor and the earthed as measured by a suitable volt meter and is said to be-

"low" where the voltage does not exceed 250 Volts under normal condition subject, however, to the percentage variation allowed by these rules;

"medium" where the voltage does not exceed 650 Volts under normal condition subject, however, to the percentage variation allowed by these rules;

"high" where the voltage does not exceed 33,000 Volts under normal condition subject, however, to the percentage variation allowed by these rules;

"extra high" where the voltage exceed 33,000 Volts under normal condition subject, however, to the percentage variation allowed by these rules;

44.A Intimation of Accidents

If any accident occurs in connection with the generation, transmission, supply or use of energy in or in connection with, any part of the electric supply lines or other works of any person and the accident results in or is likely to have resulted in loss of human or animal life or in any injury to a human being or an animal, such person or any other person authorised by the State Electricity Board in this behalf shall send to the Inspector a telegraphic report within twenty four hours to the knowledge of occurance of the fatal accident and a written report in the form set out in Annexure XIII of occurance of fatal and all other accidents.

74. Material and Strength

(1) All conductors or overhead lines other than those specified in sub rule (1) of Rule 86 shall have a breaking strength of not less than 350 Kg.

(2) Where the voltage is low and the span is less than 15 meters and is on the owner's or consumers premises a conductor having an actual breaking strength of not less than 150 Kg may be used.

75. Joints

Joints between conductors of overhead lines shall be mechanically and electrically secure the conditions of operations. The ultimate strength of the joint shall not be less than 95 percent of that the conductor, and electrical conductivity not less than that of the conductor. Provide that no conductor of an O.H. line shall have more than two joints in a span.

76. **Maximum Stresses : Factor of Safety**

1(a) The owner of every overhead line shall ensure that it has the following minimum of safety :-

i)	For metal supports	2.0
ii)	For mechanically processed concrete supports	2.5
iii)	For hand moulded concrete supports	3.0
iv)	For wood supports	3.5

The minimum factors of safety shall be based on such load as wood cause failure of the supports to perform its function (assuming that the foundation and other components of the structure are in tact).

The aforesaid load shall be -

(i) Equivalent to the yield point stress or the modulus of rupture, as the case may be, for supports subject to bending and vertical loads:

(ii) The crippling load for supports used as struts.

(a) The said owner shall also ensure that the strength of the supports in the direction of the line is not less than one fourth of the strength required in the direction transverse to the line.

Provided that in the case of latticed steel or other compound structure, factors of safety shall not be less than 1.5 under such broken wire conditions as may be specified by the State Government in this behalf.

(b) The minimum factor of safety for stay wires, guard wires or bearer wires shall be 2.5 based on the ultimate tensile strength of the wire.

(c) The minimum factor of safety for conductors shall be based on their ultimate tensile strength. In addition, the conductor tension at 32 degrees C, without external load, shall not exceed the following percentage of the ultimate tensile strength of the conductor.

Initial unload tension	35%
Final unload tension	25%

Provided that in case of conductors having cross section of a generally triangular shape such as conductors composed of 3 wires, the final unload tension at 32 degrees C shall not exceed 30% of the ultimate tensile strength of such conductors.

2. For the purpose of calculation shall be such as the State Government may specify in each case;

a) the maximum wind pressure shall be such as the State Government may specify in each case;
b) for cylindrical bodies, the effective area shall be taken as two-third of the projected area exposed to wind pressure;
c) for latticed steel or other compound structures, the wind pressure on the lee-side members shall be taken as one half of the wind pressure on the windward side members and factors of safety shall

be calculated on the crippling load of struts and upon the elastic limit of tension members;

d) the maximum and minimum temperatures shall be such as the State Government may specify in each case.

3. Notwithstanding any thing contained in sub-rule(1) and (2) in localities where overhead lines are liable to accumulations of ice or snow, the State Government may, by order in writing, specify the loading conditions for the purpose of calculating the factor of safety.

77. **Clearance Above Ground of the Lowest Conductor**

(1) No conductor of an overhead line, including service lines, erected across a street shall at any part thereof be at a height less than :

a) for and medium voltage lines	5.8 Mts.
b) for high voltage lines	6.1 Mts.

(2) No conductor of an overhead line, including service lines, erected along any street shall at any part thereof be at a height less than:-

a) for low and medium voltage lines	5.5 Mts
b) for high voltage lines	5.8 Mts.

(3) No conductor of an overhead line, including service lines erected elsewhere than along or across any street shall be at a height less than :-

a) for low, medium and high voltage lines upto and including 11,000 Volts, if bare	4.6 Mts.
b) for low, medium and high Voltage lines upto and including 11000 Volts, if insulated	4.0 Mts
c) for high voltage lines above 11000 Volts	5.2 Mts.

(4) For extra high voltage lines, the clearance above ground shall not be less than 5.2 plus 0.3 m for every 33000 Volts, or part thereof by which the voltage of the line exceeds 33000 Volts.

Provided that the minimum clearance along or across any street shall not be less than 6.1 meters.

78. **Clearance Between Conductors and Trolley Wires**

(i) No conductor of an overhead line crossing a tramway or trolley bus route using wires shall have less than the following clearance above any trolley wires.

(a) Low and medium voltage lines	1.2 Mts.

Provided that where an insulated conductor suspended from a bearer wire crosses over a trolley wire the minimum clearance for each insulated conductor shall be 0.6 meters.

(b) High voltage lines upto and including 11,000 Volts	1.8 Mts.
(c) High Voltage lines above 11,000 Volts	2.5 Mts.
(d) Extra high Voltage lines	3.0 Mts.

(ii) In any case of crossing referred to in sub rule(1) whoever lays his line later in time, shall provide the clearance between his own line and the line which will be crossed in accordance with the provisions of said rule.

Provided that if the later entrant is the owner of the lower line and is not able to provide adequate clearance, he should bear the cast for modification of the upper line to comply with this rule.

79. **Clearance From Buildings of Low and Medium Voltage Lines and Service Lines**

(1) Where a low or medium voltage overhead line passes above or adjacent to or terminates on any buildings, the following minimum clearance from any accessible point, on the basis of maximum shall be observed :-

(a) for any flat roof, open balcony, verandah roof and lean-to-roof-

(i) When the line passes above the buildings, a vertical clearance of 2.5 mts. from the highest point, and

(ii) When the line passes adjacent to the building, a horizontal clearance of 1.5 mts. from the nearest point, and

(b) for pitched roof-

(i) When the line passes above the building, a vertical clearance of 2.5 mts. immediately under the lines; and

(ii) When the line passes adjacent to the building, a horizontal clearance of 1.2 mts.

(2) Any conductor so situated as to have a clearance less than specified in sub rule (1) shall be adequately insulated and shall be attached at suitable intervals to a bare earthed bearer wire having a breaking strength of not less than 350 Kgs.

(3) The horizontal clearance shall be measured when the line is at a maximum deflection from the vertical due to wind pressure.

Explanation- For the purpose of this rule expression "building" shall be deemed to include any structure, whether permanent or temporary.

80. **Clearance from buildings of high and extra high voltage lines:**

(1) Where a high, extra high voltage overhead line passes above or adjacent to any building, or part of a building, it shall have, on the basis of maximum sag, a vertical clearance above the highest part of the building immediately under such line, of not less than:

(a) For high voltage lines upto and including 33,000 Volts 3.7 Mts.

(b)	for extra high voltage lines	3.7 Mts plus 0.3 Mtr. for every additional 33,000 Volts or part thereof

(2) The horizontal clearance between the nearest conductor and any part of such building shall, on the basis of maximum deflection due to wind pressure be not less than:-

(a)	For high voltage lines upto and including 11,000 Volts.	1.2 Mts.
(b)	For high voltage lines above 11,000 volts and upto and including 33,000 Volts	2.0 Mts.
(c)	for extra high voltage line	2.0 Mts plus 0.3 Mtr. for every additional 33,000 Volts or part thereof

81. **Clearance at Different Voltage on same Supports**

Where conductor forming parts of systems, at different voltage are erected on the supports, the owner shall make adequate provision to guard against danger to linesmen and other from the lower voltage system being charged above its normal working voltage by leakage from or contact with the higher voltage system; and the methods of construction and the clearance between the conductors of the two systems shall be subject to the prior approval of the Inspector.

82. **Erection of or alteration to buildings, structures, flood banks and elevation of roads:-**

(1) If at any time subsequent to the erection of an over head line (whether covered with insulated materials or bare) any person proposes to erect a new building or structure, or flood bank or to raise any road level or carry out any other type of work whether permanent or temporary, or to make in or upon any building or structure, flood bank or road any permanent or temporary addition or alteration, he and the contractor whom he employs to carry out the erection, addition and alteration thereto would, during or after construction result in contravention of the provision of rule 77, 79 or 80, give notice in writing of his intention to the supplier, and to an Inspector and shall furnish therewith a scale drawing showing the proposed building, structure flood bank, road any addition or alteration and scaffolding required during the construction.

(2) (a) On receipt of the notice referred to in sub rule (1) or otherwise the supplier shall examine whether the line under reference was lawfully laid and whether the person was liable to pay the cost of alteration and if so, send a notice without undue delay to such person together with an estimate of the cost of the expenditure likely, to be incurred to so alter the over head line and require him to deposit, within 30 days of the receipt of the notice with the supplier, the amount of the estimated cost.

(b) If the person referred to in sub rule (1), disputes the supplier estimated cost of alteration of the overhead line or even the responsibility to pay such cost, the dispute may be referred to the Inspector by either of the parties, where upon the same shall be decided by the Inspector.

(3) No work upon such building, structure, flood bank, road and addition or alteration shall be commenced or continued until the Inspector has certified that provisions or rule 77, 79, or 80 are not likely to be contravened either during or after the aforesaid construction:

Provided that an Inspector may, if he is satisfied that the overhead line has been so guarded as to secure the protection of persons or property from injury or risk of injury permit the work to be executed prior to alteration of overhead lines or, in the case of a temporary additions or alteration, without alteration of the overhead line.

(4) On receipt of the deposit, the supplier shall alter the overhead line within one month of the date of deposit or within such longer period as the Inspector may allow and ensure that it shall not contravene the provisions of Rule 77, 79, or 80 either during or after such construction.

(5) In the absence of an agreement to the contrary between the parties concerned, the cost of such alteration of the overhead line laid down shall be estimated on the following basis, namely:-

(a) The cost of additional material used on the alteration giving due credit for the depreciated cost of the material which would be available from the existing line;

(b) the wages of labour employed in effecting the alteration;

(c) Supervision charges to the extent of 15% of the wages mentioned in clause (b); and

(d) any charges incurred by the supplier in complying with the provisions of section 16 of the Act in respect of such alterations.

(6) Where the estimated cost of the alteration of the overhead line is not deposited, the supplier shall be considered as an aggrieved party for the purpose of this rule.

82 A **Transporting and storing of material near overhead lines:-**

(1) No rods, pipes or similar material shall be taken below or in the vicinity of any bare overhead conductors or lines if they are likely to infringe the provisions for clearance under Rule 79 and 80, unless such materials are transported under the direct supervision of a competent person authorised in this behalf by the owner of such overhead conductors or lines;

(2) Under no circumstances rods, pipes or other similar materials shall be brought within the flash over distance of bare live conductors or lines; and

(3) No material or earth work or agricultural produce shall be dumped or stored or trees grown below or in the vicinity of bare overhead conductors or lines so as to reduce the requisite safety clearance specified under rules 79 and 80.

83 **Clearance General**

For purpose of computing the vertical clearance of an overhead line, the maximum sag of any conductor shall be calculated on the basis of maximum sag in still air and the maximum temperature as specified by the State Government under rule 76(2)(d). Similarly, for the purpose of computing any horizontal clearance of an overhead line, the maximum deflection of any conductor shall be calculated on the basis of the wind pressure specified by the State Government under rule 76(2) (a) or may be taken as 35% whichever is greater.

84. **Route : Proximity to Aerodromes**

Overhead lines shall not be erected in the vicinity of aerodromes until the aerodrome authorities have approved in writing the route of the proposed lines.

85. **Maximum Intervals between Supports**

All conductors shall be attached to supports at intervals not exceeding the safe limits based on the ultimate tensile strength of the conductor and the factor of safety prescribed in rule 76.

Provided that in the case of overhead lines carrying low or medium voltage conductors, when erected in, over, along or across any street, the interval shall not without the consent in writing of the Inspector, exceed 65 meters.

86 **Conditions to apply where telecommunication lines and power lines are carried on same supports**

(1) Every overhead telecommunication line erected on supports carrying a power line shall consist of conductors each having a breaking strength of not less than 270 Kgs.

(2) Every telephone used on a telecommunication line erected on supports carrying line shall be suitably guarded against lightning and shall be protected by cut-outs.

(3) Where a telecommunication line is erected on supports carrying a high or extra high voltage power line arrangement shall be made to safeguard any person using the telephone against injury resulting from contact, leakage or induction between such power and telecommunication lines.

87. **Line crossing or approaching each other**

(1) Where an overhead line crosses or is in proximity to any telecommunication line, either the owner of the overhead line or the telecommunication line, whoever

lays his line later, shall arrange to provide for protective devices or guarding arrangements, in a manner laid down in the Code of Practice or the guidelines prepared by the Power and Telecommunications Co-ordination Committee and subject to the provision of the following sub-rules:

(2) When it is intended to erect a telecommunication line or an overhead line which will cross or be in proximity to an overhead line or a telecommunication line, as the case may be, the person proposing to erect such line shall give one month's notice of his intention so to do along with the relevant details or protection and drawing to the owner of the existing line.

(3) Where an overhead line crosses or is in proximity to another overhead line, guarding arrangement shall be provided so as to guard against the possibility of their coming into contact with each other.

Where an overhead line crosses another overhead line, clearance shall be as under :-

(As per B.I.S.)

Voltage Category	High Voltage			Extra High Voltage		
Nominal system Voltage	22 KV	33 KV	66 KV	110 KV	132 KV	220 KV
Clearance	Minimum value in Meters					
Between lines when crossing each other (derived)						
250 V	2.44	2.44	2.44	2.75	3.05	4.58
650 V	2.44	2.44	2.44	2.75	3.05	4.58
11 KV	2.44	2.44	2.44	2.75	3.05	4.58
22 KV	2.44	2.44	2.44	2.75	3.05	4.58
33 KV	2.44	2.44	2.44	2.75	3.05	4.58
66 KV	2.44	2.44	2.44	2.75	3.05	4.58
110 KV	2.75	2.75	2.75	2.75	3.05	4.58
132 KV	3.05	3.05	3.05	3.05	3.05	4.58
220 KV	4.58	4.58	4.58	4.58	4.58	4.58

Provided that no guarding are required when an extra high voltage line crosses over another extra high voltage, high voltage, medium voltage or low voltage line or road or a tram subject to the condition that adequate clearance are provided between the lowest conductor of the extra high voltage line and the top most conductor of the overhead line crossing underneath the extra high voltage line and the clearance as stipulated in Rule 77 from the topmost surface or the road is maintained.]

(4) A person erecting or proposing to erect a line which may cross or be in proximity with an existing line, may normally provide guarding arrangement on his own line or require the owner of the other overhead line to provide guarding arrangements as referred to in sub rule- (3).

(5) In all cases referred to in the preceding sub-rules the expenses of providing the guarding arrangements or protective devices shall be borne by the person whose line was last erected.]

(6) Where two lines cross, the crossing shall be made as nearly at right angles as the nature of the case admits [and is near the supports of the line as practicable, and the support of the lower line shall not be erected below the upper line.]

(7) The guarding arrangements shall ordinally be carried out by the owner of the supports on which it is made and he shall be responsible for its efficient maintenance.

(8) All work required to be done by or under this rule shall be carried out to the satisfaction of the Inspector.

. Guarding

(1) Where guarding is required under these rules the provision of sub-rules(2) to (4) shall apply.

(2) Every guard-wire shall be connected with earth at each point at which its electrical continuity is broken.

(3) Every guard-wire shall an actual breaking strength of not less than 635 KG and if made of iron or steel, shall be galvanised.

(4) Every guard-wire or cross connected system of guard-wires, shall have sufficient current carrying capacity to ensure the rendering dead, without risk of fusing of the guard wire or wires till the contact of any live wire has been removed.

(5) Lines crossing trolley-wires in the case of a crossing over a trolley-wire guarding shall fulfill the following conditions, namely:-

(a) Where there is only one trolley-wire, two guard-wires shall be erected as in diagram- A.

(b) Where there are two trolley-wires and the distance between them does not exceed 40 cms. two guard-wires shall be erected as in diagram-B.

(c) Where there are two trolley-wires and the distance between them exceeds 40 cms. but does not exceeds 1.2 meters, three guard-wires shall be erected as in diagram-C;

(d) Where there are two trolley-wires and the distance between them exceeds 1.2 meters, each trolley wires shall be separately guarded as in diagram-D

(e) The rise of the trolley boom shall be so limited that if the trolley leaves the trolley wire, it shall not foul the guard-wires, and

(f) Where a telegraph-line is liable to fall or be blown upon an arm, stay-wire span-wire and so slide down upon a trolley-wire guard hooks shall be provided to prevent such sliding.

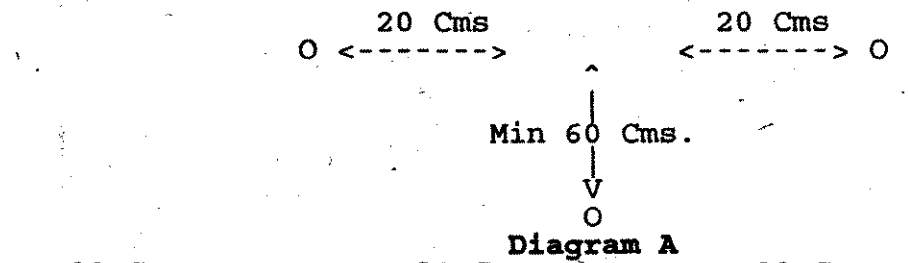


Diagram A

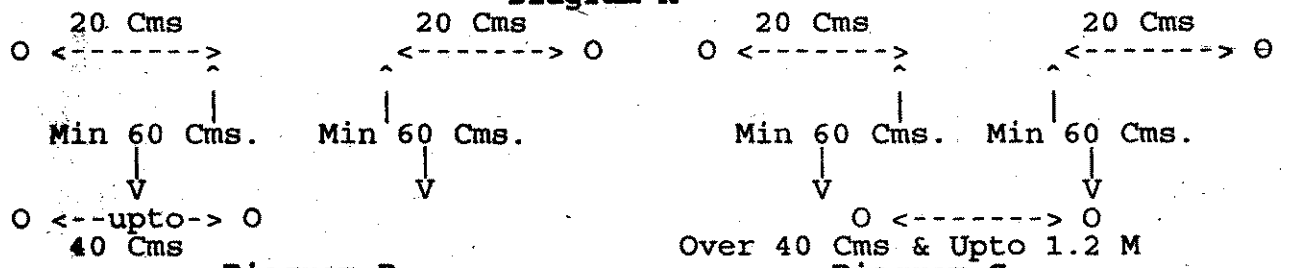


Diagram B **Diagram-C**

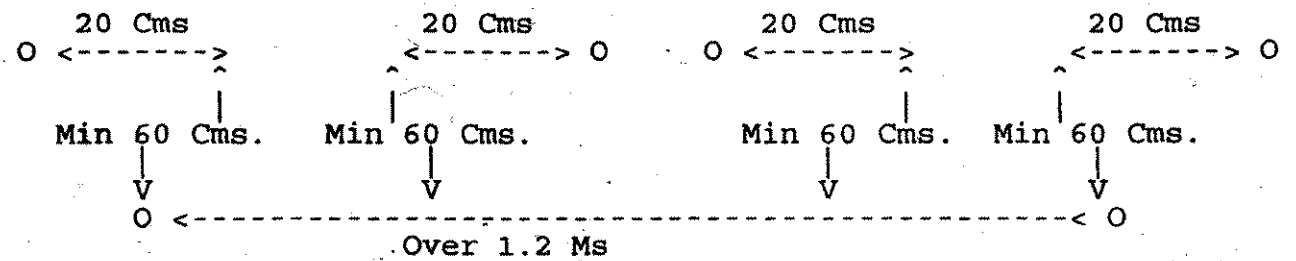


Diagram-D

89. **Service Lines from overhead lines**

No service lines or tapping shall be taken off an overhead line except at a point of support.

90. **Earthing**

(1) All metal supports and all reinforced and prestressed cement concrete supports of overhead lines and metallic fittings attached thereto shall be permanently and efficiently earthed. For this purpose, a continuous earth wire shall be provided and securely fastened to each pole and connected with earth ordinarily at three points in every kilo-meter, the spacing between the points being as nearly equi-distant as possible. Alternatively each support and the metallic fitting attached thereto shall be efficiently earthed.

[(1-A) Metallic bearer wire used for supporting insulated wires of low and medium voltage / over head/ service lines shall be effectively earthed or insulated.

(2) Each stay wire shall be similarly earthed unless an insulator has been placed in it at a height not less than 3.0 Mts. from the ground.

91. **Safety and Protective Devices**

(1) Every overhead line (not being suspended from a dead bearer wire, and not being covered with insulating material, and not being a trolley-wire) erected over any part of street or other public place, or in any factory or mine, or on any consumer's premises, shall be protected with a device approved by the Inspector for rendering the line electrically harmless in case it breaks.

(2) An Inspector may by notice in writing require the owner of any such overhead line wherever it may be erected to protect it in the manner specified in sub-rule-(1).

(3) The owner of every high and extra high voltage overhead line shall make adequate arrangement to the satisfaction of the Inspector to prevent unauthorised persons from ascending any of the supports of such overhead lines which can be easily climbed upon without the help of a ladder or special appliances. Rails reinforced cement concrete poles and pre stressed cement concrete poles without steps tubular poles. Wooden supports without steps I section and channel shall be deemed as supports which cannot be easily climbed upon for the purpose of this rule.

92. **Protection against lightning**

(1) The owner of every overhead line which is so exposed as to be liable to injury from lightning shall adopt efficient means for diverting to earth electrical surge due to lightning.

(2) The earthing lead for any lightning arrester shall not pass through any iron steel pipe, but shall be taken as directly as possible from the lightning arrester to a separate earth electrode and/ or junction of the earth mat already provided for the high and extra high voltage sub station subject to the avoidance of bends wherever practicable.

Note: A vertical ground electrode shall be connected to this junction of the earth mat.

93. **Unused overhead lines**

(1) Where an overhead line ceases to be used as an electric supply line, the owner shall maintain it in a safe mechanical condition in accordance with rule 76 or shall remove it.

(2) Where any overhead line ceases to be used as an electric supply line, an Inspector may, by a notice in writing served on the owner, require him to maintain it in a safe mechanical condition, or to remove it within fifteen days of the receipt of the notice.

137. **Mode of Entry**

All persons entering in pursuance of the Act or these rules, any building which is used as human dwelling, or a place of worship shall, in making such entry, have due regard, so far as may be compatible with the exigencies of the purpose for which such entry is made, to the social and religious usages of the occupant of the buildings entered.

138. **Penalty for breaking seal**

Where in contravention of rule 56, any seal referred to in that rule is broken-

(a) the person breaking the seal shall be punished with fine which may extend to two hundred rupees; and

(b) the consumer, when he has not himself broken the seal, shall be punishable with fine which may extend to fifty rupees, unless he proves that he used all reasonable means in his power to ensure that the seal should not be broken.

