BEFORE THE PUBLIC UTILITIES COMMISSION

OF THE STATE OF HAWAII

In the Matter of PUBLIC UTILITIES COMMISSION OF THE STATE OF HAWAII Proposed Revisions to Rules for Overhead Electric Line Construction in the State of Hawaii.	)	Docket No. 1734 Order No. 2345

Before: A. J. Vivas, Jr. — Chairman
S. Kon — Commissioner
J. B. Fernandes — Commissioner

APPEARANCE:

For the Public Utilities Commission
Department of the Attorney General
By Tom L. Peterson, Esq.
Deputy Attorney General — Counsel

REVISED GENERAL ORDER NO. 6

This matter was formally initiated by the PUBLIC UTILITIES COMMISSION OF THE STATE OF HAWAII on November 22, 1966, whereupon the Staff was directed to prepare complete and independent revisions to Commission's General Order No. 6, as amended, covering Rules for Overhead Electric Line Construction in the State of Hawaii.

Proposed revised rules and regulations were submitted to the Commission, and copies thereof circulated to the telephone and electric utilities and all interested parties, and all were given the opportunity to submit data, views, comments and arguments, verbally or in writing.

Pursuant to the provisions of Chapters 6C and 104, Revised Laws of Hawaii 1955, as amended, public hearings were duly advertised and held on each of the major islands of the State of Hawaii, as follows:

Kaunakakai, Molokai -----------	November 16, 1966
Kahului, Maui -----------------	November 16, 1966
Hilo, Hawaii ------------------	November 17, 1966
Lihue, Kauai ------------------	November 18, 1966
Honolulu, Hawaii --------------	November 22, 1966

The Commission, at its quorum meeting held March 23, 1967, having considered the final draft of the proposed revised rules and regulations and the entire record in this Docket, was of the opinion and found that the adoption of the proposed rules and regulations, as revised, is consistent with the law and will not adversely affect the operations of the utilities and should be approved and adopted in the public interest.

IT IS, THEREFORE, HEREBY ORDERED: That the Rules and Regulations attached hereto as Appendix A are hereby adopted by the PUBLIC UTILITIES COMMISSION OF THE STATE OF HAWAII and made a part of its REVISED GENERAL ORDER NO. 6, REVISED RULES FOR OVERHEAD ELECTRIC LINE CONSTRUCTION, effective ten (10) days after filing of said Revised General Order No. 6 in the Office of the Lt. Governor of the State of Hawaii.

This Revised General Order No. 6 supersedes General Order No. 6, Docket No. 1178, adopted June 12, 1953; Amended General Order No. 6, Docket No. 1500, adopted September 21, 1962; and Second Amended General Order No. 6, adopted June 20, 1963 in their entirety, including all attachments, appendices and references in all cases to General Order No. 95 of the California Public Utilities Commission and deviations and variances appertaining thereto.

The foregoing Order No. 2345 is hereby ratified as the action taken by the Commission on March 23, 1967.

PUBLIC UTILITIES COMMISSION
OF THE STATE OF HAWAII

By /S/ A. J. VIVAS, JR.
A. J. Vivas, Jr., Chairman

By /S/ LORRIN W. DOLIM
Lorrin W. Dolim, Commissioner

By /S/ JOHN B. FERNANDES
John B. Fernandes, Commissioner

By /S/ SHOJI OKAZAKI
Shoji Okazaki, Commissioner

ATTEST:

I, Albert J. Vivas, Jr., Chairman of the Public Utilities Commission of the State of Hawaii, do hereby certify that the foregoing Revised General Order No. 6 is a full, true, and complete copy of the original on file in the office of the Commission.

/S/ A. J. VIVAS, JR.
Albert J. Vivas, Jr., Chairman

C E R T I F I C A T I O N

I, ALBERT J. VIVAS, JR., Chairman of the Public Utilities Commission of the State of Hawaii, certify to the following:

That REVISED GENERAL ORDER NO. 6, RULES FOR OVERHEAD ELECTRIC LINE CONSTRUCTION, was prepared by the Staff of the Commission and the Attorney General's office;

That pursuant to Chapters 6C and 104, Revised Laws of Hawaii 1955, as amended, notices of public hearings appeared as follows:

Honolulu Star Bulletin ---------------------------- October 27, 1966
Honolulu Advertiser ------------------------------- November 1, 1966
Hawaii Tribune Herald ----------------------------- November 1, 1966
Maui News --- November 2, 1966
Garden Island News -------------------------------- November 2, 1966