138A **Penalty for breach of Rule 44A**

Where in contravention of Rule 44A, any person responsible for the generation, transformation, transmission, conversion, distribution, supply or use of energy fails to report to the Inspector and other authorities concerned, the occurrence of accident, such persons shall be punishable with fine which may extend to three hundred rupees.

140 **Penalty for Breach of Rule 82**

(a) Where no notice is given under Rule 82(1) or the amount of estimate as demanded under Rule 82(2) is not deposited, both the persons proposing and the contractor engaged for erecting a new building or structure whether permanent or temporary or for making in or upon any building or structure any permanent or temporary additions or alteration, shall be deemed to have committed a breach of Rule 82(1) and shall be punishable with a fine which may extend to three hundred rupees.

(b) If any person, commences or continues any work in contravention of Rule 82(3) in or upon any such building, structure, flood bank, road, or carries out addition or alteration thereto, the person contravening the same shall be punishable with a fine which may extend to three hundred rupees.

In addition to this the supplier shall, after obtaining the concurrence of the Inspector, discontinue the supply, if any, to such building structure, flood bank, or road, etc. but only after giving forty-eight hours' notice to the person concerned in writing of disconnection of supply and shall not commence the supply until he and the inspector are satisfied the cause has been removed.

140A **Penalty for breach of Rule 77,79, or 80**

Where a person is responsible for any construction which is or which results in contravention of the provision of Rule 77, 79, or 80, he and the contractor whom he employs shall be punishable with a fine which may extend to three hundred rupees, and in the case of a continuing breach, with a further daily fine which may extend to fifty rupees.

141 **Penalty for Breach of Rules**

Any person other than an Inspector, or any officer appointed to assist the Inspector who, being responsible for the observation of any of these rules, commits a breach there of shall be punishable for every such breach with fine which may extend to three hundreds rupees, and in the case of a continuing breach with a further fine which may extend to fifty rupees, for every day after the first during which the breach has continued.

APPENDIX-C
(Clause 1.21.2 & 1.21.3)

IMPORTANT INDIAN STANDARDS

These are in addition to those given under Appendix B of the General Specifications for Electrical Works (Part I- Internal), 1994 as relevant to External EI works.

	Poles :	
(1)	Reinforced concrete poles for overhead power and telecommunication lines	785-1964
(2)	Prestressed concrete poles for overhead power, traction and telecommunication lines	1678-1978
(3)	Precast prestressed concrete street lighting poles	2193-1986
(4)	Precast reinforced concrete street lighting poles	1332-1986
(5)	Methods of test for concrete poles for overhead power and telecommunication lines	2905-1989
(6)	Tubular poles for overhead power and telecommunication lines	2713-1980 (Part 1 to 3)
	Conductors	
(1)	Aluminium conductors for overhead transmission purposes :-	
(i)	Aluminium stranded conductors	398(Part-1)-1976
(ii)	Aluminium conductors galvanised steel reinforced	398(Part-2)-1976
(iii)	Aluminium alloy stranded conductors	398(Part-4)-1979
(2)	Aluminised steel core wire for aluminium conductors (ACSR)	3835-1966
(3)	Conductors and earthwire accessories for overhead power lines : Armour rods, binding wires and tapes for conductors	2121(Part-1)-1981
(4)	Conductors and earthwire accessories for overhead power lines : Mid span joints and repair sleeves for conductors	2121(Part-2)-1981
	Cables :	
(1)	PVC insulated (heavy duty) electric cables :-	
(i)	For working voltage upto and including 1100V	1554(Part-1)-1988

(ii)	For working voltage from 3.3 KV upto and including 11 KV	1554(Part-2)-1988
(2)	Paper insulated lead sheathed cables for electricity supply	692-1973
(3)	Cross linked polyethylene insulated PVC sheathed (XLPE) cables :-	
(i)	For working voltage upto and including 1100 Volts	7098(Part-1)-1988
(ii)	For working voltage from 3.3 KV upto and including 33 KV	7098(Part-2)-1985
(4)	Recommended current ratings for cables :-	
(i)	Paper insulated and lead sheathed cables	3961(Part-1)-1967
(ii)	PVC insulated and PVC sheathed heavy duty cables	3961(Part-2)-1967
(5)	Recommended short-circuit ratings of high voltage PVC cables	5819-1980
	Insulators :	
(1)	Porcelain insulators for overhead power lines with a nominal voltage upto and including 1000V	1445-1977
(2)	Porcelain insulators for overhead power lines with a nominal voltage greater than 1000 V	731-1971
(3)	Porcelain guy strain insulator	5300-1969
(4)	Characteristics of string insulator units	3188-1980
(5)	Insulator fittings for overhead power lines with a nominal voltage upto and including 1000 V	7935-1975
(6)	Insulator fittings for overhead power lines with a nominal voltage greater than 1000 V	
(i)	General requirements and tests	2486(Part-1)-1971
(ii)	Dimensional requirements	2486(Part-2)-1974
(iii)	Locking devices	2486(Part-3)-1974
	Codes of Practice :	
(1)	Design, installation and maintenance of overhead power lines	

(i)	Upto and including 11 KV	5613-(Part-1 Sections 1 and 2)-1985
(ii)	Above 11 KV and upto and including 220 KV	5613 (Part-2 Sections 1 and 2)-1985
(2)	Selection, handling and erection of concrete poles for overhead power and telecommunication lines	7321-1974
(3)	Installation and maintenance of power cables upto and including 33 KV rating	1255-1983
(4)	Lighting of public thorough-fares for main and secondary roads (Group A and B)	1944-(Parts 1 and 2)-1970
	Safety Standard :	
(1)	Guide for safety procedures and practices in electrical works:	
	(i) General	5216(Part-1)-1982
	(ii) Life saving techniques	5216(Part-2)-1982
(2)	Excavation work	3764-1966
(3)	Rubber gloves for electrical purposes	4770-1981
	General :	
(1)	Dimensions for hot rolled steel beam, column channel, and angle sections	808-1989
(2)	Galvanised stay strand	2141-1979
(3)	Galvanised steel barbed wire for fencing	278-1978
(4)	Cast iron manhole covers and frames :	1726(PartII)-1974
(5)	Luminaires for road and street lighting	10322(Part-5/1988
(6)	Voltage bands for electrical installations including preferred voltage and frequency	12360-1988
	Electro-technical Vocabulary	
(1)	Overhead transmission and distribution of electrical energy	1885(Part-30)-1971
(2)	Cables, conductors and accessories for electricity supply	1885-(Part-32)-1971
(3)	Insulators	1885-(Part-54)-1980

Lightning Arrester

(1)	Application guide for non-linear resistor type surge arresters for a.c. system	4004-1985
(2)	Lightning arresters for a.c. systems: Non-linear resistor type lightning arresters	3070(Part-1)-1985

APPENDIX - D
(Clauses 1.24 and 1.26.1)

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, as amended up-to-date as well as the C.P.W.D. General Specifications for Electrical Works (PartII-External) 1994.

Electrical Installation at ....

Voltage and system of supply .....

Test result in the prescribed proforma enclosed.....

..... Yes/No.

Signature of Supervisor

Name and address

Signature of Contractor

Name and address

PROFORMA - A

CABLE LAYING

(To be shown for each cable separately, voltage wise)

DATE(S) OF TEST :.....

Voltage of Megger used :.....V

Continuity of cores	IR Value (mega ohm)			
	Before laying		Before back filling	
	Between	Value	Between	Value
1) From.....To.....PVC/XLPE/PILCA....X.....sqmm LV/MV/HV cable.....m in length				
	R-N		R-N	
	Y-N		Y-N	
	B-N		B-N	
	R-Y		R-Y	
	B-R		B-R	
	Y-B		Y-B	
	R-E		R-E	
	Y-E		Y-E	
	B-E		B-E	

Signature of Supervisor

Signature of Contractor

PROFORMA -B

CABLE JOINTING

(To be shown for each joint separately, voltage-wise)

Voltage of megger used..... **DATE OF TEST :.....**

Number of joint	1	2	3
Location			
Type of cable(s)			
Type of joint (Indoor/Outdoor, straight through/termination, LV/MV/HV).			

Insulation resistance(Mega ohm) before jointing.

Cable I-	(a) Between	R	& Y
		Y	& B
		B	& R
	(b) Between	R	& N
		Y	& N
		B	& N
	(c) Between	R	& E
		Y	& E
		B	& E
		N	& E
Cable II-	(a) Between	R	& Y
		Y	& B
		B	& R
	(b) Between	R	& N
		Y	& N
		B	& N
	(c) Between	R	& E
		Y	& E
		B	& E
		N	& E

Insulation resistance (Mega ohm) of Jointed cable.

(a)	Between	R	& Y
		Y	& B
		B	& R
(b)	Between	R	& N
		Y	& N
		B	& N
(c)	Between	R	& E
		Y	& E
		B	& E
		N	& E

Signature of Supervisor Signature of Contractor

PROFORMA-C

OVERHEAD LINES
(HV and MV/LV to be shown separately)

DATE OF TEST :.....

1. Voltage and system of supply :-

   (i) AC/DC
   (ii) No. of phase
   (iii) Volts.

2. Total route length

3. No. of spans.

4. Span length :

   (i) Maximum
   (ii) Minimum

5. Configuration of conductors- Vertical/Horizontal

6. Type of conductors used.

7. Minimum size of conductor

8. No. of tensioned joints in conductor.

9. Whether street lighting provided

   Type and no. of street light fittings.

   Size of continuous earth wire.

   Type and size of guard wire.

10. Certificate :- It is certified that :-

    (a) Clearances above ground of the lowest conductor are in accordance with Rule 77 of I.E. Rules.

    (b) The horizontal and vertical clearance of overhead lines are in accordance with Rules 79 and 80 of I.E. Rules.

    (c) Adequate guarding arrangement has been provided between system of different voltages erected on the same support.

    (d) Guarding has been provided in case of crossing of two systems of overhead lines in accordance with Rule 87 of I.E. Rules.

    (e) The metal supports and metallic fittings attached thereto have been permanently and efficiently earthed as required under Rule 90 of I.E. Rules.

    (f) The stay wire has been bonded with continuous earth wire (cl. 3.5.10.2).

    (g) All the supports carrying HV lines have been provided with anti-climbing device(Cl. 3.5.11.2).

14. Result of insulation resistance test:-

	Normal Megger test	HV Megger test
(a) Circuit number.....		
(b) Date of test.		
(c) Voltage of meggers used.		
(d) Between phase conductors-		
(i) R & Y		
(ii) Y & B		
(ii) B & R		
(e) Between conductors and neutral		
(i) R & N		
(ii) Y & N		
(iii) B & N		
(iv) St. light phase conductor & N		
(f) Between conductors and earth		
(i) R & E		
(ii) Y & E		
(iii) B & E		
(iv) St. Light Phase Conductor & E		
(v) N & E		

15. Result of High Pressure Test .....

Signature of Supervisor

Signature of Contractor

PROFORMA-D

TESTING BEFORE COMMISSIONING

(a) CABLE WORK Date(s) of Test .....

(i) Whether high pressure test conducted - Yes/No.
(ii) If conducted-system of supply .....
Test pressure applied .....KV ..... Minutes.
Result of test- Satisfactory/Unsatisfactory.
(iii) If not conducted :-
Voltage of Megger used :-
Result of Megger testing :-
Between R & Y
Y & B
B & R
Between R & N
Y & N
B & N
Between R & E
Y & E
B & E
N & E

(b) OVERHEAD LINE WORK (H.V.)

(i) Whether high pressure test conducted - Yes/No.
(ii) If conducted- System of supply .....
Test pressure applied .....KV.....Minutes.
Result of Test - Satisfactory/Unsatisfactory.

(iii) If not conducted -
Voltage of Megger used :-
Results of Megger Testing :-

		Circuit I	Circuit II
Between phase conductors	R & Y		
	Y & B		
	B & R		
Between conductors and neutral.	R & N		
	Y & N		
	B & N		
	St. light phase conductor & N		
Between conductors and earth.	R & E		
	Y & E		
	B & E		
	St. light Phase Conductor and E		
	N & E		

(c) **FEEDER PILLAR:-**

(i) Pillar Number:

(ii) Voltage of megger used:

(iii) Result of megger testing:

(d) EARTHING :-

(i) Total number of earth eletrodes- .....

(ii) Earth resistance of each earth electrode-

Sl. No.	Location	Value

Signature of Supervisor **Signature of Contractor**

APPENDIX E
(Clause 1.28)

MAINTENANCE REQUIREMENTS

1. General

Following details/records shall be maintained. These shall be perused by inspecting officers.

(i) Drawing(s) showing routes of UG cables and overhead lines.

(ii) Record of tests for Insulation Resistance, earthing, and feeder loading.

(iii) Record of breakdowns/faults encountered, and/or replacements made.

2. UG cables

(i) Inspect every termination once a year. Look for any sign of overheating (visually and/or by unusual burning smell); Identify the cause and rectify. (such as loose connection, bad crimping, weathered soldering, overload etc.)

(ii) Measure with a clip-on ammeter, current in every feeder/distributor cable once a year and record. (This test may be done at a period when the cable is expected to carry the maximum current).

(iii) Carry out insulation resistance test, section wise, during monsoon.

3. Overhead lines

(i) All sections of overhead lines shall be visually inspected by patrolling along the routes. Any extraneous materials clinging to the lines should be removed. Tree branches likely touch the line should be trimmed. Any abnormality noted should be corrected such as slipped conductors, abnormal/ unequal sag, broken/ charred strands at jumpers etc.

(ii) Insulators should be checked for chipping/cracking, once a year.

(iii) Painting of poles, cross arms etc. should be done once in every year.

(iv) Carry out Insulation test section wise, during monsoon and earth test during summer and keep a record of the same.

(v) Keep a record of the maximum load on each section of the line.

4. Road/ Street/ Compound Lighting

(i) Check weekly for proper working of all luminaires and ensure that the looping boxes are not left open. Check daily for important/ sensitive installations.

(ii) Clean covers of light fittings once every three months. and every month for sensitive installations.

(iii) Check looping boxes once every three months for proper termination of cables and ensuring proper condition of components inside.

(iv) Poles to be painted/ marked every year.

5. Feeder Pillars

(i) Check weekly to ensure doors are locked and not left open.

(ii) **Yearly Check** to ensure proper cable termination, proper conditions of all components including busbars, insulation, switchgears, fuses. No openings/ holes in the enclosure.

(iii) Yearly painting and marking.

APPENDIX - F
(Clause.2.7.8)

JOINTING OF POWER CABLE

F-1 General:-

The reliability of a power cable network depends, among other factors, on the quality of joints made (End/Tee/Straight through) in the network. The conductivity and insulation under normal and short circuit conditions should be the same in the joint as in the conductor proper and the breaking load of joint shall be atleast 60 percent of that of the conductor.This is achieved by using materials, accessories and tools of approved standards and to a large extent this also depends upon the skill in adhering to standard procedures approved for such work.All materials and accessories shall conform to relevant Indian Standards wherever they exist. For special type of splicing connector kits or epoxy resin spliced joints, makes approved for such applications shall be used.

F-2. Jointing Procedure :-

F-2.1. The joint operation consists briefly of removal of the serving and/or sheathing, armour where provided and core insulation of the cable(s), jointing the conductor and completing the joint either with compound in case of paper insulated/PVC cable or with cold resin epoxy for PVC cables. Jointing in more than one cable laid in the same trench should be staggered as shown in Figure 12.

F-2.2. **Jointing of Conductor :-**

Aluminium is now the conductor material in general use. The jointing of aluminium conductors is an important step and the methods generally adopted, irrespective of the type of insulation of the cable are

(a) Soft soldering

(b) Welding

(c) Mechanical compression.

Brief particulars on the above methods of jointing of conductors are given in paras F-2.2.2., F-2.2.3, and F-2.2.4 respectively.For complete details reference may be made to IS:1255-1983.

F-2.2.3. **Soft Soldering Method :-**

F-2.2.3.1 In order to ensure that the wires are firmly embedded in solder, the strands at the joint end of the cable are fanned out, after removing the insulation about 10mm more than the length required for the conductor jointing.Individual strands shall be cleaned thoroughly by a scraper to remove any impregnation compound or oil. The conductor shall be preheated by basting with solder in the interstices of the strands and then applying the aluminium solder flux with a stiff brush, particular care being taken to ensure that the flux and

solder reach the underside of the conductor .The flux removes the oxide film and assists the spreading of molten solder.The conductor shall be basted with solder several times and the process repeated till a shining surface is obtained. Basting, which consists of pouring of liquid (solder in this case) with a small ladle, is done usually from the insulated end to the cut end of the conductor to push away any traces of flux left in the interstices of the conductor.The fanned out strands are closed back together in a circular shape and excess solder wiped out. The ferrule which is generally weak back type and is of copper shall also be tinned with aluminium solder and flux and fitted on to the conductor firmly but not completely.The ferrule is then basted with solder to allow the solder to fill in between the conductor and ferrule properly.Excess solder is wiped out. As the oxide film which is a bad conductor of electricity forms rapidly over any surface of pure aluminum exposed to atmosphere , the whole process should be carried out skillfully and quickly.

In case of termination with a cable lug, a similar procedure is adopted. However , in the case of large sockets (say for 50 sq. mm. and above) a hole is drilled at the closed end of the lug before tinning the same.After the conductor is inserted in the lug, the space between the lug and the conductor insulation is filled with fiber glass/ asbestos, held in position by a flame resistant tape, to save the insulation from being damaged by the molten solder. Molten solder is poured through the drilled hole. Gentle tapping of the solder point would facilitate the setting of the solder inside the lug. The pouring is continued till the solder flows freely. Excess solder is wiped and the assembly is allowed to cool without disturbance. Particular care is required when jointing PVC cables, to ensure that the PVC insulation/sheath are not damaged due to excessive heat.

The most important precaution in this method is the maintenance of temperature of solder within limits in accordance with the recommendations of the manufactures. The liquids temperature for solder is about 220 degrees C and its solid temperature, 150 degrees C. Care should be taken that the pouring temperature does not exceed 300 degrees C. as the flux tends to char at temperature exceeding this limit. This is normally achieved by maintaining the pot temperature at 300 degrees C.

As the temperature of solder plays an important role in the jointing of conductors, any crude method of checking the adequacy of heating the solder should not be resorted to. A thermometer should invariably be used for the measurement of temperature of solder.

F-2.2.2.2 Friction soldering method is also followed for soldering conductors. Special solder sticks with embedded cadmium crystals are used in this method. No flux is used.After heating the strands and the solder sticks, the strands are wiped with solder stick when the cadmium scratches out the oxide film and the solder adheres to the strands.

F-2.2.3. Welding Method

The strands of the conductor end are first welded solid. For this, the strands are cleaned with petrol or kerosene after the insulation is stripped and the strands have been fanned out. The strands are smeared with aluminium flux and then brought back to position. With the conductor end kept vertical a pair of cooling tongs, an asbestos flame shield disc, a two part sheet steel tube , or a carbon tube (mould) are placed along the conductor in the above order from the insulation end. The tube should project about 5 to 10 mm above the conductor end. The conductor is heated and welded by puddling with an iron wire and adding aluminium metal. The welded conductor strands and the solid aluminium at the end should be about 10 to 20 mm depending on the cross sectional area of the conductor.

The two conductor ends to be jointed after being welded solid are placed in a mould whose interior is coated with a mould paint.A thin coat of flux is applied to the ends and the conductors are welded by heating an aluminium wire, coated with a thin layer of flux. Care is taken to ensure that only part of the solid ends is melted in this operation. The flame shield and cooling tongs are also used as above, one set for each cable.

After welding, the mould is allowed to cool and then removed. The joint is then filed smooth. Instead of an open mould, some times a closed mould is used, where initial welding of individual conductor end is not necessary after cleaning of the strands and smearing them with flux. The weld should be puddled with continued heating to ensure that it fills the mould fully without any cavity etc.

In the case of end terminations, the solid welded conductor end is welded to the cable lug, as above, using the flame shield, cooling tongs etc. Figure 13 illustrates the arrangements for solid end, open and closed mould welding methods.

F-2.2.4 Mechanical Compression Method

A special sleeve is pressed on to the conductor ends to be jointed with some gap between the ends (or the conductor ends and the inner edge of lug as the case may be) to allow for elongation by a hydraulic/ mechanical compressor with a special die holder or compression tool. The compression is done in stages from the center to the sleeve end with an overlap of 1/3 of the die width. The recommendations of manufacturers of the tool in this regard should be followed.

F-2.3. Jointing of Paper Insulated Cable

F-2.3.1. Section 11 of IS: 1255-1983 describes the jointing method of paper insulated cables. The brief particulars extracted therefrom are given below for general guidance.

F-2.3.2. It should be ensured that all jointing materials and tools are clean and free from any trace of moisture.

F-2.3.3. The cables to be jointed are lined up side by side with adequate overlap and suitably supported. The serving, armour and bedding are cut and removed, after making and binding with wire binders the points upto which they are to be removed.

F-2.3.4. The lead sheaths are cleaned and the points thereon of wipe are marked with plumbers black and the clean portion of sheath treated with a coat of tallow. The joint center is marked on the sheaths of both the cables. The cables are cut squarely allowing at least 6 mm overlap of the cable ends.

F-2.3.5. With one of the cables wrapped in cloth/paper the lead sleeve is slid over it and rested with its compound filling hole facing down and covered with another piece of cloth. Lead plumbing rings are passed on, one for each cable and bolted down at the correct distance.

F-2.3.6. The limits upto which the lead sheaths need to be removed are marked by a peripheral cut to about half the sheath thickness.The sheath is cut through , starting from the cable end and peeled out. A binding of insulation tape (belt tape) is applied to about 35 mm width over the insulation, near the cut ends of sheath.

F-2.3.7. Belt insulation where provided, paper /jute fillers etc. are cut and removed upto the belt tape applied above. Commencing at the crotch, a layer of protective non-adhesive tape is applied individually to the remainder of the cores.

F-2.3.8. The cores to be jointed are placed in position and the joint center is marked. The protective tape and paper insulation are removed upto the desired length (i.e. half the ferrule length + 10 mm). Shaped conductors are made round.

F-2.3.9. Before jointing the paper insulation layers, one next to the sheath and the other next to conductor are tested for the presence of moisture. For this, single strips of paper from these layers are immersed in hot insulating compound or paraffin wax. Presence of moisture is indicated by formation of bubbles in compound and cracking sound in case of paraffin wax. These test strips of paper insulation should be handled carefully to avoid contamination by perspiration (refer IS: 1255-1983)

F-2.3.10. The cores are jointed as explained in F-2.2. above.

F-2.3.11. The protective tape is removed sufficiently at either end of the ferrule, a temporary binder applied on the paper insulation which is then trimmed with a knife into the form of a sharpened pencil.

F-2.3.12. Insulation tape is applied tight, first to build up the spaces between the ferrule and the binder and then end to end over the ferrule and core insulation to the required thickness. Care is taken that while taping there is an overlap of about half the width of tape. The binders protective tape etc. are removed when taping.

F-2.3.13. The core spreaders are inserted between cores at about 12 mm from the ends of belt insulation and bonded to the cores with insulation tapes.

F-2.3.14. The lead sleeve that had been slipped earlier is warmed to remove traces of moisture inside. It is then passed over the joints and gently pressed down to the plumbing rings/ sheath itself as the case may be.

F-2.3.15. The sheath is cleaned and plumbers black applied to limit the flow of plumbing metal to the area to be plumbed. When dry, the rest of sheathing is coated with tallow.Warming the cable and sleeve, the plumb (wipe) is built up from the metal pot and finally finished with a blow lamp and tallowed pad of mole skin cloth.

F-2.3.16. Lead strips are wrapped over the armour till it equals the diameter of the armour grip or joint box. The bottom of the box is placed in position and securely fixed with armour clamps. The bottom of the box and sleeve are filled with hot compound (pouring temperature not exceeding 150 degrees C.) and the sleeve topped up after cooling and sealed by plumbing. The bottom of the box is then topped with compound until it spills over the vee groove when the top of the box is bolted in position.The remainder of the box is then filled up with compound and plugged when the compound is still hot. The procedure is described in detail in IS:1255-1983. Care should be taken to use compound of standard makes in cable joints as the joint is likely to fail with a poor quality compound.

F-2.3.17. Typical straight through joint and indoor type termination for paper insulated cables are shown in figures 14 and 15 respectively. Typical out door cable termination arrangement is shown in figure 16.

F-2.4. Jointing of PVC Cables

F-2.4.1. Jointing Using Cable Compound

The procedure outlined above shall mutadis mutandis be applicable for outdoor jointing of PVC cables also, but the operations concerning lead sleeve etc. are not applicable as the sheathing is also of PVC. Since too hot compound could damage the PVC insulation, adequate care is to be exercised to maintain the temperature of compound within recommended limits.

F-2.4.2. Epoxy jointing

Cold pouring casting resin system for PVC cable jointing has been developed for application upto 11 KV grade cables. The compound consists of a resin base and a poly amino hardener. The two component liquids are mixed at site in accordance with the recommendation of manufacturers. In this system of jointing, the insulation etc. are removed and conductors jointed as explained in clause F-2.2. The jointed cores in case of LV/MV cables should be kept apart to avoid any flash over between them. Spacers are provided between them. Spaces are provided between cores for HV cables. No insulation is applied over the jointed cores. A cover ring is placed tight over the two cut ends of

armour and soldered to the armour wires. The two rings are then jointed by a copper wire and the cut ends of armoring are bent over the rings.

Sand paper is applied to the inner sheath surface and cleaned using methyl chloride. The joint is enclosed by plastic mould which is in two parts whose ends are duly cut to match the size of cables. PVC tape is wrapped at the two places where the mould will touch the cables. The two halves are pasted together and kept clamped to avoid any air gap. The mould ends are enclosed with putty which is supplied in the joint kit.

Expiry date of resin is checked and hardener added to resin. The mixture is churned thoroughly for about 15 to 20 minutes till the colour of the mixed compound is grey. The mix is poured slowly into the mould taking care to avoid formation of air bubbles till the mould is filled and it comes out at the risers.

Allow the joint to set for minimum three hours till it becomes a solid mass before changing the cable. The mould may be removed, if desired.

Normally all the components required for joints are supplied as a kit for various sizes of cables.

Figures 17 and 18 illustrate a typical straight through and outdoor termination of PVC cable with epoxy resin respectively.

F-2.4.3. Termination Using Compression Glands

PVC cables upto 1.1 KV grade shall preferably be terminated in the indoor electrical switchgear using compression glands.

The nipple of the gland is first screwed to the switch gear to which the cable is to be terminated and locked with check nut from inside the housing. Compression ring, washer, rubber ring and again another washer are slipped in succession over the cable .The cable sheath is removed to desired length and the armour strands splayed out. The armour wire is then cut to the overall diameter of the second washer. Sharp edges are removed and armour cleaned. A third washer is now slipped on to trap the trimmed strands and armour between the second and the third washer. The cable end is pushed through the gland nipple (body). The compression ring is then tightened when the rubber ring will expand and hold the cable tightly by the sheath. The cores are terminated in the usual manner. Typical termination by this method is shown in figure 19. Figure 20 illustrates a typical outdoor termination of PVC cable using compression gland with a protective M.S. box.

F-2.4.4 Jointing using Heat shrinkable insulating material for MV cables

Heat shrinkable tubes of different diameters are available, for cable jointing applications. Tube of the appropriate size and of good quality (going by the successful test certificates from Independent bodies) should only be used. After preparing the cable end for

jointing, the tube is inserted over the cable end and held back. The lugging/straight through conductor jointing operation is done. The surface is thoroughly cleaned. The tube is moved over the joint and heated from one end towards the other by a blow lamp, so that no air bubble gets entrapped. The tube shrinks on to the insulation and lug. (Cases are reported of moisture travel through the space close to the lugs and hence the covering the same is desirable.) The joint can be energised, immediately after the surface has cooled down.

F-2.5 Use of heat shrinkable joints on High Voltage joints.

This type of joint can be adopted indoor/outdoor, for HV upto and including 33 KV (at present). The size of cable, as well as voltage of system should be indicated while ordering. In the case of HV cables, the electrostatic stresses tend to concentrate near the screen which is earthed, at the location where the cable is cut (for any type of joint). This stress has to be relieved, in order to avoid failure of insulation at that location. Semi-conducting tapes can be used for the purpose, but if the workmanship is not satisfactory, there can be entrapped air pockets where partial discharge can occur. Heat shrinkable tube with semi-conducting properties can be provided there and shrunk. A further insulating tube is heat shrunk over the same. In HV joints, particular precautions are taken to (i) stress relief at cut ends, (ii) prevention of moisture entry at lug position and (iii) build up of the required insulation with the outer covering having anti-tracking property. Heat shrinkable joint can be used for PVC, PILC and XLPE cables, for end terminations as well as for straight through/tee joints. The procedure, though apparently simple, needs to be carefully and skillfully followed to avoid failures later. Assistance may be taken from Manufacturer's representative.

F-2.6. Jointing of XLPE (Cross Linked Polythene insulated) Cables

F-2.6.1 XLPE cable is highly resistant to moisture, hence jointing and terminations of XLPE cable is similar than PILC cables. Upto 3.3 KV grade, cable can be terminated straightaway with compression glands similar to other PVC cables.

F-2.6.2 Jointing of Conductors

Since the maximum permissible short circuit temperature is 250 degrees C in XLPE cables, soldered type joints become unsuitable as solder melts at much lower temperature. Welded or crimped/ compression type conductor joints are therefore adopted for XLPE cables.

F-2.6.3 Insulation Build Up

The conductor joint is insulated lapping of EPR self amalgamated (SA) tape to required thickness. S.A. tape is universally accepted as most reliable jointing materials because of its resistance to water and ozone, capacity to operate at higher temperature, high dielectric strength and void amalgamating properties.

For cables above 3.3 KV grade semi conducting S.A. tape is to be applied on the conductor before starting insulation build up to equalise distribution of electrical stress on conductor surface.

The insulated jointed cores are further lapped with semi conducting SA tape to serve as core screening.

For cable rated at 3.3 KV and below use of semi-conducting SA tape is not necessary.

F-2.6.4 Straight Through Joints

The jointed assembly (with insulated cores is encapsulated in special cast resin compound.

F-2.6.5 Stress Relived Termination

The termination of cables above 3.3. KV is provided with stress cone to relive electrical stresses formed on the insulation at the point of termination of cable screen. SA tape is lapped over the insulation to the required thickness to build up the stress cone.

F-2.5.6. Indoor Type Termination

Indoor type termination for cables above 3.3 KV is provided with stress cone but it does not require any compound for encapsulation. However, it must be protected by lapping of adhesive PVC for protection against external abuses.

F-2.5.7. Outdoor Termination

Outdoor type termination for cable above 3.3 KV is provided with stress cone but this termination is encapsulated in special cast compound to protect the joint from atmosphere abuses.

Note:- The above procedure is only indicative of the general requirements. However, the procedure detailed by the manufacturer as suitable for the type of cables, and for the type of joints shall be strictly followed.

APPENDIX - G
(Clause 3.2.3.1(iii))

SELECTION OF STAY SETS

1. General

Stay sets are required to be provided in overhead line work at locations where there is likely to be a horizontal pull from the line, on a pole, as for example, terminal poles, poles at locations of deviations of a line etc. Stay sets are provided at Tee-off positions and steep gradient locations also. The horizontal component of tension in the stay wire provides the balancing force, so that the stability of the pole is not adversely affected.

2. Size of stay wire

Stay wire is a multistranded galvanised steel wire. The sizes adopted in this specification are 7/3.15 mm and 7/4 mm dia. In certain other Standards, a size of 7/2.5 mm dia is also adopted. The strength of these wires is as under:

Size	Ultimate strength	Permissible strength
7/2.5mm	2300KG	920KG
7/3.15mm	3625KG	1450KG
7/4mm	5500KG	2200KG

3. Force From The Line

The pull experienced by a pole is governed by the number of conductors in the line, their sizes, span, wind force on the conductor and deviation angle of the line. The force can be calculated from these parameters in individual cases. The tension calculation is elaborated in IS:5613 (Part 1/sec 1)-1985.

4. Stay Selection

(i) The stay angle is selected from 30 to 60 degrees to verti- cal, 45 degrees being common. Higher the angle, higher will be the horizontal component, but beyond a limit the anchoring becomes less effective. Depending on the soil condition, the angle may be around 45 degrees.

(ii) The tension needed to counter the pull can be calculated. After applying factor of safety, the size may be selected for stay wire. There may be a need to go for 2 stay sets at the same support, if the calculated tension is such that the permissible tension will be exceeded in case a single stay set is proposed.

(iii) Similarly, the expected tension for the stay wire at angular deviations can be evaluated, from principles of Mechanics, taking into consideration whether the stay set will be located at the angular bisector of the deviation or individually for each arm of the deviation. The size and number are then decided.

(iv) Standardised charts are also available in the standards like REC standard.

5. Two/ Three/ Four pole structure locations

(i) For 2/3 pole structure locations, minimum 2 stays in each direction of the line or in the angular bisector, should be provided.

(ii) Normally no stays may be required at 4 pole structure locations, as the forces are generally balanced. The requirement may however be examined in individual cases.

DETAILED INDEX

1.25 Commissioning an completion

1.26 Completion plan and completion certificate

1.27 Guarantee

1.28 Maintenance

2. CABLE WORK

2.1 Scope

2.2 Types of cables

2.3 Armouring and serving

2.4 Selection of cable sizes

2.5 Storage and handling

2.5.1 Storage and handling

2.5.2 Handling

2.6 Installation

2.6.1 General (i/c bending radius and end sealing)

2.6.2 Route

2.6.3 Proximity to communication cables

2.6.4 Railway crossing

2.6.5 Way leave

2.6.6 Methods of laying

2.6.7 Laying direct in ground

2.6.7.1 General

2.6.7.2 Trenching
(i) Width of trench

(ii) Depth of trench

(iii) Excavation of trenches

2.6.7.3 Laying in trench
(i) Sand cushioning

(ii) Testing before laying

(iii) Testing before covering

(iv) Sand covering

(v) Extra loop cable

(vi) Mechanical protection over the covering

2.6.7.4 Back filling

3.3.1 General

3.3.1.2 LV/MV lines

3.3.1.3 Layout drawing

3.3.1.4 Way leave

3.3.1.5 Cutting of trees etc.

3.3.2 Spacing of poles

3.3.3 Clearances

3.4 Excavation for foundation

3.4.1 General

3.4.2 Excavation for supports

3.4.3 Excavation for stays

3.4.4 Excavation for struts

3.5 Erection

3.5.1 Erection of supports

3.5.2 Erection of stays and struts

3.5.2.11 Bow stay

3.5.2.12 Fly Stay

3.5.2.13 Erection of Struts

3.5.3 Erection of line materials

3.5.3.1 Cross arms

3.5.3.2 D-Iron clamps

3.5.4 Erection of insulators

3.5.5 Stringing of conductors (i/c handling)

3.5.6 Binding of conductors

3.5.7 Jumpers

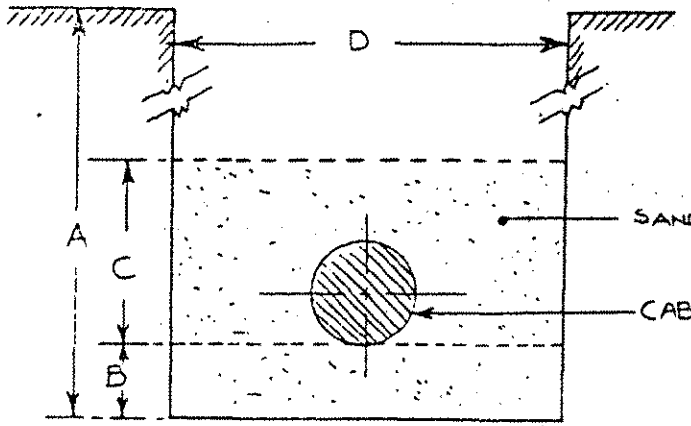
3.5.8 Earth wire

3.5.9 Erection of guard

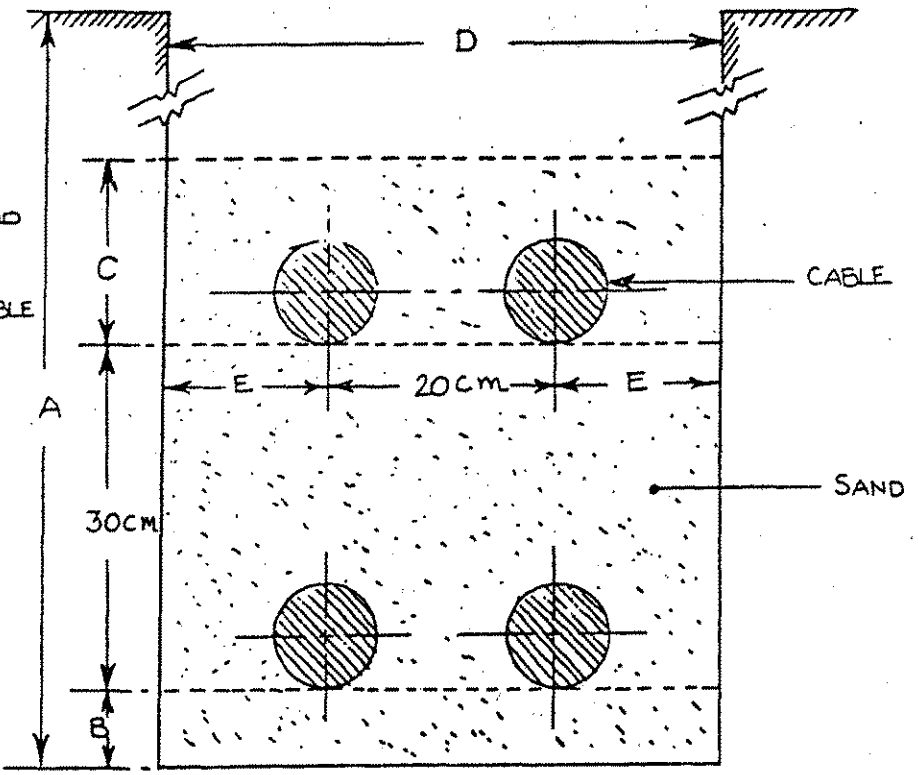
3.5.10 Earthing

3.5.11 Safety and protective devices

NOT TO SCALE



FOR CABLE OF RATING		
Ref.	Up To 1·1 K.V	Exceeding 1·1 K.V
A	75 Cm.	120 CM
B	8 CM	8 Cm
C	17 Cm	17 Cm
D	35 Cm	35 Cm

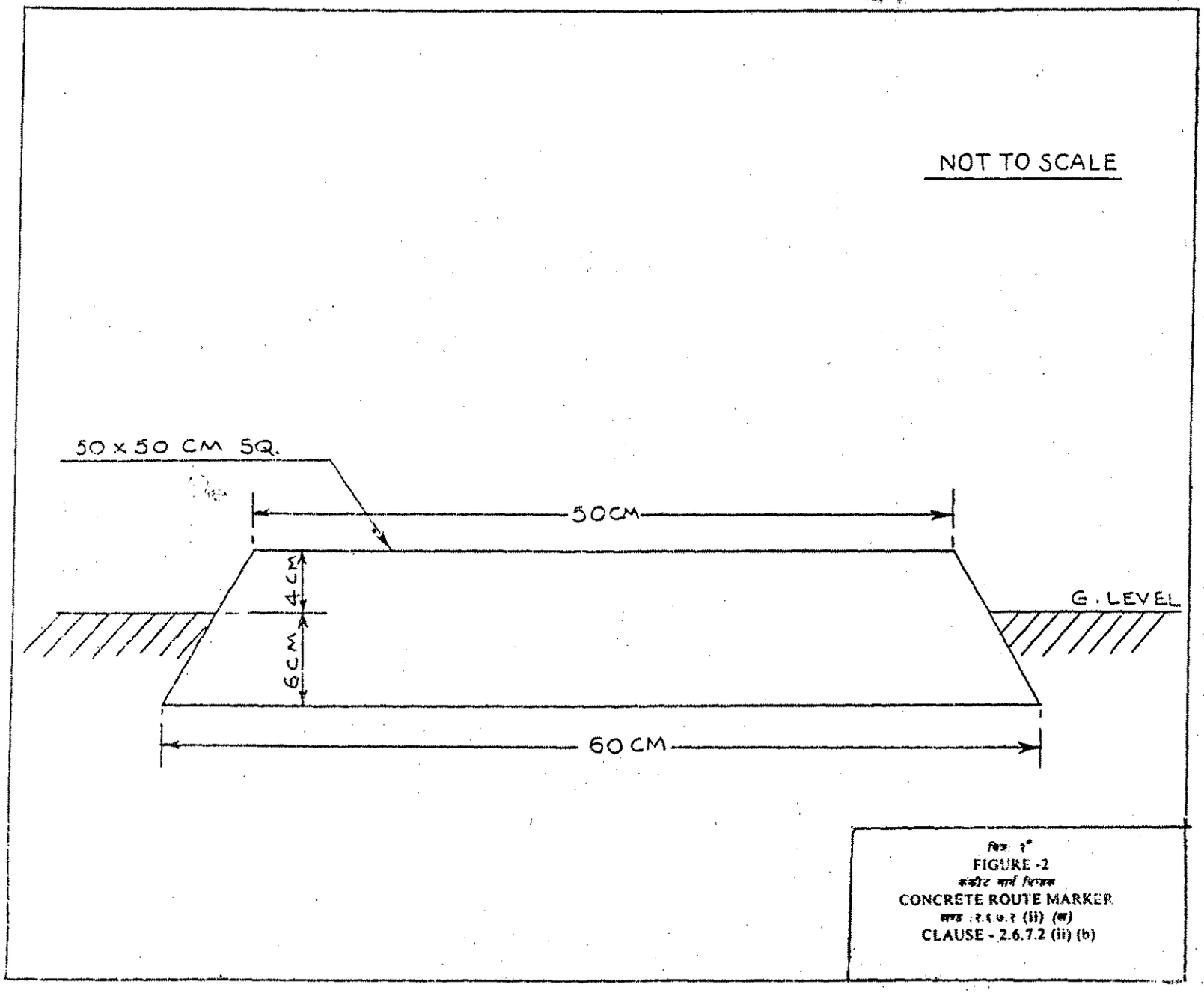


n1 – Number of Additional cables in Vertical formation.

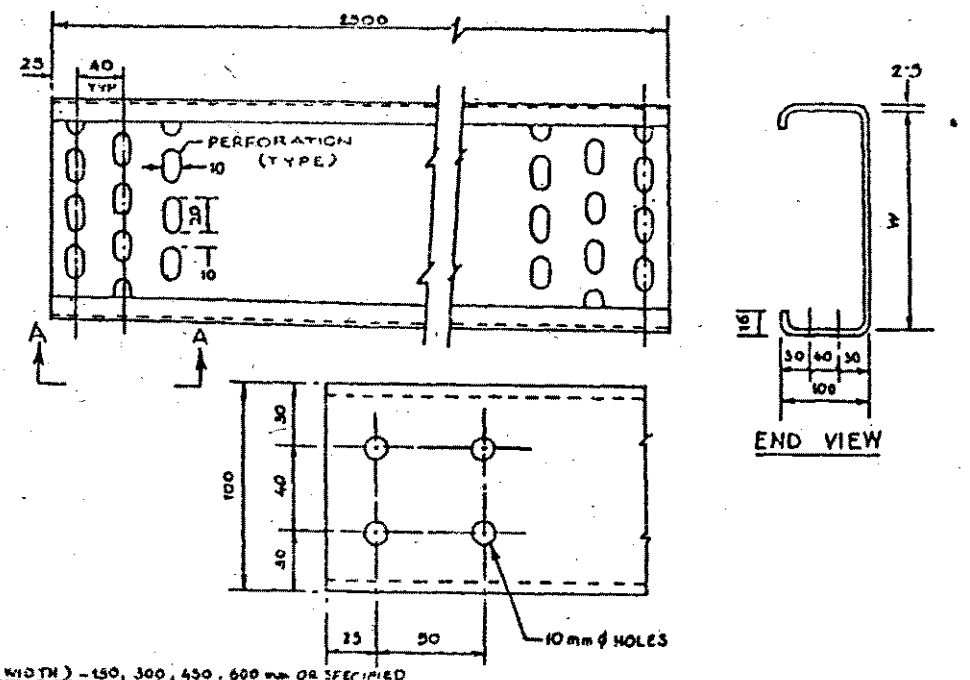
n2 – Number of Additional cables in Horizontal formation

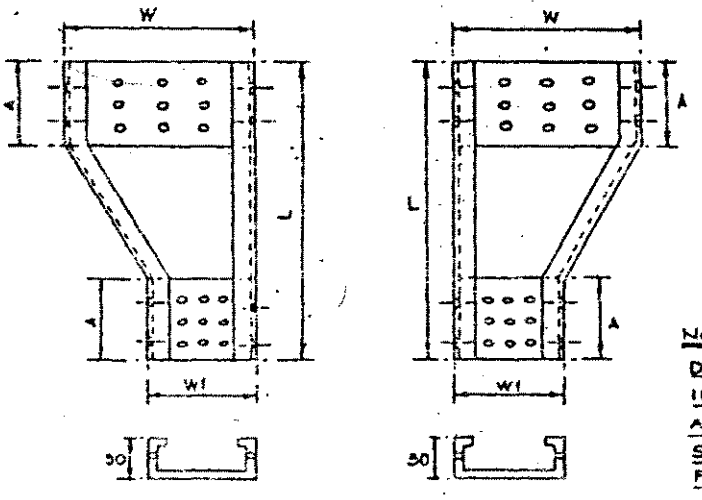
FOR CABLE OF RATING		
Ref.	Upto 1·1 KV	Exceeding 1·1 KV
A	(75 + n1 × 30) Cm.	(120 + n1 × 30) Cm.
B	8 CM	8 Cm
C	17 CM	17 CM
D	(30 + n2 × 20) CM	(30 + n2 × 20) CM
E	15 CM	15 CM

चित्र 1 FIGURE-1
MINIMUM DIMENSIONS OF CABLE TRENCH
खण्ड 2.6.7.2 (i) एवं (ii) ।
CLAUSE - 2.6.7.2 (i) & (ii)



चित्र २
FIGURE -2
कंक्रीट मार्ग चिन्हक
CONCRETE ROUTE MARKER
खण्ड : २.६.७.२ (ii) (ब)
CLAUSE - 2.6.7.2 (ii) (b)





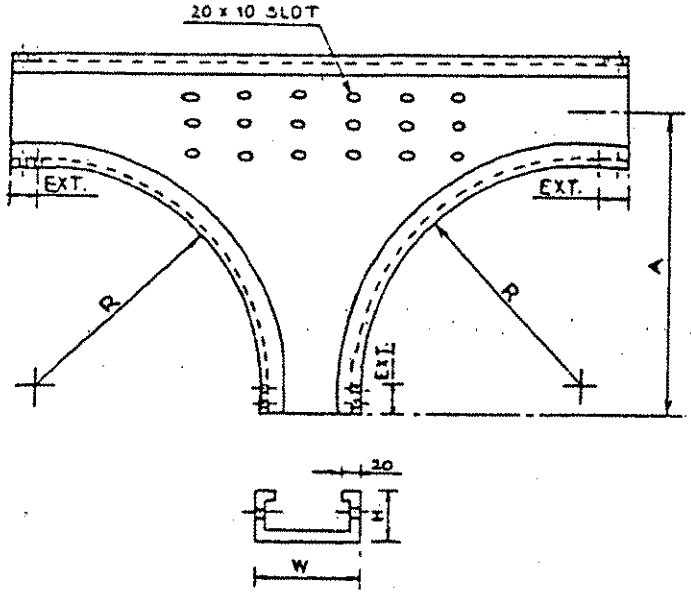
NOTE

DETAILS SHOWN ARE ILLUSTRATIVE. DEVIATIONS AS PER MANUFACTURER'S STANDARD DESIGN IS PERMISSIBLE.