That copies of a direct notice dated October 31, 1966 were transmitted to all the electric and telephone utilities operating in the State of Hawaii;

That hearings were held as prescribed by law, as follows:

Kaunakakai, Molokai ------------------------- November 16, 1966
Kahului, Maui ------------------------------- November 16, 1966
Hilo, Hawaii -------------------------------- November 17, 1966
Lihue, Kauai -------------------------------- November 18, 1966
Honolulu, Hawaii ---------------------------- November 22, 1966; and

That the Rules and Regulations in Docket No. 1734 were approved and adopted by the Commission at its quorum meeting held March 23, 1967 as Revised General Order No. 6.

/S/ ALBERT J. VIVAS, JR.
Albert J. Vivas, Jr., Chairman

Approved As To Form, November 27, 1968

/S/ ROY M. MIYAMOTO
Roy M. Miyamoto
Deputy Attorney General

Approved November 29, 1968

/S/ EDWIN H. HONDA
Edwin H. Honda
Director of Regulatory Agencies

Approved February 27, 1969

/S/ JOHN A. BURNS
John A. Burns
Governor, State of Hawaii

Filed in the Office of the Lt. Governor: February 27, 1969

Effective: March 9, 1969

DEPARTMENT OF REGULATORY AGENCIES
STATE OF HAWAII

TITLE VI - PUBLIC UTILITIES COMMISSION

RULES FOR OVERHEAD
ELECTRIC LINE CONSTRUCTION

PART I - CONTENTS

PART II - TABLES

PART II - TABLES

SECTION CONTENTS

SECTION I

GENERAL PROVISIONS

DEPARTMENT OF REGULATORY AGENCIES
TITLE VI - PUBLIC UTILITIES COMMISSION

RULES FOR OVERHEAD ELECTRIC LINE CONSTRUCTION

SECTION I

GENERAL PROVISIONS

11. PURPOSE OF RULES

The purpose of these rules is to formulate, for the State of Hawaii, uniform requirements for overhead electrical line construction, the application of which will insure adequate service and secure safety to persons engaged in the construction, maintenance, operation or use of overhead electrical lines and to the public in general.

12. APPLICABILITY OF RULES

These rules apply to all overhead electrical supply and communication lines which come within the jurisdiction of this Commission, located outside of buildings, as follows:

12.1 Construction and Reconstruction of Lines

The requirements apply to all such lines and extensions of lines constructed six months after the date the Public Utilities Commission of the State of Hawaii approves these modifications and shall become applicable also to such lines now existing or any portion thereof, whenever they are reconstructed.

The reconstruction of an element of a line requires that all elements subordinate to the reconstructed element meet the requirements of these rules. For the purpose of this order reconstruction will be construed to mean that work which in any way changes the identity of the pole, tower or structure on which it is performed excepting:

A. Service Drops

Service drops may be added to existing plant without necessitating changes in the circuit or line from which they originate.

B. Conductors

Conductors or circuits added to crossarms installed prior to March 1, 1929 will not be required to afford greater ground clearance than the ground clearance provided by conductors of the same or higher voltage classification which are already in place on such arms.

All other clearances with which such added conductors or circuits are concerned shall be in accord with these rules.

C. Subordinate Element

An element (such as a crossarm or a conductor) added to a pole, tower or structure shall meet all requirements of these rules but does not require any change in like elements already existing except where the added element is related in buck arm construction to an existing arm in which case all construction on the related arms shall meet the requirements of these rules. A crossarm, pole, tower or other structure to which any subordinate element is added shall meet the strength safety factor requirements specified in Rule 44.2.

D. Replacement of Poles, Towers or Other Structures

The replacement of poles, towers or other structures is considered to be reconstruction and requires adherence to all strength and clearance requirements of these rules. The clearances of the spans adjacent to the new support need not be changed but the new support shall be such that when the adjacent support is replaced the span between will meet all the provisions of this Order.

12.2 Maintenance of Lines

All lines and portions of lines shall be maintained in such condition as to provide safety factors not less than those specified in Rule 44.2. Lines and portions of lines constructed or reconstructed on or after the effective date of this Order shall be kept in conformity with the requirements of this Order.

The restoration of clearance originally established prior to the effective date of this Order, where the original clearance has been reduced by additional sagging or other causes, is not considered to be reconstruction and the reestablished clearance shall conform to the requirements of the rules in effect at the time the original clearance was established. The changing of clearance for any other purpose is reconstruction and clearances so changed shall comply with the rules of this Order applicable to reconstruction.