W	W1	L	A	TH
600	450	350	100	3
450	300	"	"	"
600	300	300	"	"

RIGHT HAND REDUCER LEFT HAND

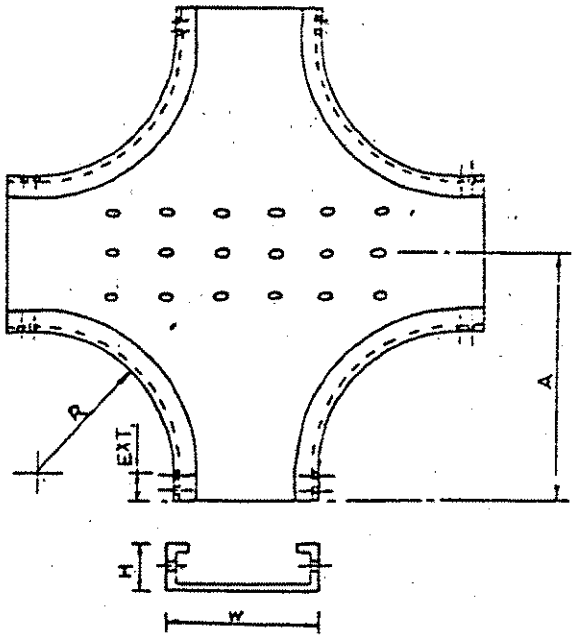
चित्र १ 'अ'
FIGURE -3 'A'
सिडिंग वायर टाइप केबिल ट्रे
SHEET TYPE CABLE TRAY COMPONENT
क्लाज २.६.११.२ (ii)
CLAUSE - 2.6.11.2 (ii)



TEE

W	H	R	EXT.	TH.
600	50	600	100	3
450	"	"	"	"
300	"	"	"	"
150	"	"	"	"
"	"	1000	"	"
"	"	"	"	"
"	"	"	"	"
"	"	"	"	"
"	"	"	"	"

NOT TO SCALE



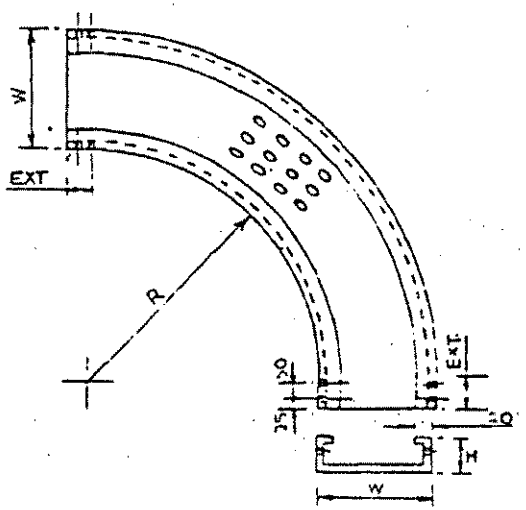
CROSS

W	H	R	EXT.	TH	A
600	50	600	100	3	1000
450	"	"	"	"	925
300	"	"	"	"	850
150	"	"	"	"	775

NOTE
DETAILS SHOWN ARE ILLUSTRATIVE. DEVIATIONS AS PER MANUFACTURE'S STANDARD DESIGN IS PERMISSIBLE.

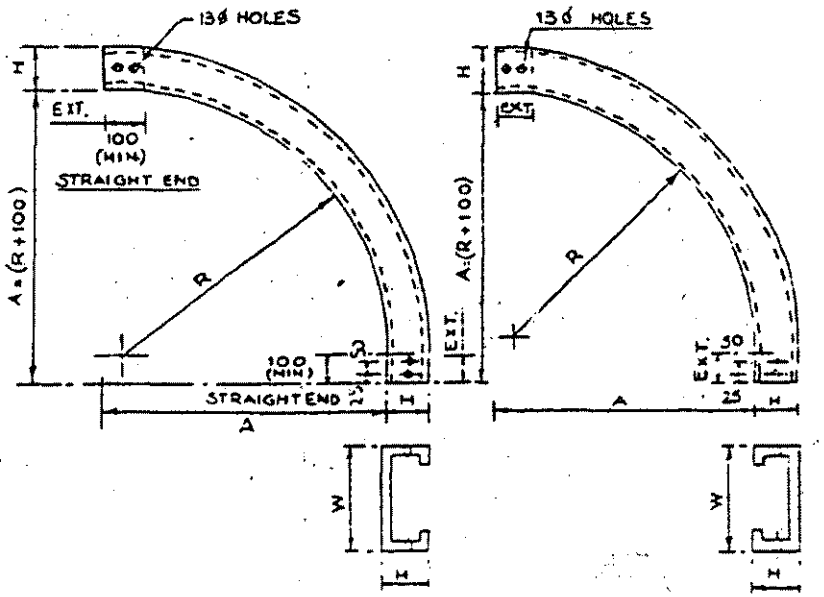
चित्र: १ 'ब'
FIGURE -3 'B'
छिद्रित घातर टाइप केबिल ट्रे
SHEET TYPE CABLE TRAY COMPONENT
खण्ड :२.६.११.२ (ii)
CLAUSE - 2.6.11.2 (ii)

NOT TO SCALE



W	H	R	EXT	TH
600	50	600	100	3
450	"	"	"	"
300	"	"	"	"
150	"	"	"	"

90° HORIZONTAL BEND OUTSIDE

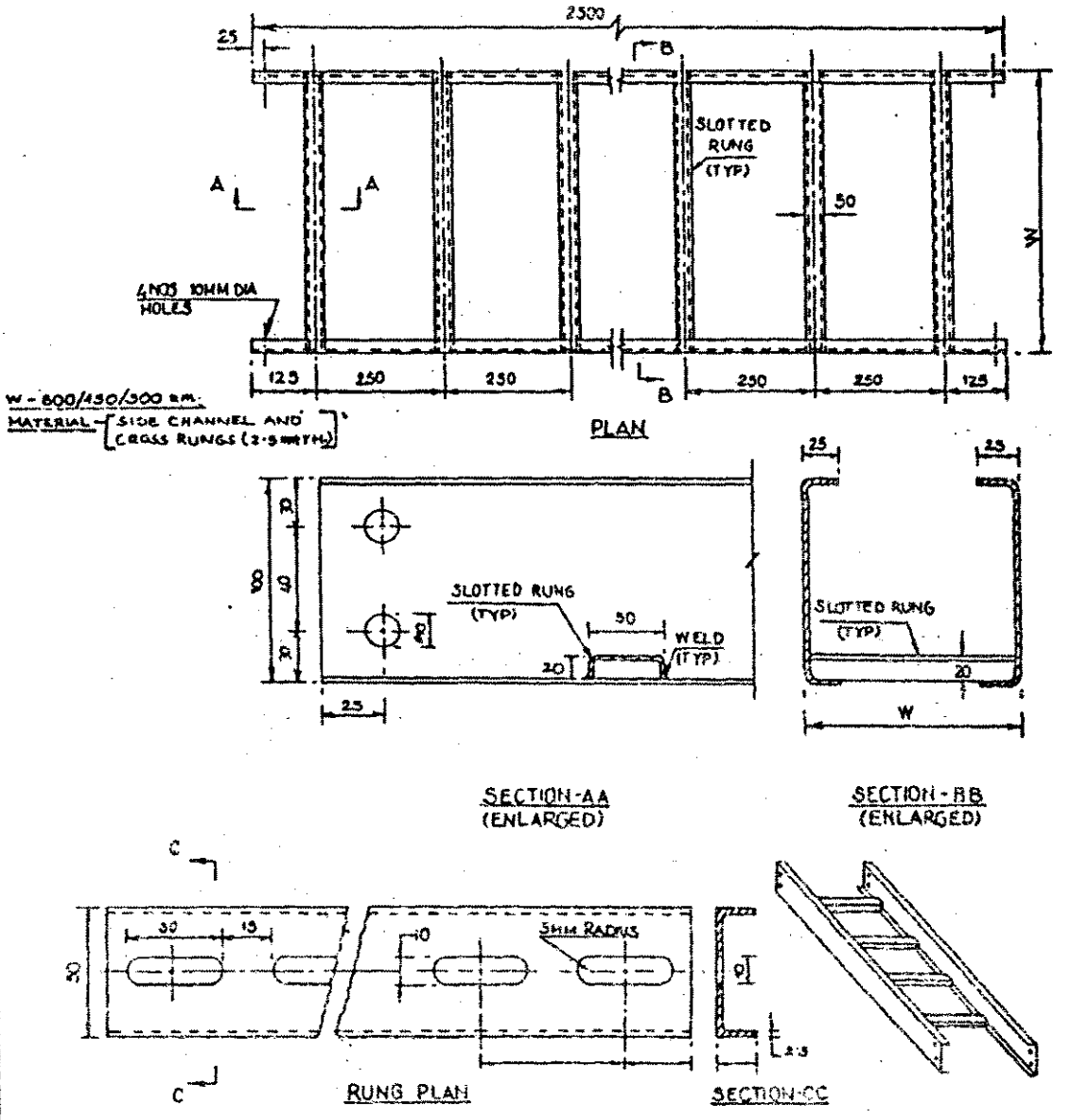


W	H	R	EXT.	TH	A (R+100)
600	50	1000	100	3	1100
450	"	"	"	"	"
300	"	"	"	"	"
150	"	"	"	"	"
600	"	600	"	"	700
450	"	"	"	"	"
300	"	"	"	"	"
150	"	"	"	"	"

90° VERTICAL BEND OUTSIDE AND INSIDE

चित्र : ३ 'ग'
FIGURE -3 'C'
छिद्रित ट्रे प्रकार केबिल ट्रे
SHEET TYPE CABLE TRAY COMPONENT
खण्ड : २.११.२ (ii)
CLAUSE - 2.6.11.2 (ii)

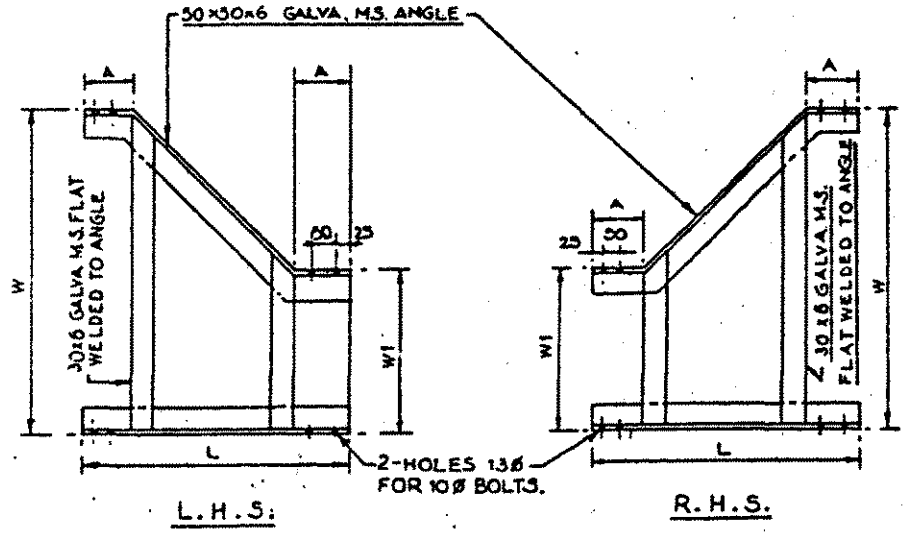
NOTE
DETAILS SHOWN ARE ILLUSTRATIVE DEVIATIONS AS PER MANUFACTURER'S STANDARD DESIGN IS PERMISSIBLE.



NOTE.

DETAILS SHOWN ARE ILLUSTRATIVE. DEVIATIONS AS PER MANUFACTURER'S STANDARD DESIGN IS PERMISSIBLE.

चित्र: ४ 'क'
FIGURE -4 'A'
लिपित सीढ़ी टाइप केबिल ट्रे
LADDER TYPE CABLE TRAY COMPONENT
खण्ड २.६.११.३ (iii)
CLAUSE - 2.6.11.3 (iii)

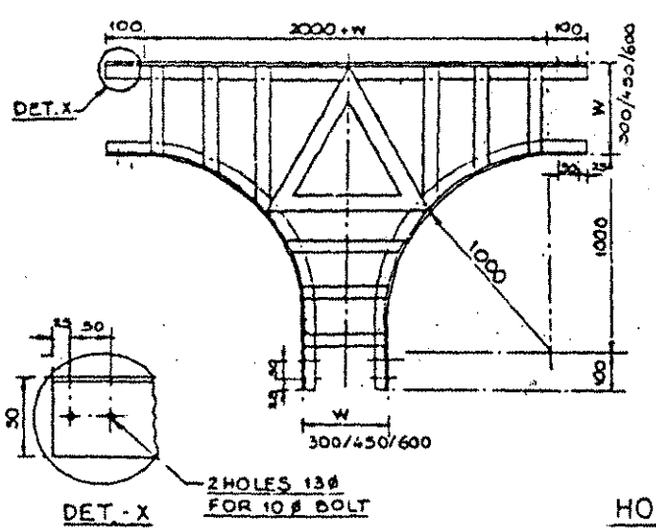


W	W1	L	A
600	300	500	100
600	450	350	100
450	300	350	100

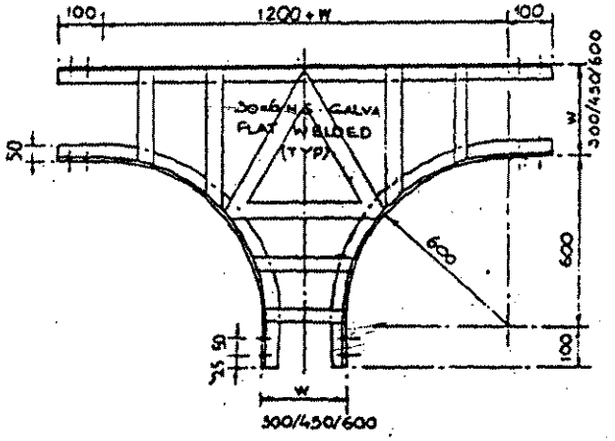
VERTICAL REDUCER

NOTE:-
DETAILS SHOWN ARE ILLUSTRATIVE&DEVIATIONS AS PER MANUFACTURER'S STANDARD DESIGN IS PERMISSIBLE.

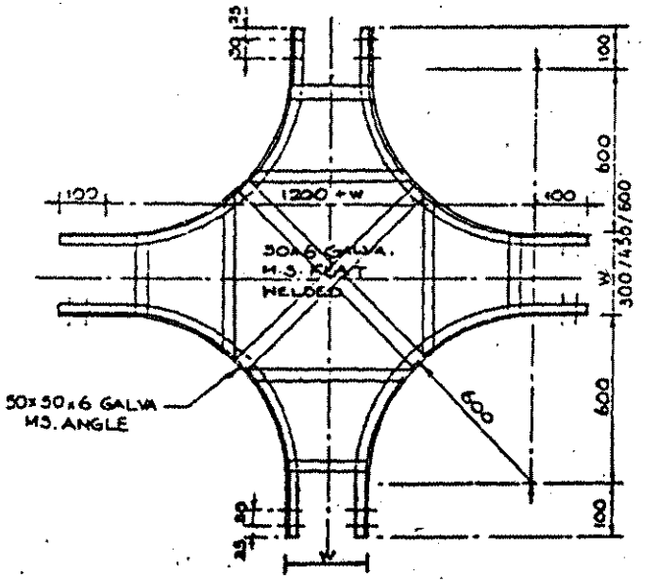
चित्र: ४ 'ब'
FIGURE -4 'B'
खण्ड : २.६.११.३ (iii)
CLAUSE - 2.6.11.3 (iii)



DET. - X



HORIZONTAL TEE

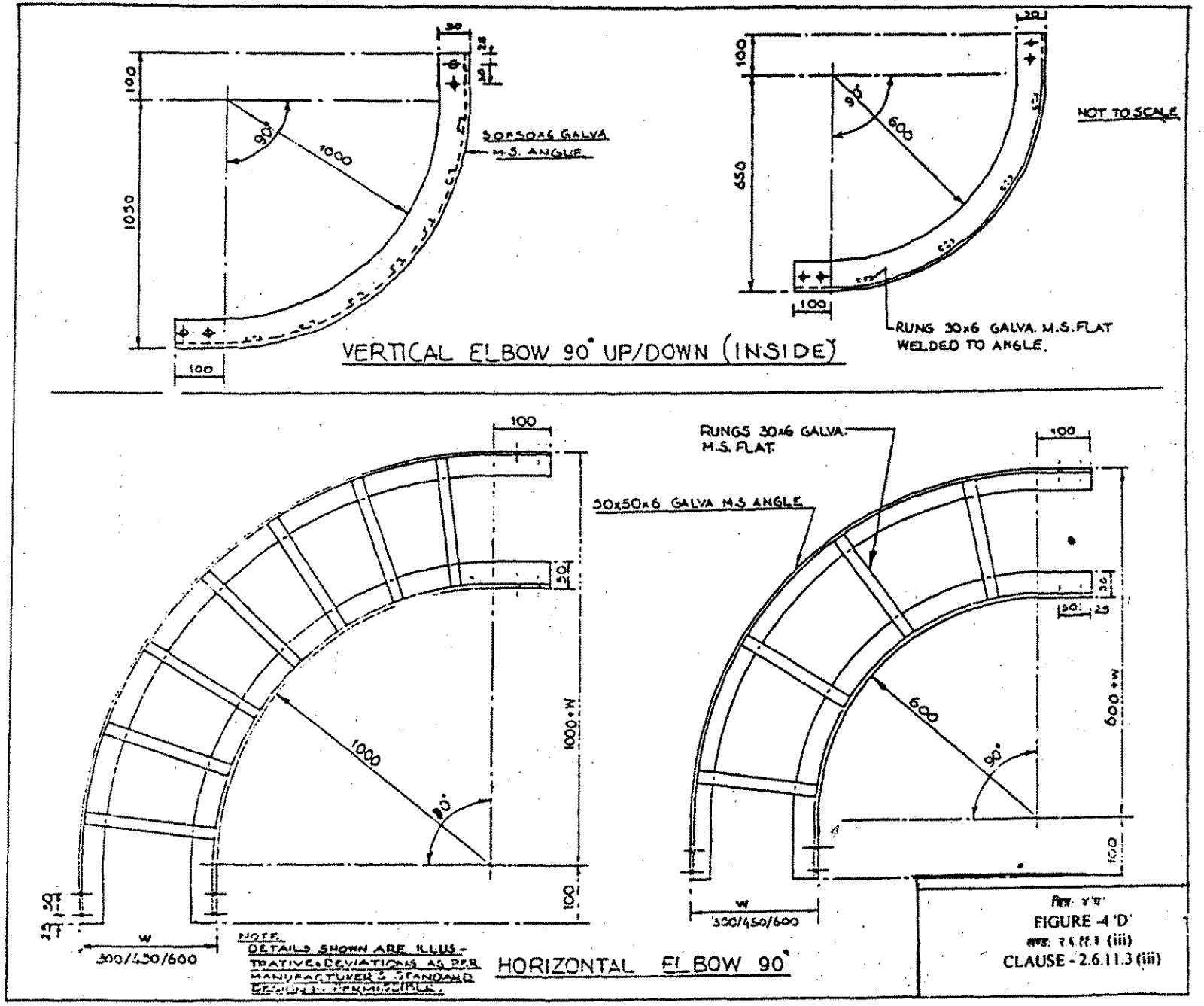


HORIZONTAL JUNCTION

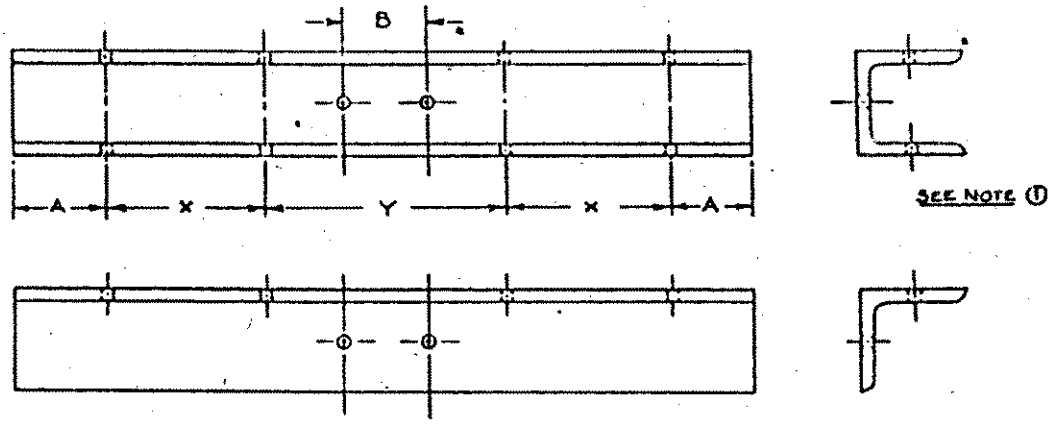
NOTE :-

DETAILS SHOWN ARE ILLUSTRATIVE. DEVIATIONS AS PER MANUFACTURER'S STANDARD DESIGN IS PERMISSIBLE.

Rev. v 'B'
FIGURE -4 'C'
Rev. 2.6.11.3 (iii)
CLAUSE - 2.6.11.3 (iii)



चित्र: ४'ड'
FIGURE -4 'D'
खण्ड: २.६.११.३ (iii)
CLAUSE - 2.6.11.3 (iii)



DIMENSIONS

A : 50 mm FOR LV/MV LINES.
100 mm FOR 11KV LINES.

B : TO SUIT THE POLES.

X : 300 mm
Y : 450 mm } FOR LV/MV LINES (SEE NOTES 2 & 3).

X = Y = 1050 mm FOR HV LINES (SEE NOTES 3 & 4).

CHANNEL SIZE : 75 mm x 40 mm x 4·8 mm (7·14 KG/M).

ANGLE SIZE : 50 mm x 50 mm x 6 mm (4·5 KG/M) FOR LV/MV LINES.
& 65 mm x 65 mm x 6 mm (5·8 KG/M) FOR 11 KV LINES.

NOTE

① HOLES TO BE DRILLED (SHOWN) TYPICALLY) SHALL SUIT THE REQUIREMENT OF FIXING HARDWARE, AS PER NUMBER AND TYPE OF INSULATOR.

② X & Y DIMENSIONS ARE BASED ON 750 mm (MAX.) SAG.

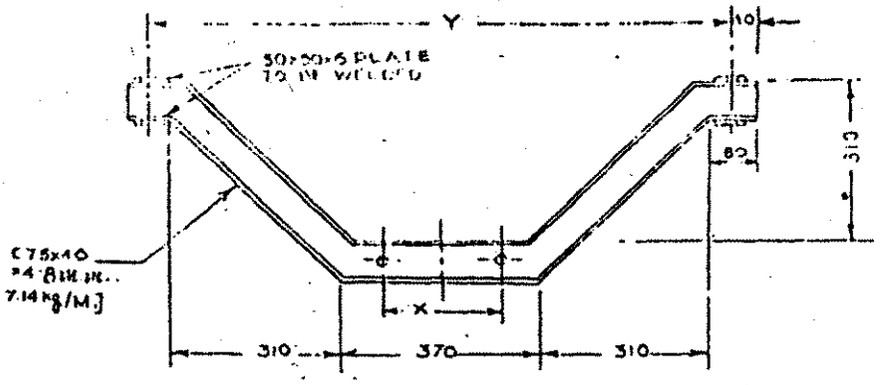
③ FOR TAKING ONLY 2 CONDUCTORS, 'X' DIMENSIONS WILL BE ZERO.

④ FOR 11 KV LINES THE SPACING BETWEEN HOLES (3 NOS FOR 3 CONDUCTORS) SHOULD BE 1050 mm (MIN.).

⑤ FOR HV LINES, DOUBLE CLAMPING WITH WELDED ADDITIONAL ANGLE IRON BRACKET SHALL BE ADOPTED AS SHOWN IN FIGURE - 5C.

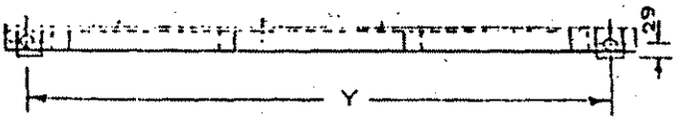
NOT TO SCALE

FIGURE -5 'A'
STRAIGHT CROSS ARM
(LV/MV/11 KV LINES)
CLAUSE - 3.2.2 (iv)



ELEVATION

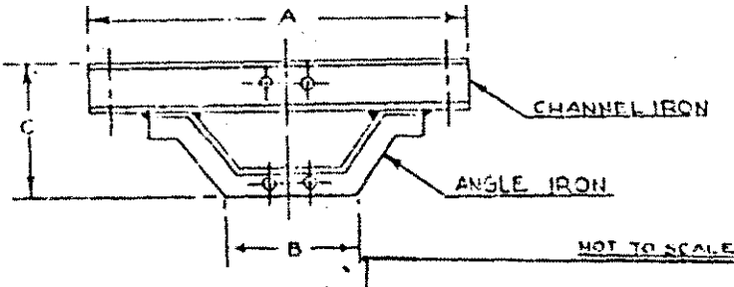
X = TO SUIT THE POLE.
Y = 1050 FOR 11KV &
1500 FOR 33KV



PLAN

	A
11 KV	0·25M
33KV	0·30M

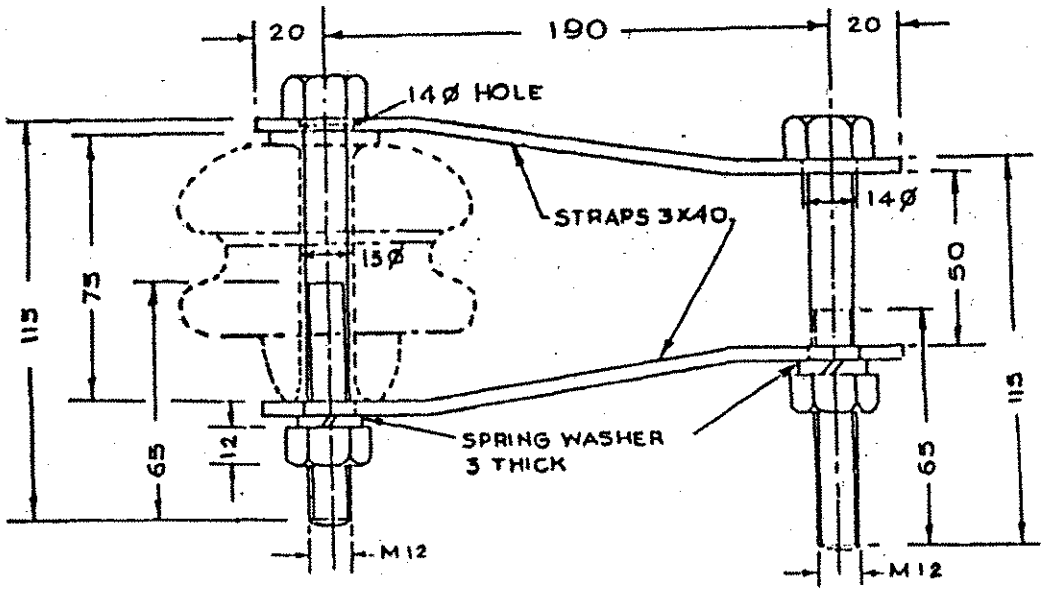
FIGURE -5 'B'
V- CROSS ARM FOR
HV LINES
CLAUSE - 3.2.2.1 (iv)



NOT TO SCALE

	A	B	C
11 KV	1·1M	0·45M	0·6M
33 KV	1·6M	0·6M	0·75M

FIGURE -5 'C'
CROSS ARM FOR SINGLE
CONDUCTOR & DOUBLE CLAMPING
FOR HV LINES
CLAUSE - 3.2.2.1 (iv)



CLAUSE - 3.2.2.3(i)

FIG. 6B. G.I. STRAPS

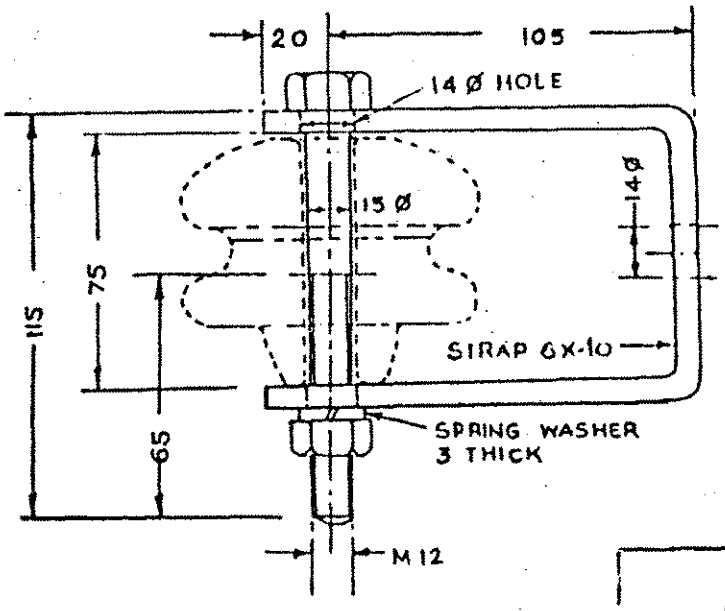


FIG. 6A D-IRON CLAMP

ALL DIMENSIONS IN mm.

FIGURE -6 'A'
415/240 V INSULATORS & FITTINGS
HARDWARE FOR SHACKLE INSULATOR
CLAUSE - 3.2.2.2 (ii)

N.T.S.

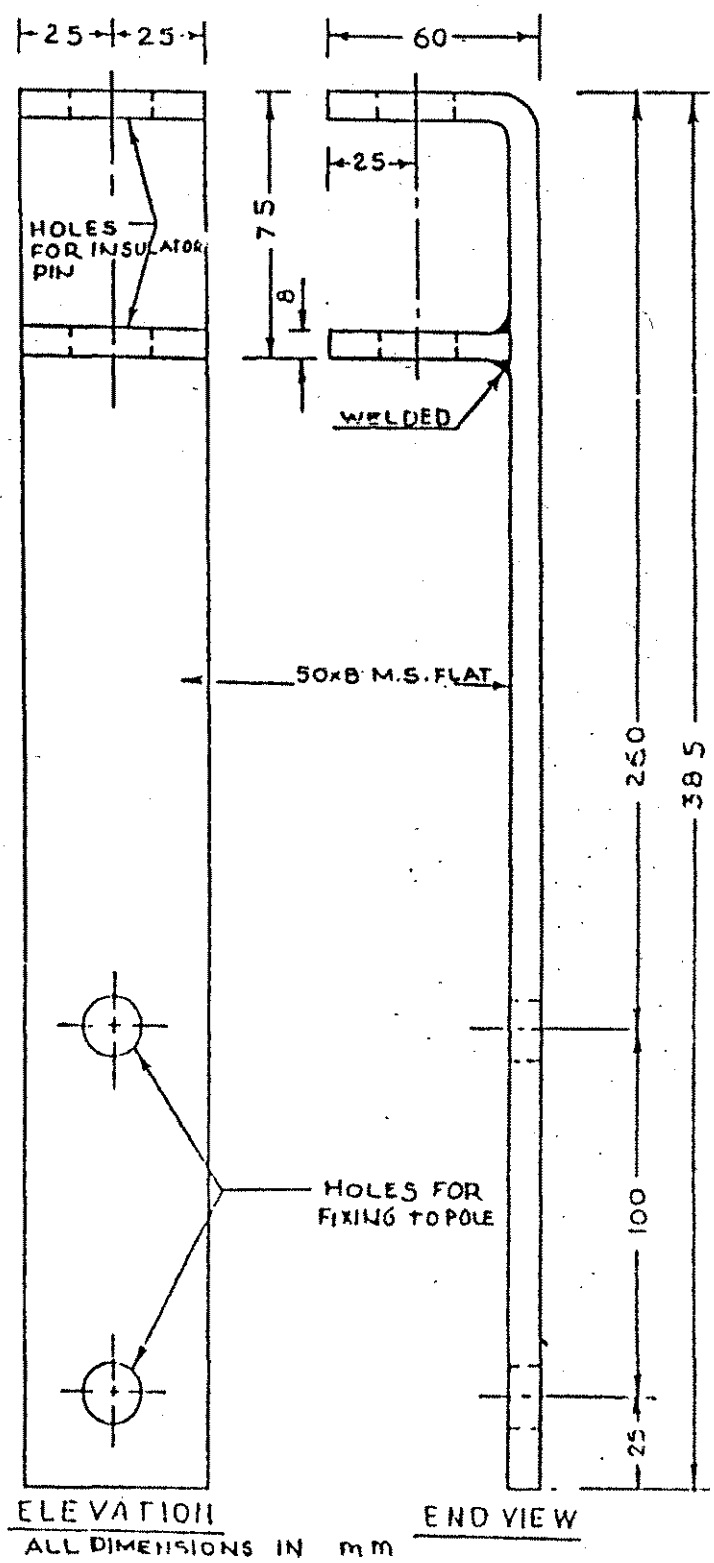


FIGURE -6 'C'
POLE TOP BRACKET
CLAUSE - 3.2.2.4

TYPICAL ARRANGEMENT OF STAY SET

NOT TO SCALE

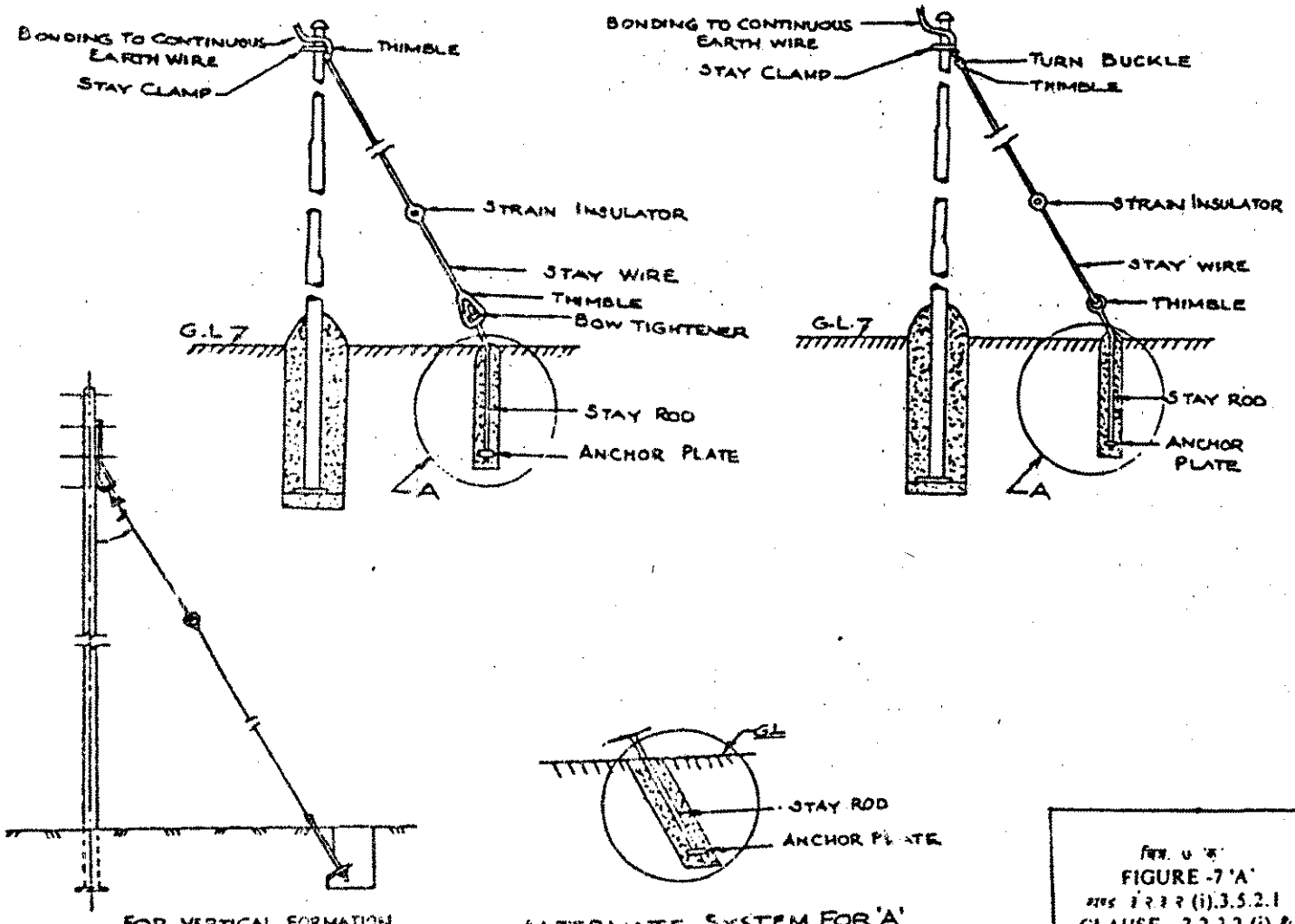


FIG. U 'A'
FIGURE -7 'A'
IS 3 2 2 (i).3.5.2.1
CLAUSE - 3.2.3.2 (i) & 3.5.2.1

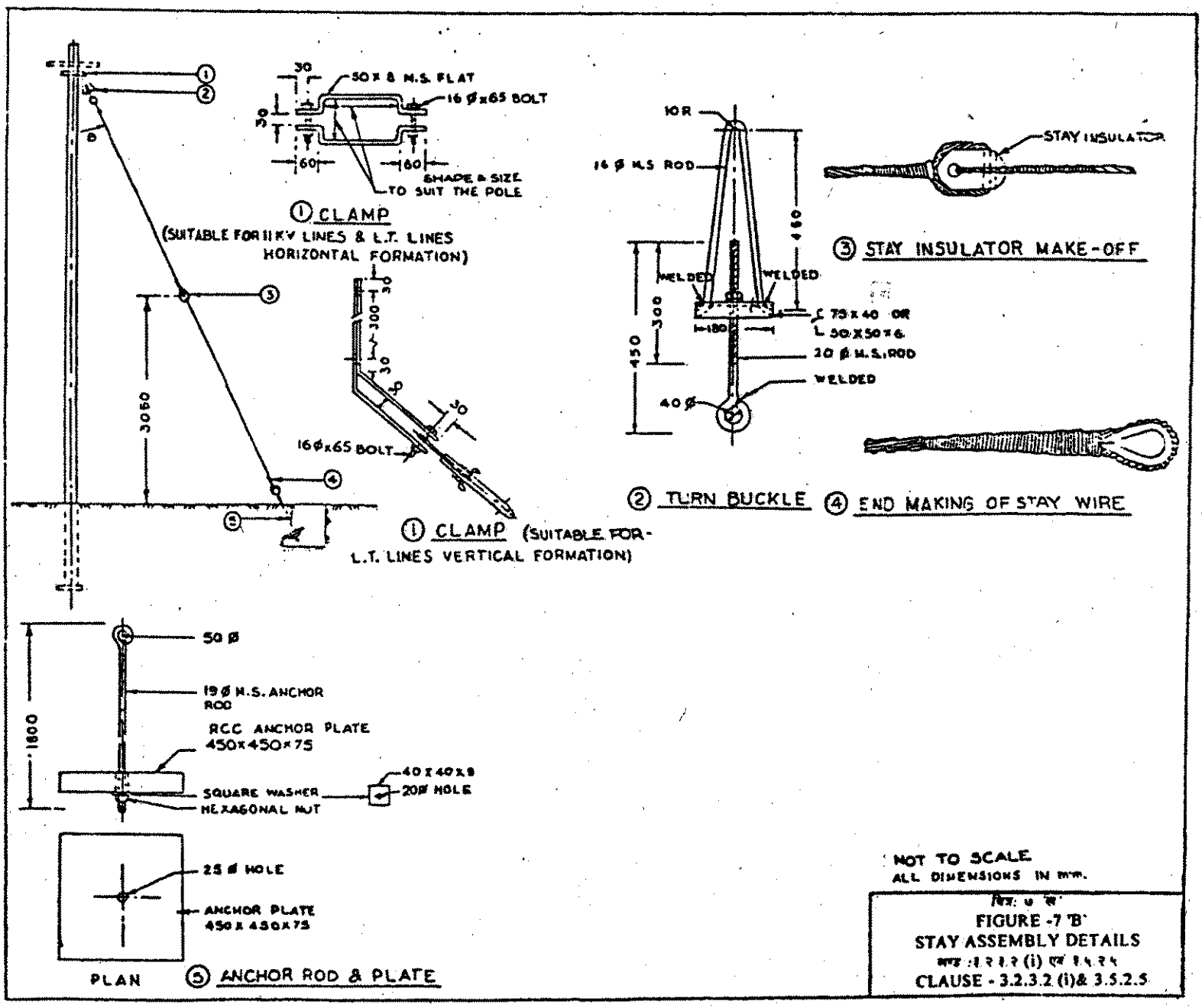
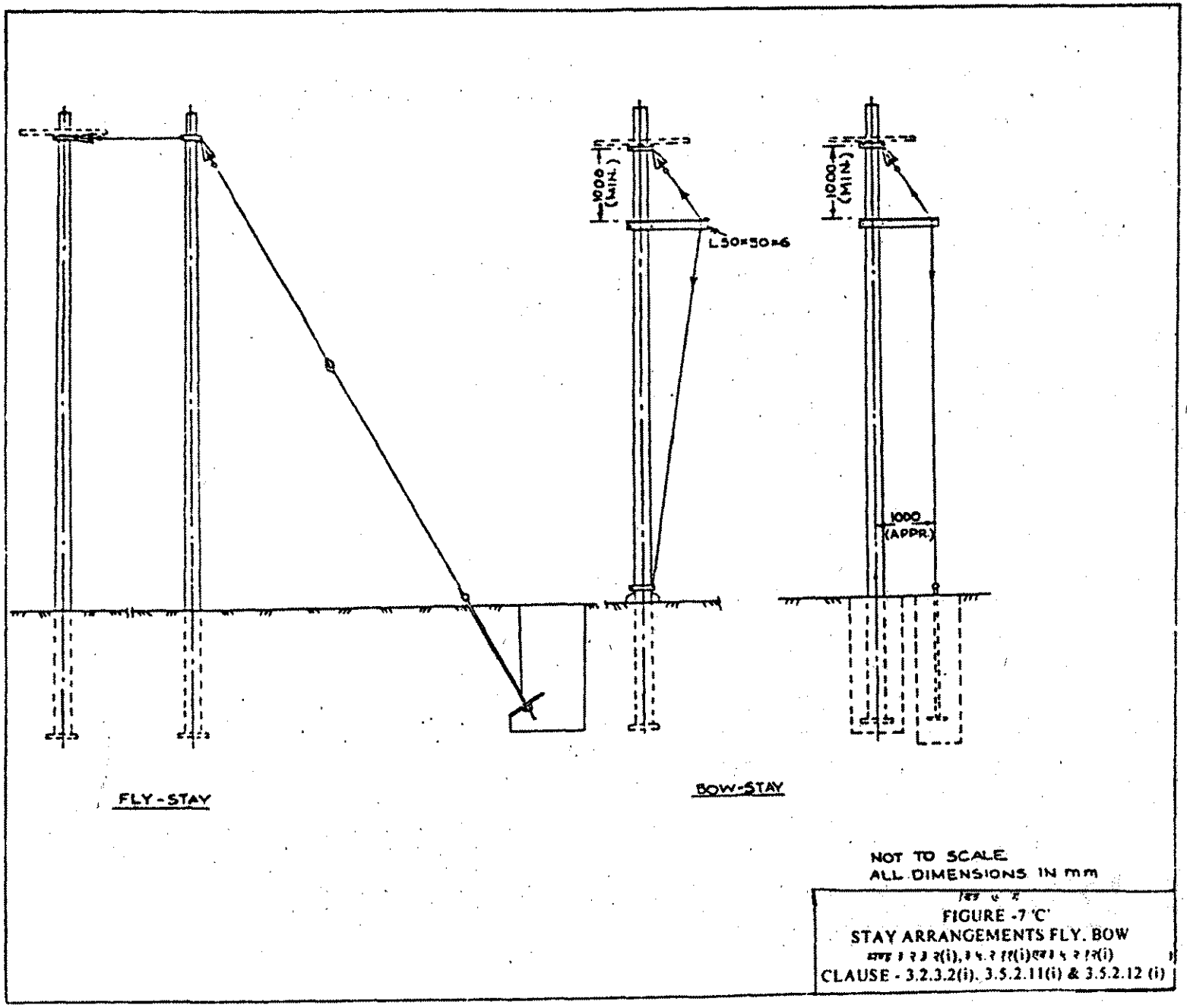


FIGURE -7 'B'
STAY ASSEMBLY DETAILS
CLAUSE - 3.2.3.2 (i)& 3.5.2.5

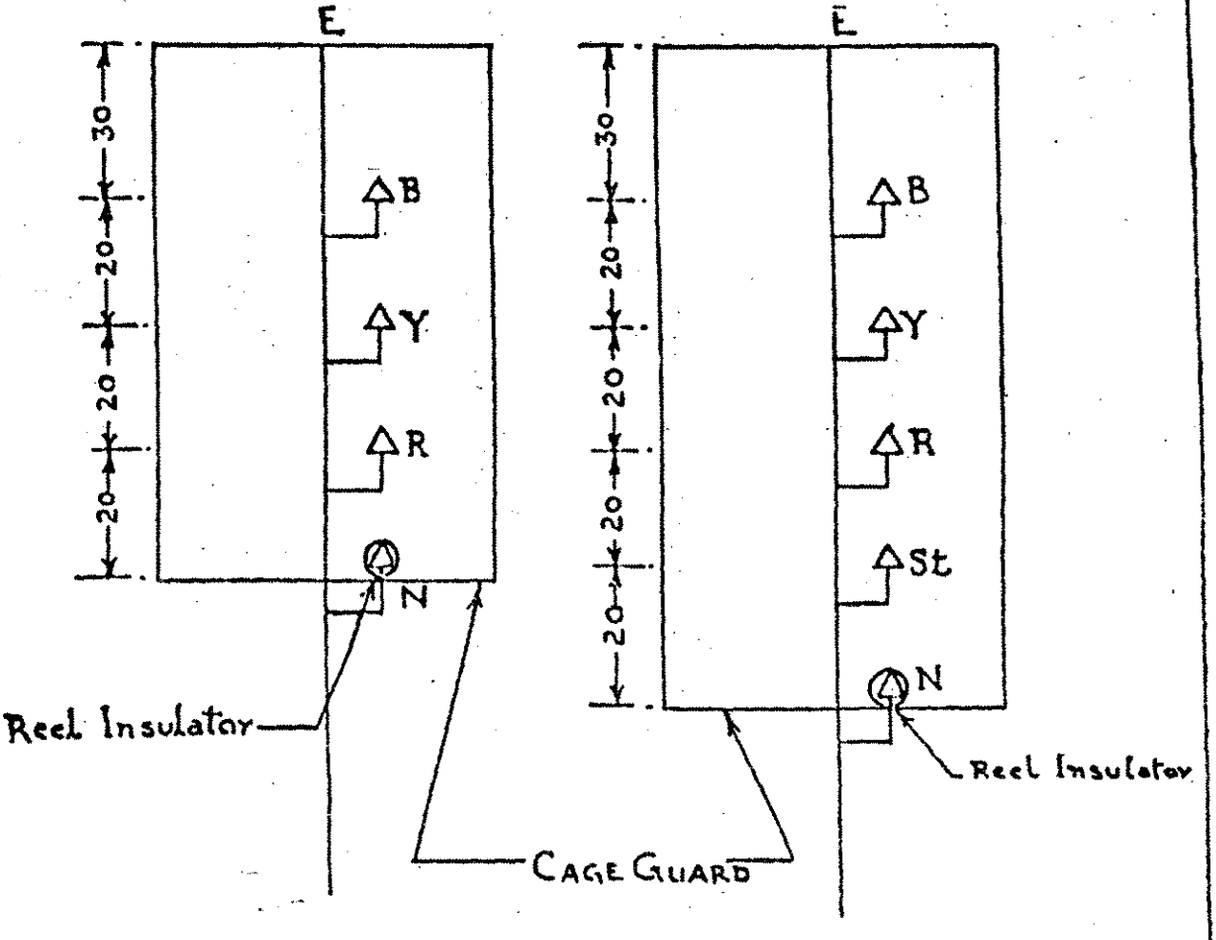


NOT TO SCALE
ALL DIMENSIONS IN mm

FIGURE -7 'C'
STAY ARRANGEMENTS FLY. BOW
CLAUSE - 3.2.3.2(i). 3.5.2.11(i) & 3.5.2.12 (i)

MEDIUM VOLTAGE LINE CONSTRUCTION VERTICAL CONFIGURATION

NOT TO SCALE



Formation Without Street Light Conductor.