12.3 Lines Constructed Prior to This Order

The requirements of this Order, other than the safety factor requirements specified in Rule 12.2, do not apply to lines or portions of lines constructed or reconstructed prior to the effective date of this Order. In all other particulars, such lines or portions of lines shall conform to the requirements of the rules in effect at the time of their construction or reconstruction.

12.4 Reconstruction or Alteration

If, in its opinion, safety or public interest requires, the Commission may order reconstruction or alteration of existing lines.

13. SCOPE OF RULES

These rules are not intended as complete construction specifications, but embody only the requirements which are most important from the standpoint of safety and service. Construction shall be according to accepted good practice for the given local conditions in all particulars not specified in the rules.

14. LIMITING CONDITIONS SPECIFIED

The requirements specified in these rules as to spacing, clearance, and strength of construction are limiting conditions expressed as minimum or maximum values as indicated. In cases where two or more requirements establish limiting conditions, the most stringent condition shall be met, thus providing compliance with the other applicable conditions.

Greater strength of construction and more ample spacings and clearances than herein specified may be desirable in some cases and may be provided accordingly if other requirements are not violated in so doing.

15. EXEMPTIONS OR MODIFICATIONS

If, in a particular case or a special type of construction, exemption from or modification of any of the requirements herein is desired, the Commission will consider an application for such exemption or modification when accompanied by a full statement of conditions existing and the reasons why such exemption or modification is asked and is believed to be justifiable. It is to be understood that, unless otherwise ordered, any exemption or modification so granted shall be limited to the particular case or the special type of construction covered by the application.

16. SAVING CLAUSE

The Commission reserves the right to change any of the provisions of these rules in specific cases when, in the Commission's opinion, public interest would be served by so doing.

Compliance with these rules is not intended to relieve a utility from any statutory requirement.

SECTION CONTENTS

SECTION II

DEFINITIONS OF TERMS AS USED IN THE RULES OF THIS ORDER

SECTION CONTENTS

SECTION II

SECTION CONTENTS

SECTION II

SECTION CONTENTS

SECTION II

SECTION II

DEFINITIONS OF TERMS AS USED IN THE RULES OF THIS ORDER

20.1 BACKBONE means an auxiliary span support for pull-offs and cross-spans to trolley contact conductors to which it is approximately parallel.

20.2 BRIDGE means a structure which is used primarily for foot, vehicular or train traffic as distinguished from those which span certain areas and support signals or wires and which are classed as supporting poles, towers or structures.

20.3 CABLE means a stranded conductor (single conductor cable) or a combination of conductors insulated from one another (multiple-conductor cable).

20.4 CATENARY CONSTRUCTION, applied to trolley systems, means construction wherein auxiliary wire or cable messengers are in alignment with and support trolley contact conductors at one or more (usually many) points throughout the spans.

20.5 CIRCUIT means a conductor or system of conductors located outside of buildings and through which an electric current is intended to flow.

A. Class C Communication Circuits mean circuits which are used for public or private communication service and which operate at not exceeding 400 volts to ground nor 750 volts between any two points of the circuit and the transmitted power of which does not exceed 150 watts. When operated at less than 150 volts no limit is placed on the capacity of the system.

NOTE-Telephone, telegraph, messenger-call, clock, fire or police alarm circuits are included in this classification and other circuits used for signal purposes in which the above limitations are not exceeded may be included.

(1) Major Class C Circuits mean communication circuits which include the following:

More than four conductors (open, paired or in cable) used chiefly for local exchange service.

Toll telephone or telegraph circuits used for transmission of messages of the general public, and not including clock, messenger-call, railway signal, police, fire alarm and other special communication circuits.

(2) Minor Class C Circuits mean communication circuits not included in the definition of Major Class C Circuits. (See Rule 20.5-A1.)

B. Private Communication Circuits mean circuits used for private communication, signal or control service in the operation of other facilities. (See Rules 78.2 and 89.)

C. Railway Signal Circuits mean those supply and communication circuits used primarily for supplying energy for controlling the operation of railway block signals, highway crossing signals, interlocking apparatus and their appurtenances.

Circuits which operate at less than 400 volts to ground are considered as communication (Class C) circuits and shall be so classified and treated provided that, if the voltage exceeds 150 volts between conductors the power transmitted shall not exceed 150 watts. Where all circuits of a line are owned and operated by one utility, the voltage between conductors carrying in excess of 150 watts may be increased to not more than 250 volts and the signal circuits may be considered as communication (Class C) circuits.

All railway signal circuits which do not meet the requirements above shall be treated as supply circuits of corresponding voltage.

D. Supply Circuits mean those circuits which are used for transmitting a supply of electrical energy.

(1) Class H Circuits include the following:

Constant potential alternating current circuits of 5000 volts or more between any two conductors

Constant potential alternating current circuits of 2900 volts or more between any conductor and ground

Constant potential direct current circuits exceeding 750 volts between any conductor and ground

Constant current circuits of 7.5 amperes or less supplied from transformers or devices having a normal full-load output voltage of 5000 volts or more

Constant current circuits of more than 7.5 amperes supplied from transformers or devices having an open-circuit voltage of 2900 volts or more.

(2) Class L Circuits include the following:

Constant potential alternating or direct current supply circuits of lower voltage than Class H

Constant current circuits of 7.5 amperes or less supplied from transformers or devices having a normal full-load output voltage less than 5000 volts

Constant current circuits of more than 7.5 amperes supplied from transformers or devices having an open-circuit output voltage less than 2900 volts.

E. Class T Circuits mean trolley contact conductors, feeder wires and other conductors metallically connected to such contact conductors, used in electric railway or trolley operation. These Class T circuits are supply circuits, further classified as Class L or Class H depending upon the voltage and nature of current used (see Rule 20.5-D).

20.6 CLIMBING SPACE means the space reserved along the surface of a climbable pole or structure to permit ready access for linemen to equipment and conductors located on the pole or structure.

20.7 COMMON NEUTRAL SYSTEMS mean those electrical supply distribution systems wherein the same specially grounded conductor is utilized as a neutral conductor of primary circuits of less than 15,000 volts and secondary circuits of 0-750 volts supplied therefrom.

20.8 CONDUCTOR means a wire, or combination of wires not insulated from one another, suitable for carrying electric current.

A. Lateral Conductor means a conductor extending in a general horizontal direction and usually at an angle of approximately 90 degrees to the direction of the line conductors.

B. Line Conductor means an overhead conductor which extends from the last point of support on one overhead line structure to the first point of support on another overhead line structure.

C. Open Wire Conductors mean communication conductors separately supported.

D. Unprotected Conductors mean supply conductors not covered by a "suitable protective covering" (see Rule 22.2), grounded metal conduit, grounded metal sheath or shield, or impregnated fiber, and not enclosed in a grounded metal pole.

20.9 CROSSARM or ARM means a horizontal support of wood or metal attached to poles or structures generally at right angles to the conductor supported,

A. Combination Arm means a crossarm supporting supply conductors of 0-750 volts and supply conductors of 750-7500 volts.

B. Related Buck Arm means a crossarm used to change the direction of all or a part of the conductors on the line arm immediately above or below. A buck arm is generally placed at right angles to the line arm.

C. Clearance Arm means a crossarm supporting conductors installed on a pole of another line for the purpose of maintaining the prescribed clearances of this order which, if the other line did not exist, could be maintained without such clearance arm.

D. Guard Arm means a wood crossarm installed on a pole directly above and parallel to the messenger, cable or conductors being guarded. Guard arms are required in certain cases of low voltage rack construction (see Rule 54.9-E) and certain cases of cable construction (see Rules 57.7, 87.7, and 92.1). Guard arms shall not be used to support conductors or other line facilities except as specifically provided in these rules. This rule will not make the use of guard-arms mandatory provided that the electric and communication companies involved agree that the basic minimum clearances specified by this general order and its revisions, are adequate without the use of guard arms. (See Rule 84.8-B2c and 87.7-B)

21.0 DISTRICTS mean areas as defined in the following:

A. Urban Districts mean thickly settled areas (whether in cities or suburbs) or where congested traffic often occurs. Highways on which traffic is often very heavy or locations such as picnic grounds, summer resorts, etc., where people congregate seasonally, are considered as urban.

B. Rural Districts mean all areas not urban, usually in the country but in some cases within city limits.

C. Loading Districts mean those areas in which the specified loadings of Rule 43 apply and are known as "Heavy" and "Light" loading districts.

21.1 GROUND CONNECTION means the equipment used in establishing a conducting path between an electric circuit or equipment and earth. A ground connection consists of a ground conductor, a ground electrode and the earth (soil, rock, etc.) which surrounds the electrode.