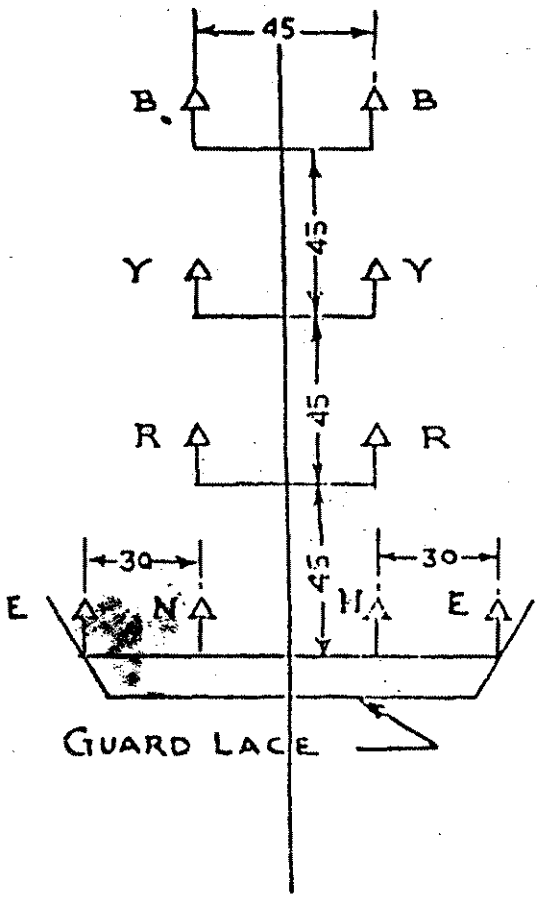
Formation With Street Light Conductor.

All Dimensions In Centimetres.

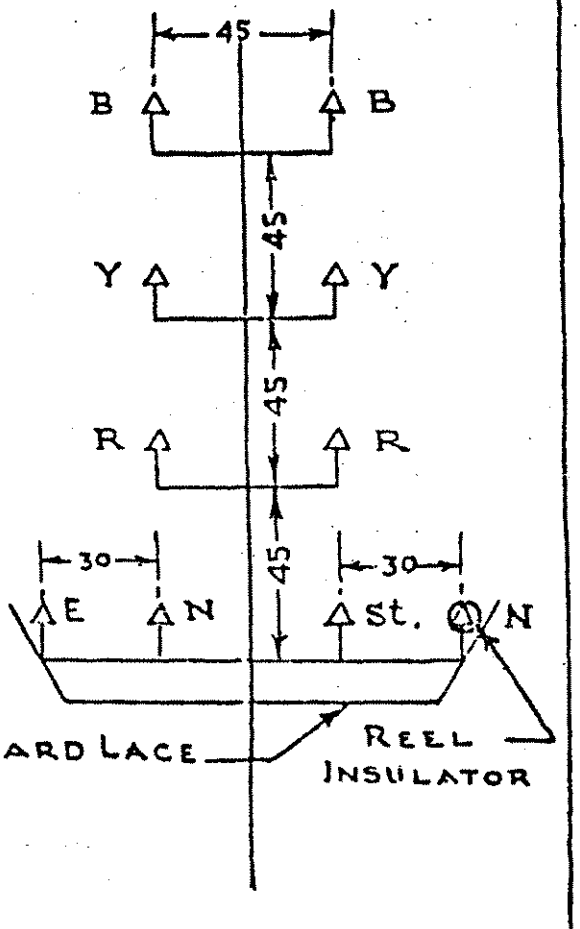
FIGURE -8 'A'
CLAUSE - 3.3.3.1

TYPICAL DOUBLE CIRCUIT LINE
VERTICAL FORMATION

NOT TO SCALE



Formation Without Street Light Conductor.



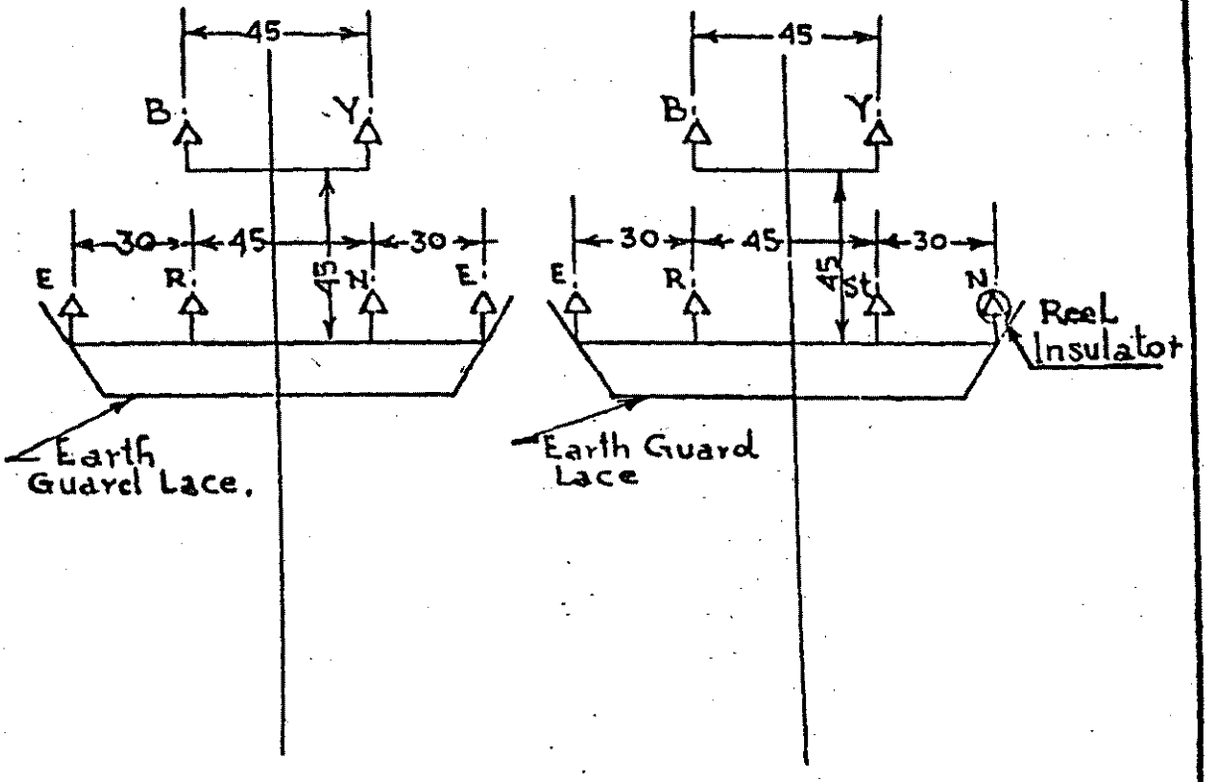
Formation With Street Light Conductor.

All Dimensions In Centimetres.

FIGURE-8 'B'
CLAUSE - 3.3.3.1

TYPICAL SINGLE CIRCUIT M.V. HORIZONTAL FORMATION

NOT TO SCALE



Formation Without Street Light Conductor

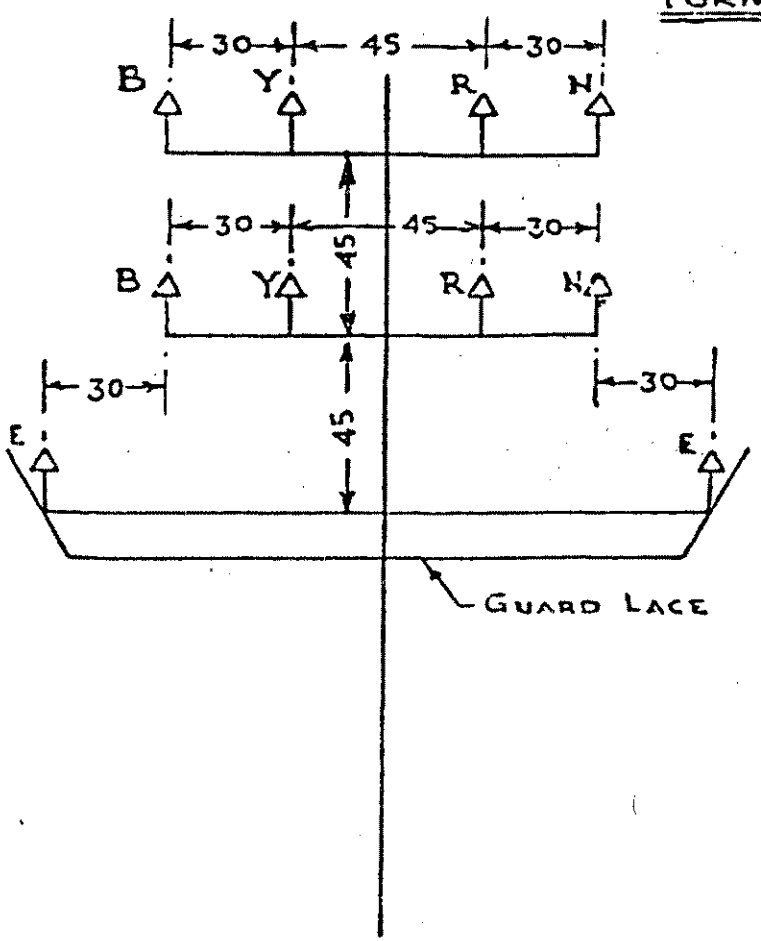
Formation With Street Light Conductor.

All Dimensions In Centimetres.

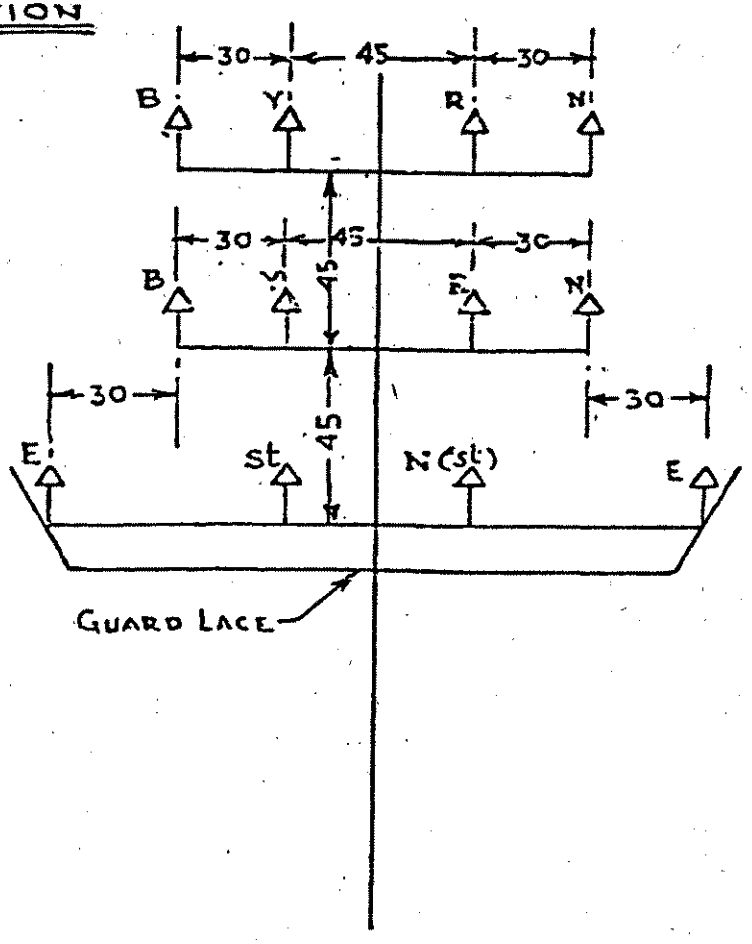
FIGURE -8 'C'
CLAUSE - 3.3.3.1

TYPICAL DOUBLE CIRCUIT M.V. HORIZONTAL FORMATION

NOT TO SCALE



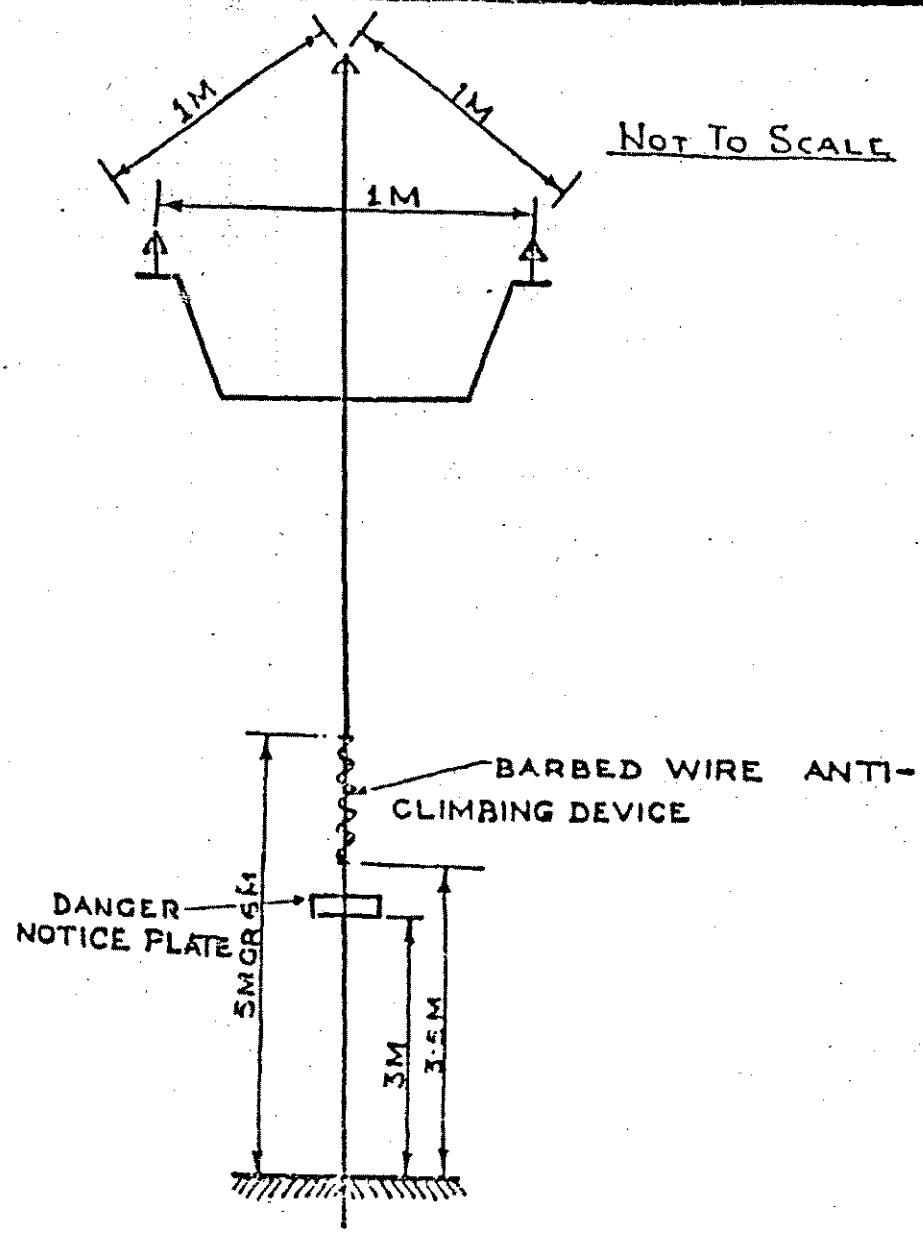
Formation Without Street Light Conductor



Formation With Street Light Conductor.

All Dimensions In Centimetres.

FIGURE -8 'D'
CLAUSE - 3.3.3.1



TYPICAL H.V. LINE TRIANGULAR FORMATION

ALL DIMENSIONS IN METRES

FIGURE-8 'E'
CLAUSE - 3.3.3.1

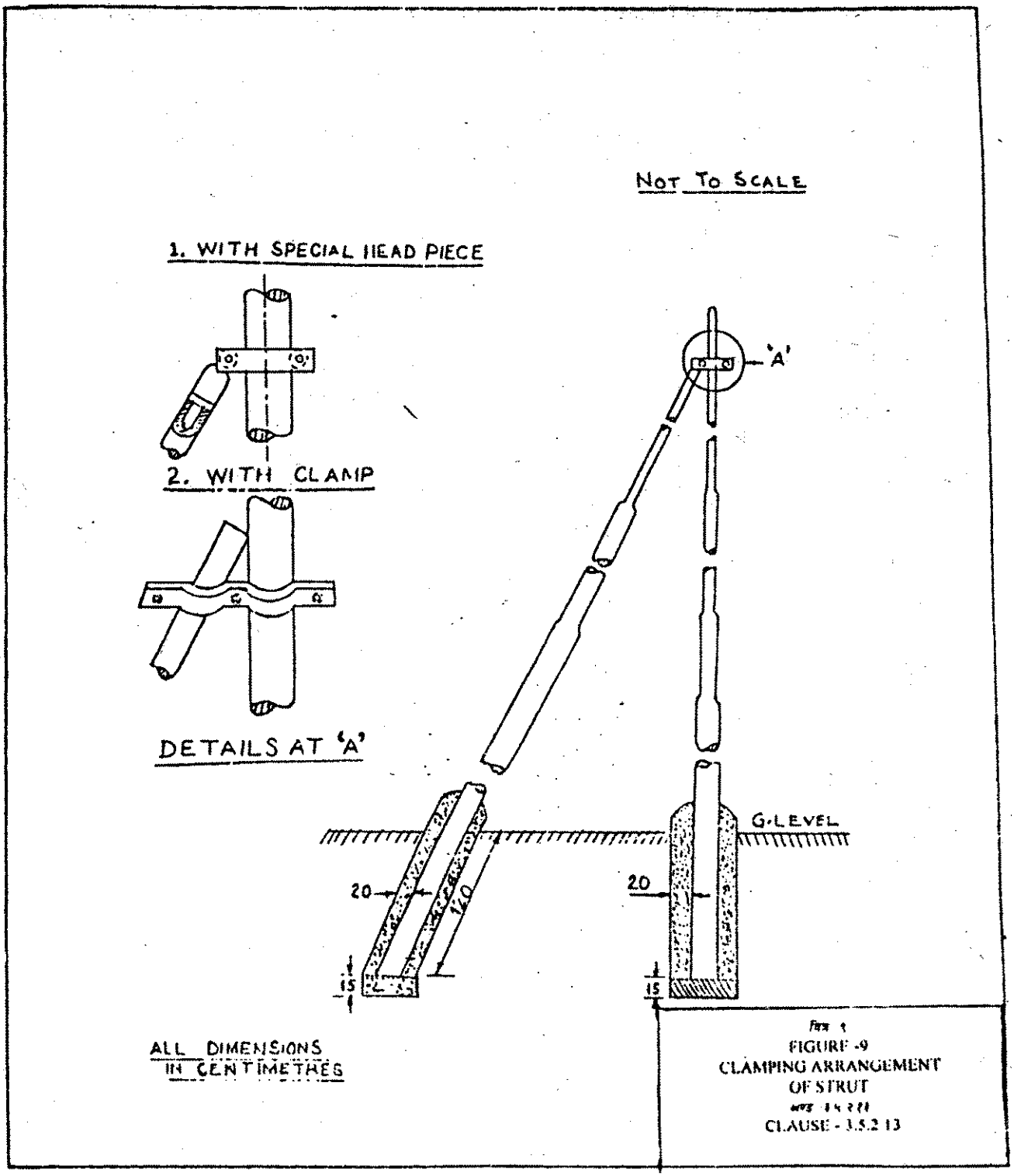
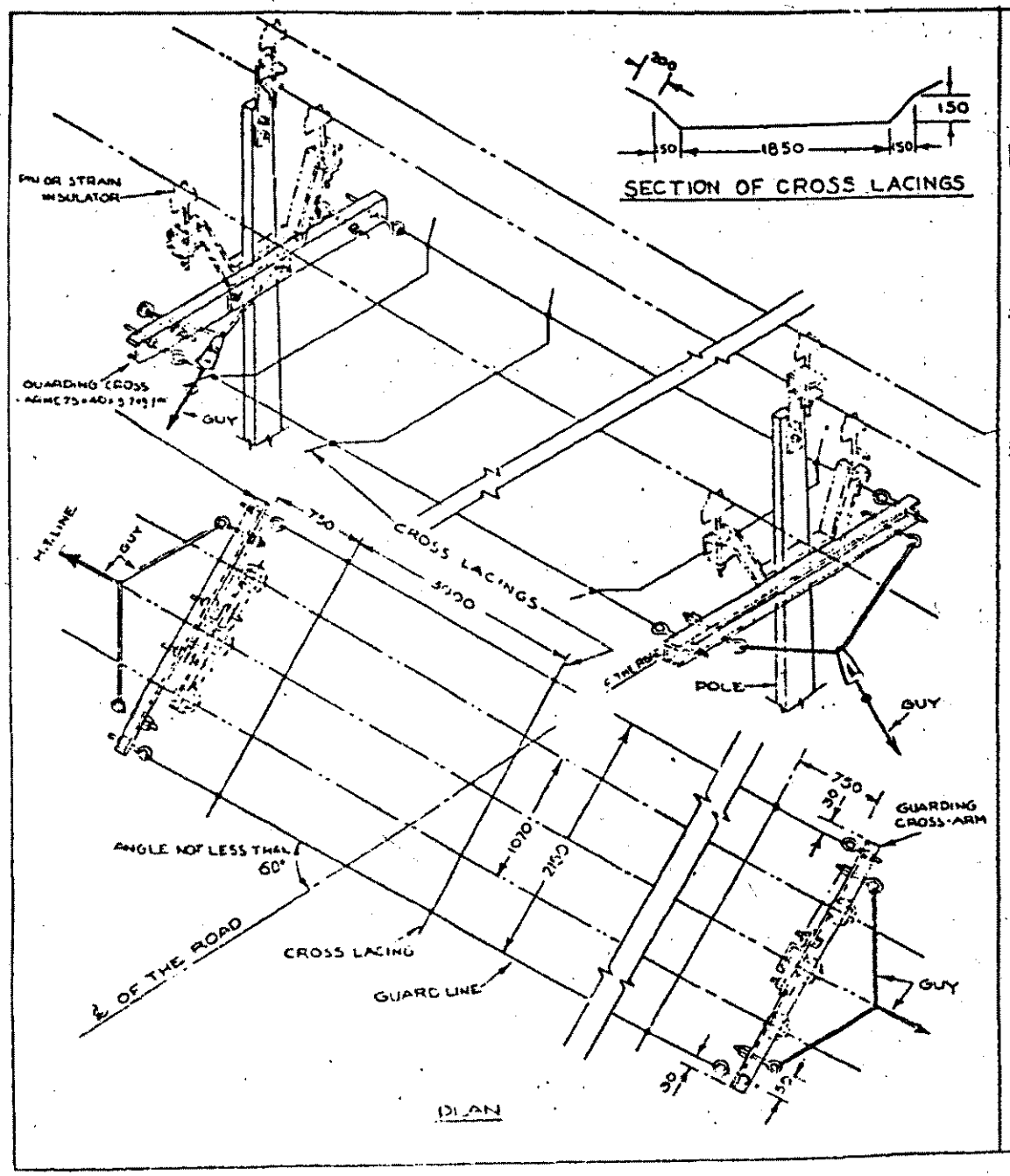


Fig. 9
FIGURE -9
CLAMPING ARRANGEMENT
OF STRUT
CLAUSE - 3.5.2.13

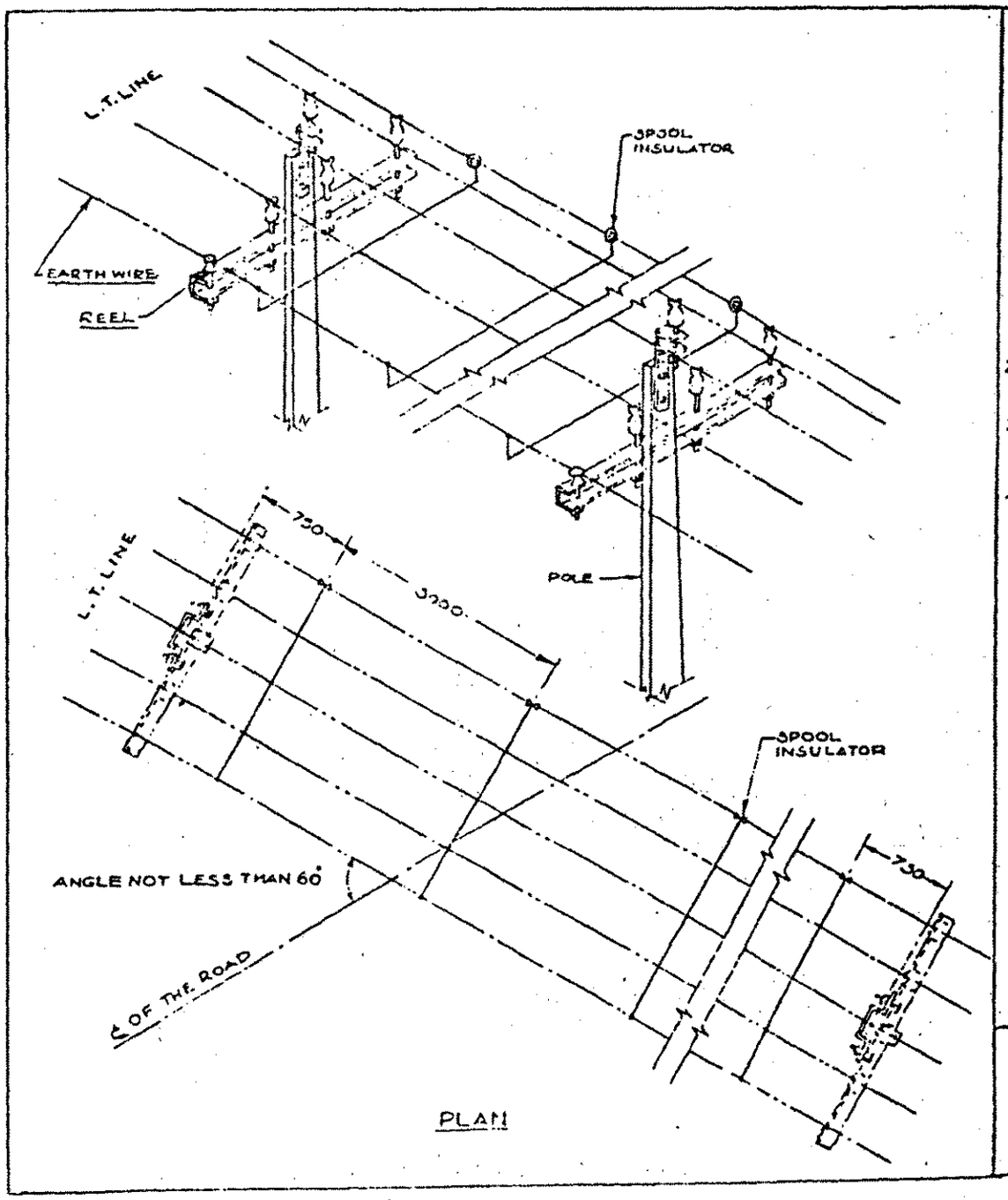


NOTES

1. No. OF CROSS LACINGS TO SUIT THE REQUIREMENTS. CROSS LACINGS BE PROVIDED FOR THE WIDTH OF THE ROAD PLUS ONE EACH NEAR THE SUPPORT.
2. SPECIAL SUPPORTS MAY BE NEEDED TO ALLOW MINIMUM CLEARANCE FROM GROUND AS PER I.E. RULE NO. 77 i.e. 6.1 METRES & TO TAKE CARE OF ADDITIONAL WIND LOAD DUE TO GUARD WIRES.
3. STRUCTURES ON EITHER SIDE OF THE ROAD TO BE EARTHED.
4. CROSSING ANGLE SHOULD NOT BE LESS THAN 60°

ALL DIMENSIONS IN MM. UNLESS OTHERWISE INDICATED

FIGURE -10 'A'
PROTECTIVE GUARDING
CLAUSE - 3.5.9.2



NOT TO SCALE

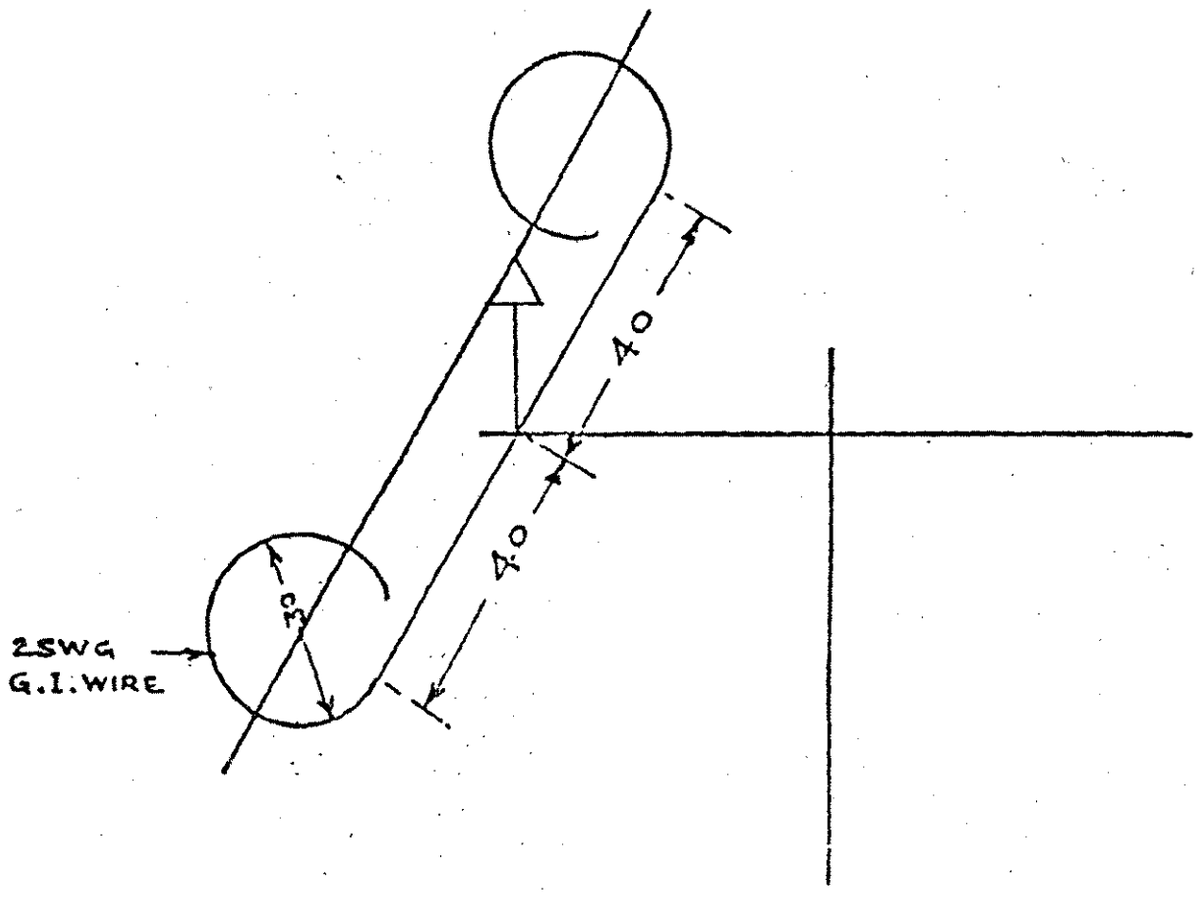
NOTES

1. No. OF CROSS LACINGS TO SUIT THE REQUIREMENTS. CROSS LACINGS BE PROVIDED FOR THE WIDTH OF THE ROAD PLUS ONE EACH NEAR THE SUPPORT.
2. STRUCTURES ON EITHER SIDE OF THE ROAD TO BE EARTHED.
3. CROSSING ANGLE SHOULD NOT BE LESS THAN 60°.
4. SPECIAL SUPPORTS MAY BE NEEDED TO ALLOW MINIMUM CLEARANCE FROM GROUND AS PER I.E. RULE NO. 77. i.e. 5.8 METRES.

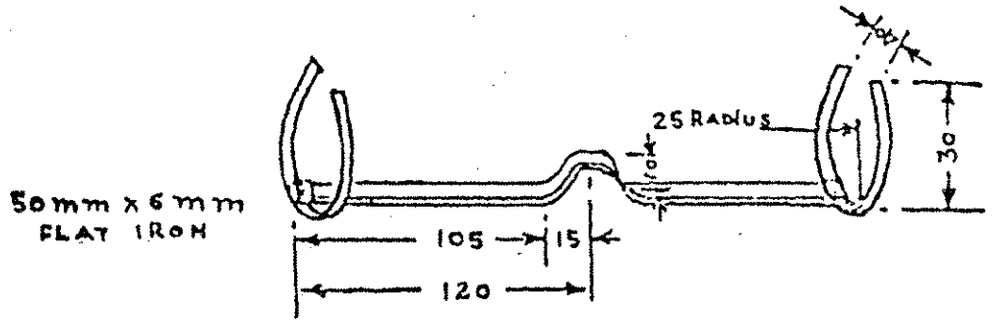
ALL DIMENSIONS ARE IN MM.

FIGURE -10 'B'
PROTECTIVE GUARDING ACROSS THE ROAD HORIZONTAL FORMATION
CLAUSE - 3.5.9.2

TYPICAL ARRANGEMENT OF RING GUARD



DOUBLE ARM ANTI-BUCKLING TYPE FOR FIXING UNDER THE INSULATOR PIN & GUARDING ONE CONDUCTOR

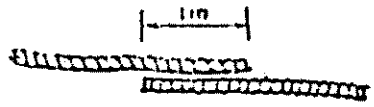


NOT TO SCALE

All Dimensions In Centimetres.

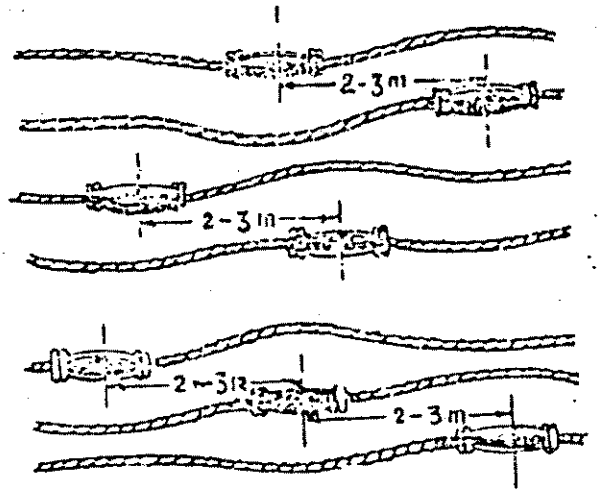
for ll
FIGURE -11
TYPICAL ARRANGEMENT OF
RING GUARD
CLAUSE - 3.5.9.2

STAGGERING OF JOINTS.



(a)

(b)



(c)

Arrangment of cables and joint boxes

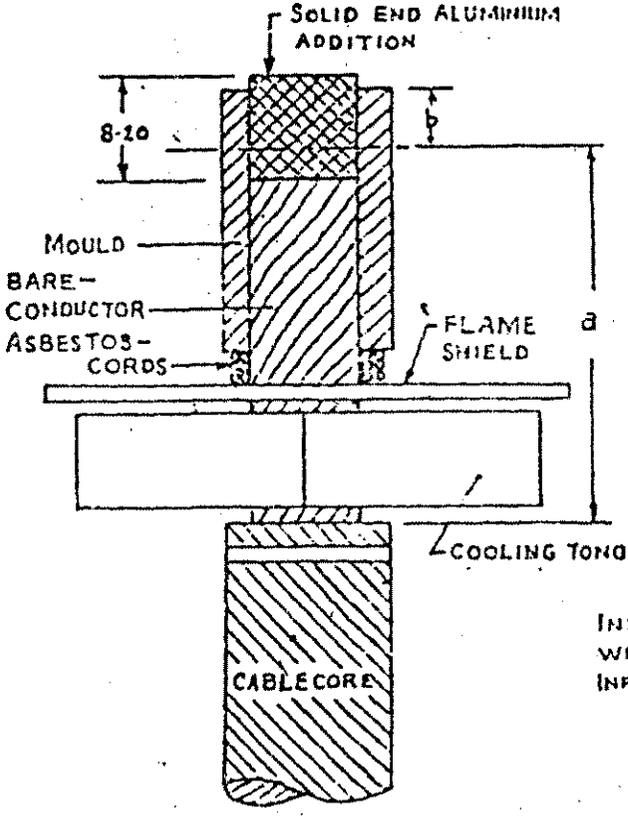
(a) - determining centre position of joint box w.r.t cable ends.

(b) - wave of slack left near joint box.

(c) - staggering of joint boxes.

FIGURE - 12
Appendix F
CLAUSE F - 2.1

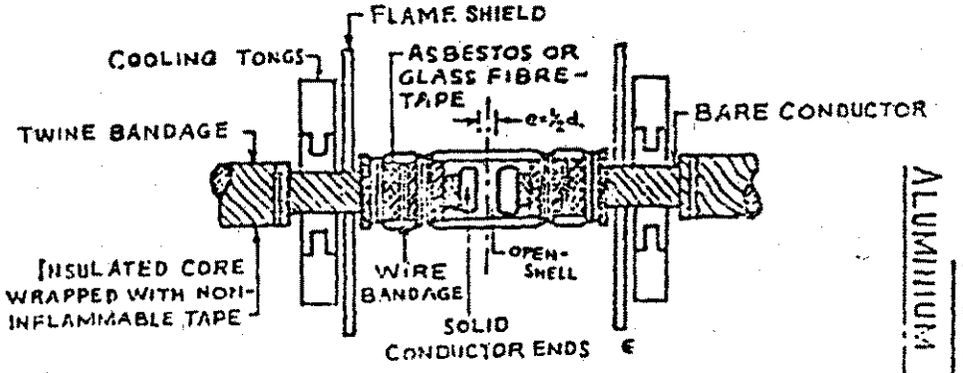
WELDING METHODS OF ALUMINIUM CONDUCTOR JOINTING



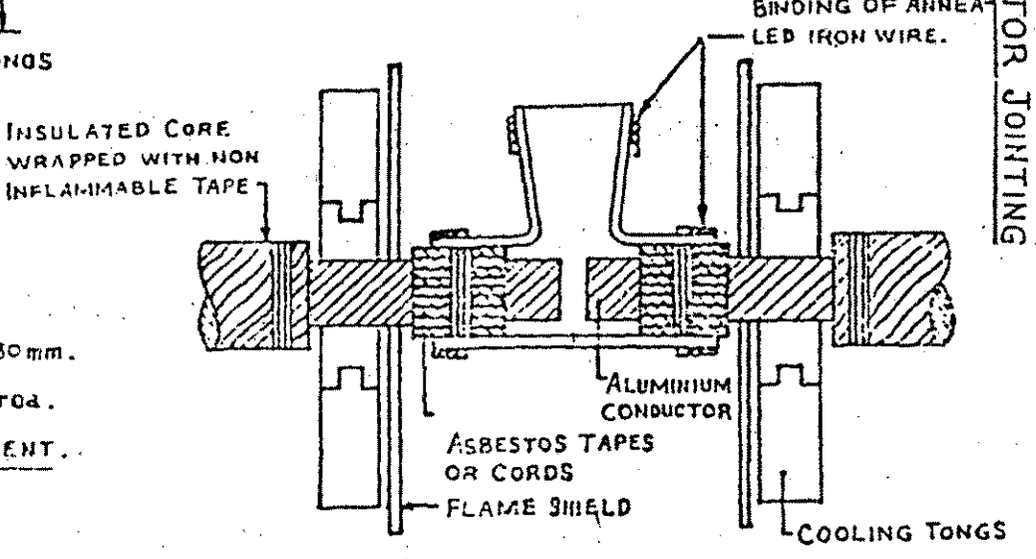
a) Length of Bore of Cable-Lug Sleeve 20+30 mm.

b) 5 to 10 mm. Depending on Cross-Sectional Area.

SOLID END WELDING ARRANGEMENT.

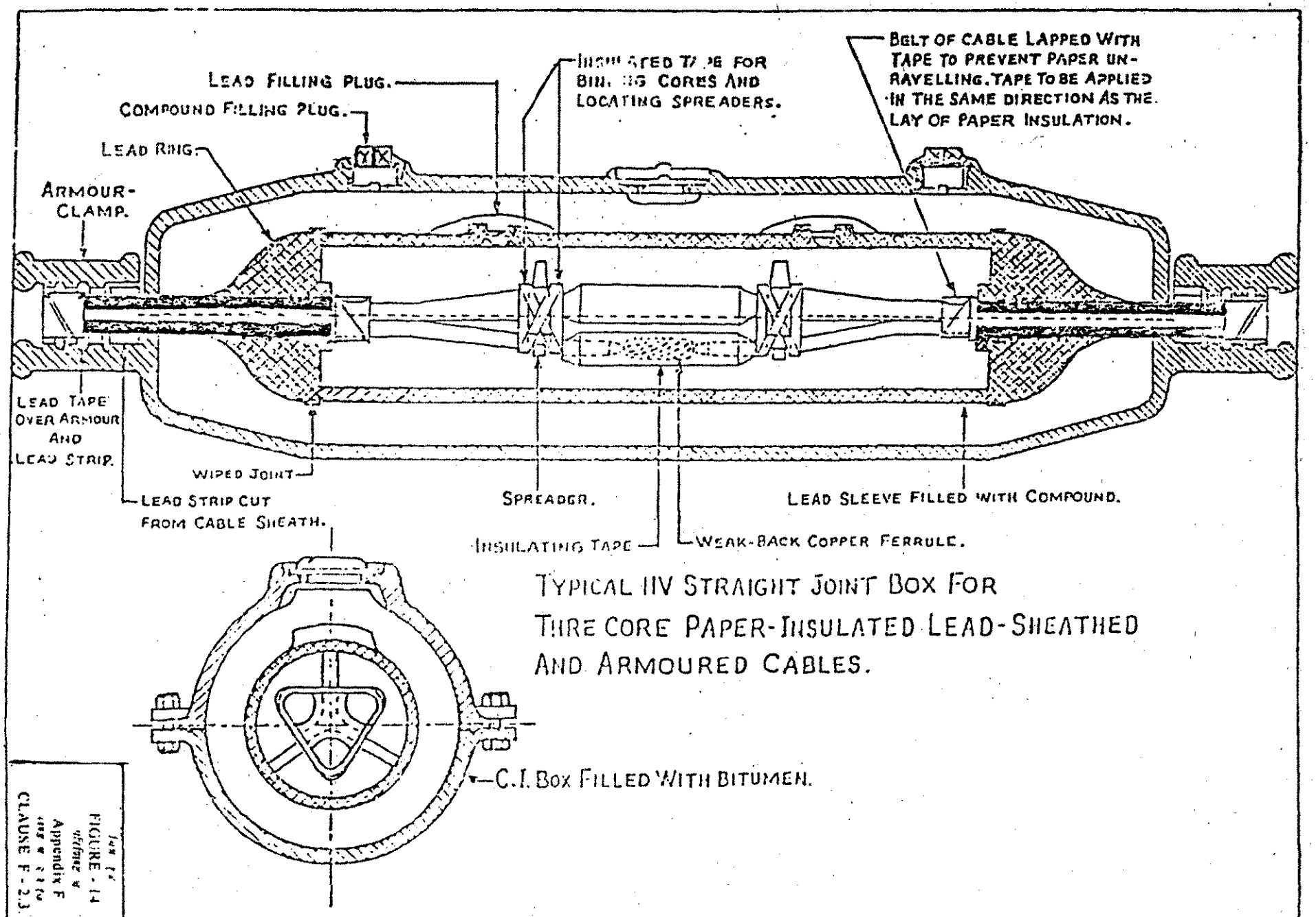


ARRANGEMENT FOR OPEN MOULD WELDING.



ARRANGEMENT FOR CLOSED MOULD WELDING OF ALMUNIUM CONDUCTORS.

FIGURE - 13 -
Appendix F
CLAUSE F-2.2.3



TYPICAL IIV STRAIGHT JOINT BOX FOR THREE CORE PAPER-INSULATED LEAD-SHEATHED AND ARMOURED CABLES.

FIGURE - 14
Appendix F
CLAUSE F-2.3.17

(XXVIII)

TYPICAL H.V. DIVIDING BOX (INDOOR)

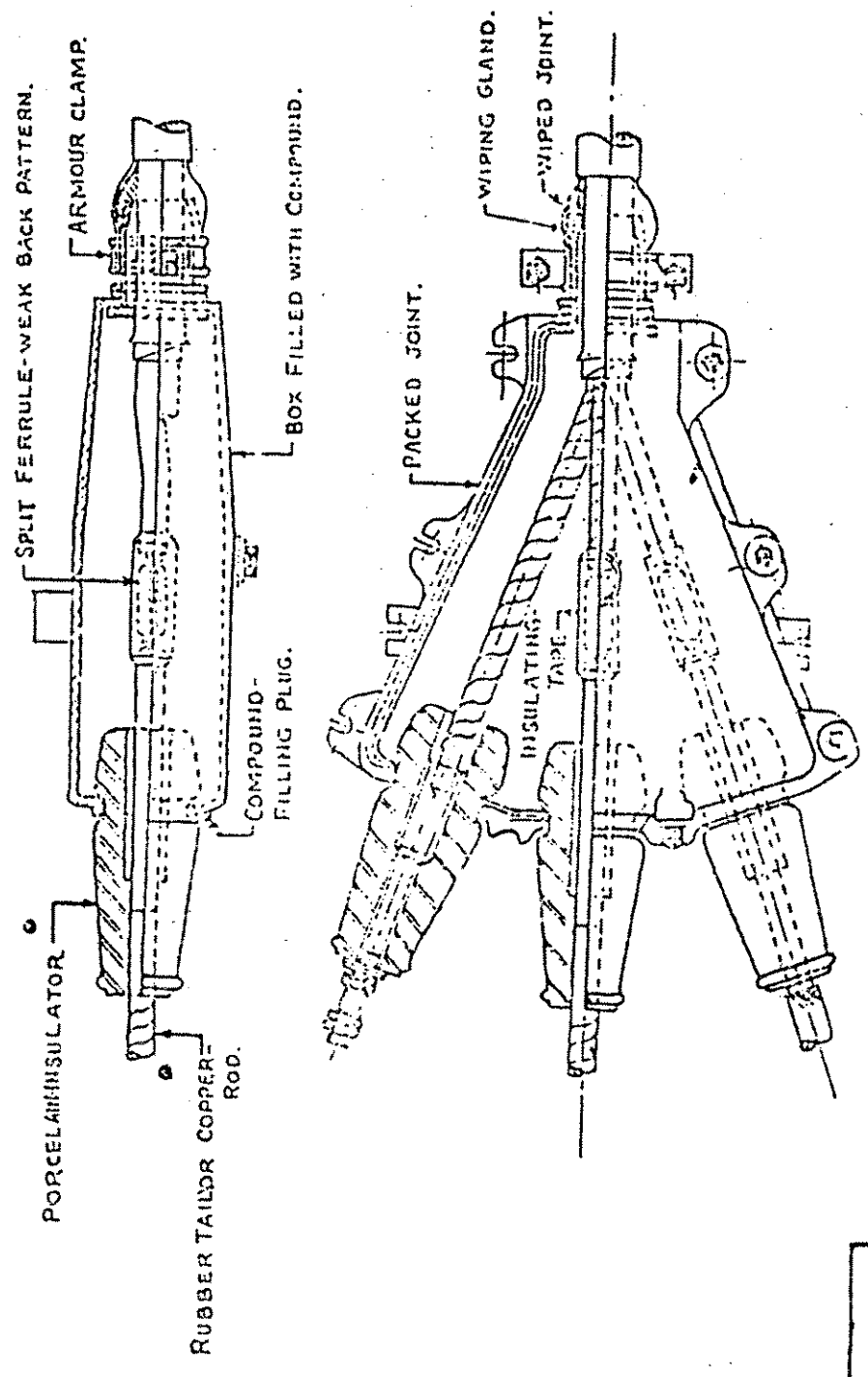


FIGURE - 15
Appendix F
CLAUSE F - 2.3.17

TYPICAL OUTDOOR TERMINATION.
(PILC CABLE WITH COMPOUND)

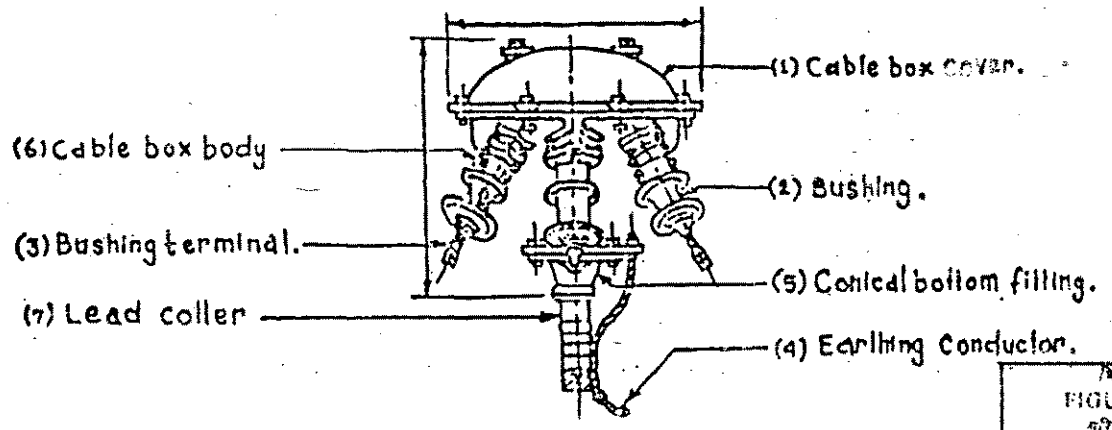


FIGURE - 16
Appendix F
CLAUSE F - 2.3.17

TYPICAL EPOXY STRAIGHT JOINT FOR PVC CABLE.

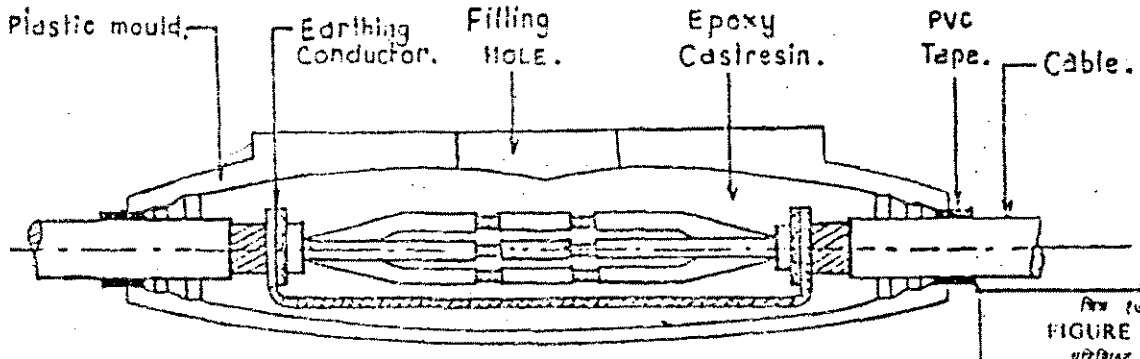


FIGURE - 17
Appendix F
CLAUSE F - 2.4.2

TYPICAL OUTDOOR TERMINATION (PVC CABLE WITH EPOXY)

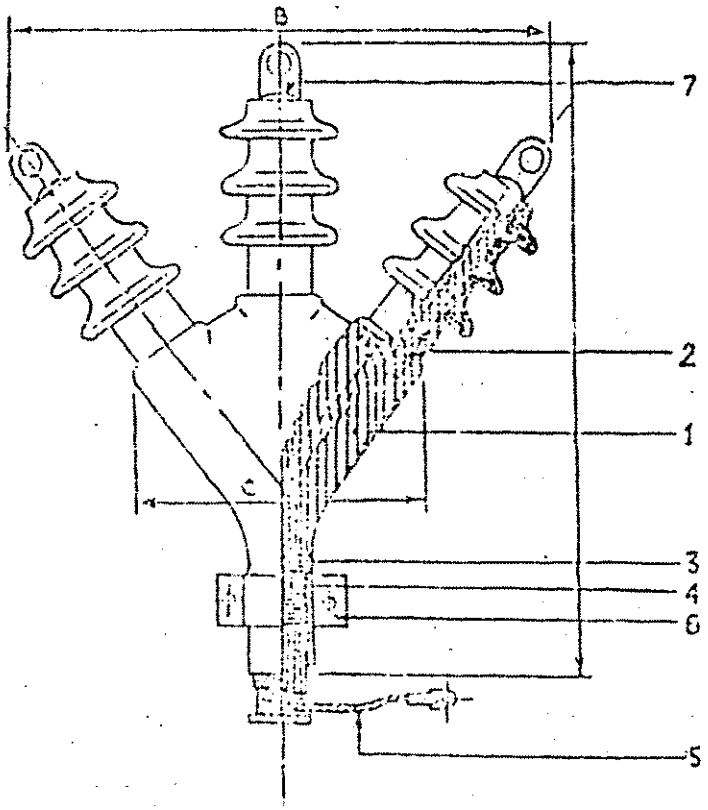


FIGURE - 18
Appendix F
CLAUSE F - 2.4.2

1. Sealing-end body, 2. Porcelain bushing, 3. Tapered serving of screen to distribute electric stresses more uniformly; 4. Neck of sealing-end; 5. Earthing connector, 6. Fixing clip, 7. Cable terminal.

COMPRESSION TYPE CABLE GLAND ASSEMBLY.

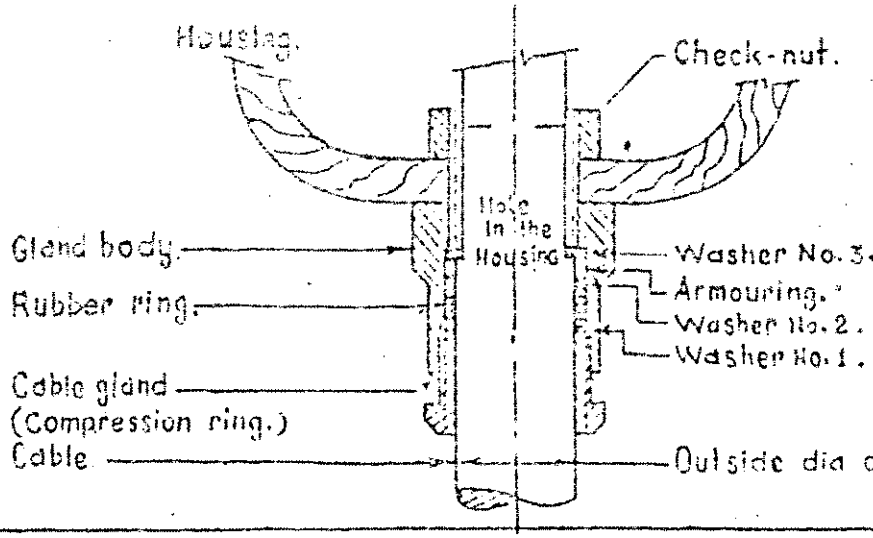


FIGURE - 19
Appendix F
CLAUSE F - 2.4.3

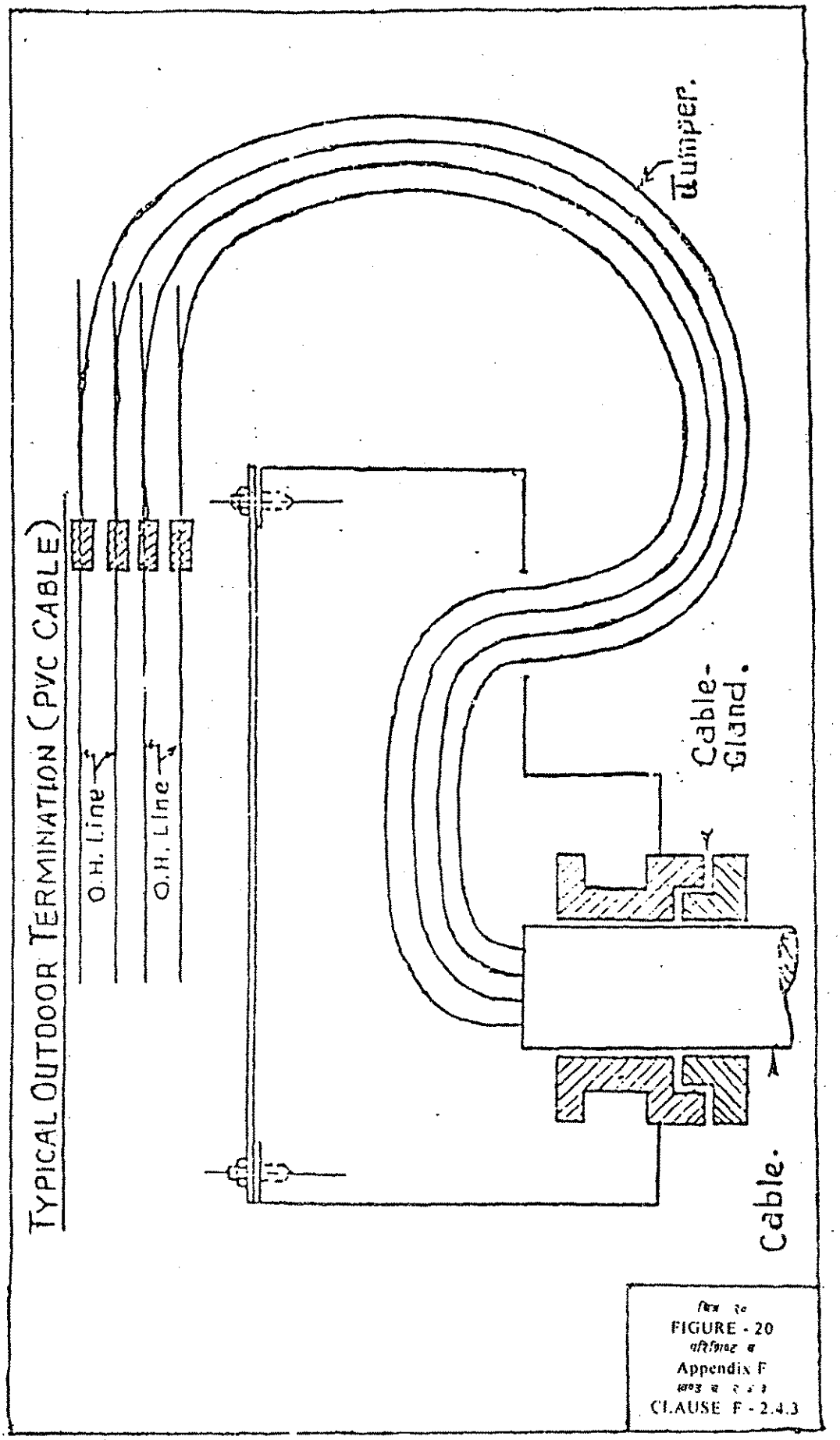
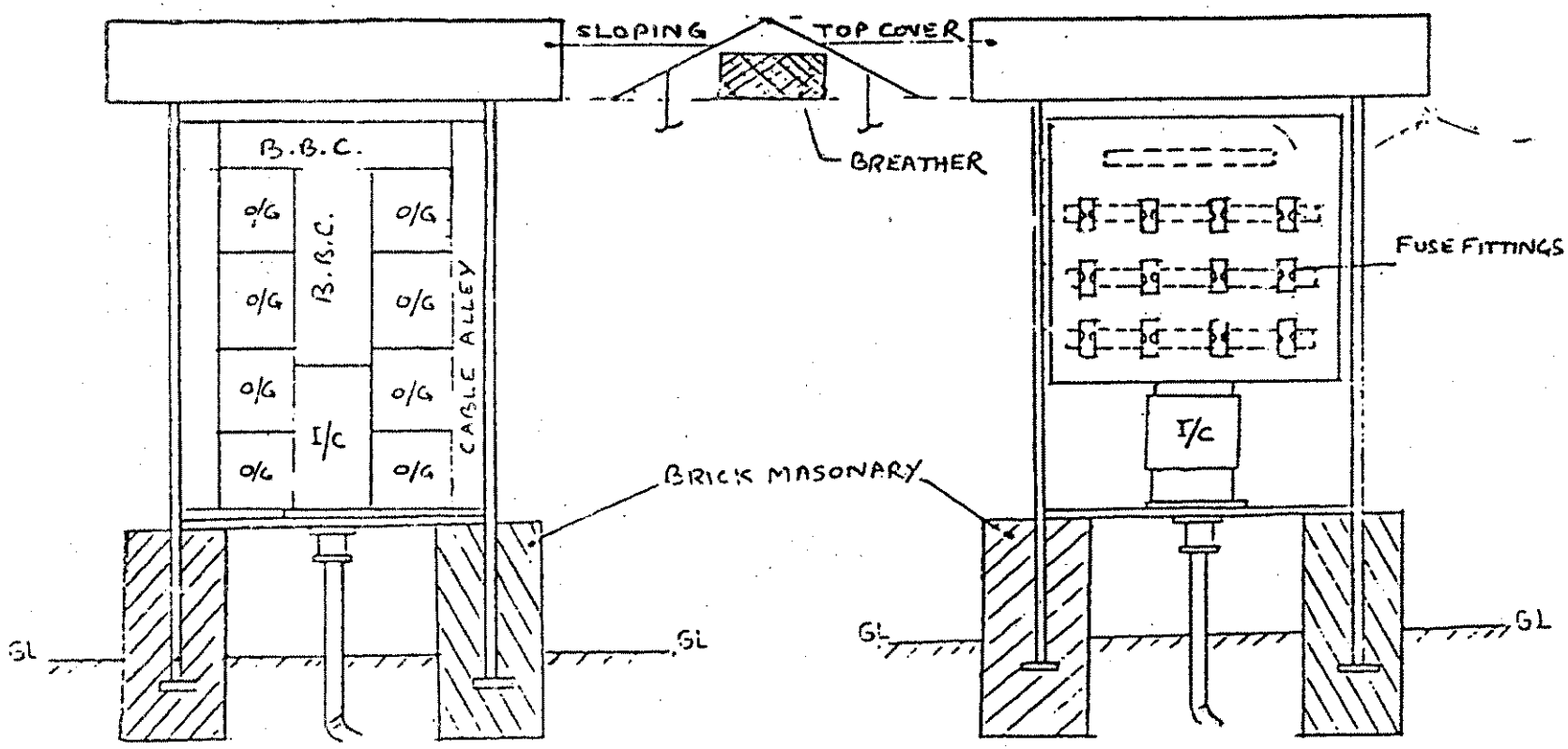


FIGURE - 20
Appendix F
CLAUSE F - 2.4.3

ILLUSTRATIVE SKETCH OF FEEDER PILLAR



FRONT VIEW

CUBICAL PANEL TYPE

FRONT VIEW

OPEN BUS BARS TYPE

FIGURE -21 'B'
CLAUSE - 4.3.3 (ix)

ILLUSTRATIVE SKETCH OF FEEDER PILLAR

WITH INDUSTRIAL TYPE SWITCH BOARD

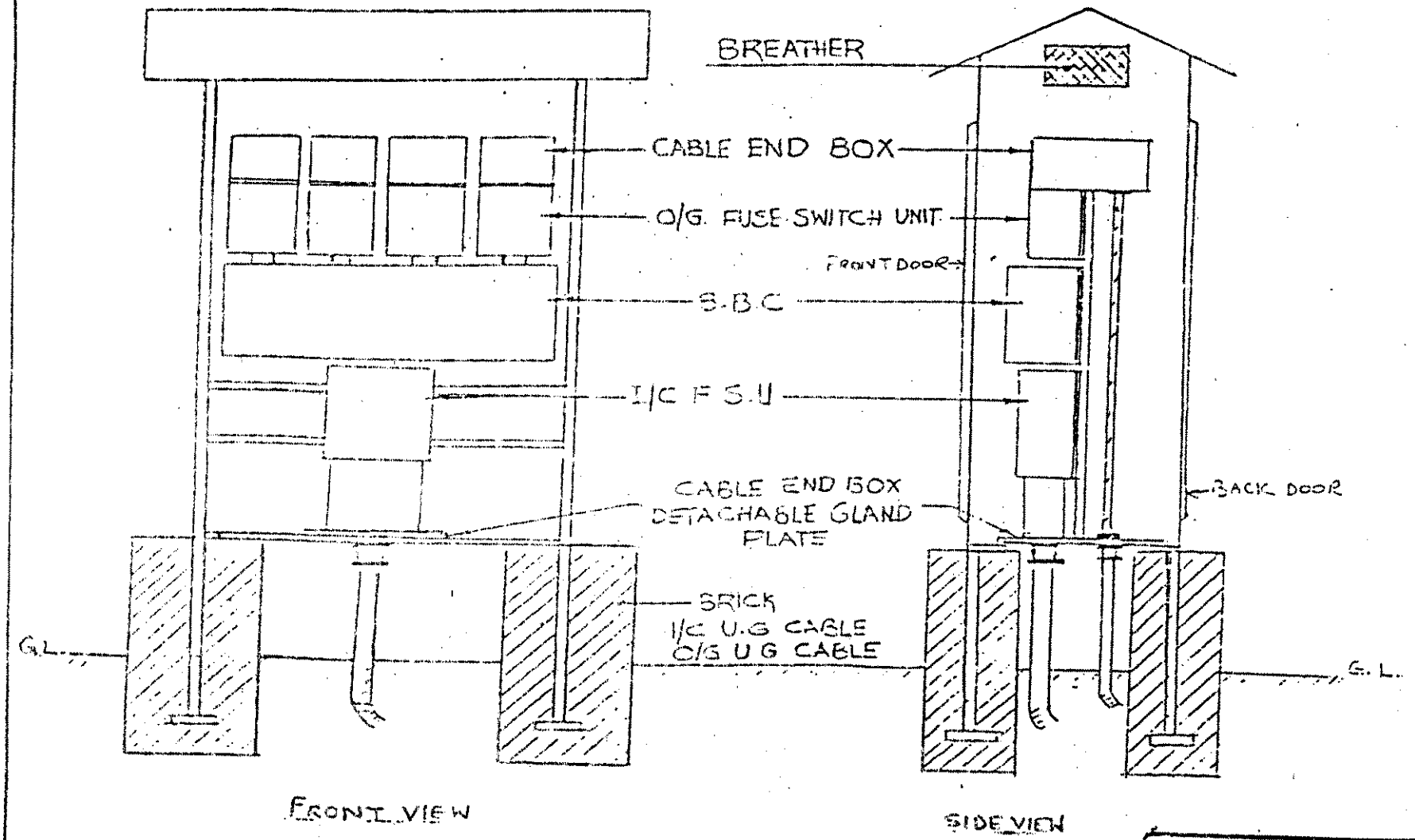


FIGURE -21 'A'
CLAUSE - 4.3.3 (ix)