21.2 GROUNDED means connected to earth by a ground connection or by an unintentional conducting path.

A. Effectively Grounded means grounded through a ground connection of sufficiently low impedance (inherently and/or intentionally obtained) that fault grounds which may occur cannot build up voltages dangerous to connected equipment.

If an impedance of less than 25 ohms is not obtained, the equivalent of a ground conductor not less than No. 6 AWG copper connected to two corrosion resisting rods, not less than ½ inch in diameter and 8 feet in length and continuous throughout, driven to a minimum depth of 8 feet in the earth at not less than 6 foot centers, will be considered an effective ground for the purpose of these rules.

Three interconnected ground rods, each ½ inch in diameter, 6 feet in length, driven in the earth with no less than 6 feet separation between any two, will also be considered an effective ground.

Where a common neutral system is installed, the grounding provisions for such systems, as covered in Rule 59.4 shall apply.

B. Permanently Grounded refers to time, and means grounded while the equipment concerned is in place under the conditions specified in the rules.

C. Securely Grounded means connected to earth through a metal surface in good contact with the earth (soil, rock, etc.) such as the contact of anchor rods or metal poles set directly in the ground. Metal poles set in concrete are considered as grounded but will not be considered as securely grounded.

21.3 GUY means a tension member (a solid wire or stranded wires) used to withstand an otherwise unbalanced force on a pole, crossarm or other overhead line structure (see Rule 21.9 for definition of messenger).

A. Overhead Guy means a guy extending from a pole, crossarm or structure to a pole, crossarm, structure or tree and is sometimes called a span guy.

B. Anchor Guy means a guy which has its lower anchorage in the earth and is sometimes called a sidewalk, truss or ground guy.

C. Exposed Guy means a guy of which any part is less than 8 feet horizontally from the vertical plane of any supply conductor of more than 250 volts (see App. G, Fig. 44).

D. Guy In Proximity means a guy of which any part is both within a vertical distance of less than 8 feet from the level of supply conductors and a radial distance of less than 6 feet from the surface of a wood pole or structure (see App. G, Fig. 45).

21.4 JOINT USE OF POLES OR POLES JOINTLY USED means occupancy of poles or structures by circuits of different ownership or by two or more of the following classes of circuits of the same ownership:

Communication circuits for public use
Railway or trolley circuits
Supply circuits other than trolley circuits

A luminaire mounted four feet or more from the surface of the pole shall not constitute reason to deem the pole jointly used.

21.5 LEAD WIRES mean those wires which are sometimes termed "jumpers," "bridle wires" or "taps" and which are used for connecting the line conductors to equipment and apparatus.

21.6 LIGHTNING ARRESTERS, SET OF, means lightning arresters (one or more) at one location connected to the various conductors of a single circuit.

21.7 LINES mean those conductors together with their supporting poles or structures and appurtenances which are located outside of buildings.

A. Conflicting Lines (lines in conflict or conflicts) mean lines so situated with respect to each other (except at crossings) that the overturning of one line will result in contact of its poles or conductors with the poles or conductors of the second line, assuming no conductors are broken in either line; except that lines on opposite sides of a thoroughfare are not considered as conflicting if separated by a distance not less than 60 per cent of the height of the higher pole line above the ground line and in no case less than 20 feet (see App. G, Fig. 1).

B. Colinear Lines mean:

Conflicting lines so situated that one line is wholly or partly over the other line, often called "overbuild"

Conflicting lines not "overbuilds" but separated a horizontal distance of less than the required pin spacing of the highest voltage circuit involved

Conflicting lines not "overbuilds" but separated a horizontal distance of less than one foot, regardless of pin spacing. (See App. G, Figs. 2 and 3.)

NOTE-For the purpose of measurement, the horizontal distance between the conflicting lines shall be that distance measured horizontally between vertical planes passing through the adjacent extremities of the conflicting lines.

C. Tower Lines (Class H, L and T) mean supply lines, the supporting structures of which are of steel or other metal and have a maximum outside dimension of more than 4 feet measured either along or across the line in a horizontal plane at the ground level. Metal supporting structures, "A" frames or "H" structures, having a dimension from outside of one support to outside of another support greater than 4 feet at the ground level will be classified as towers.

NOTE-Steel or metal structures having maximum outside dimensions of 4 feet or less, measured along and across the line in a horizontal plane at the ground level, will be classified as poles under supply lines.

21.8 MAINTENANCE means the work done on any line or any element of any line for the purpose of extending its life (excepting the replacement of the supporting poles or structures) and includes the replacement, for any reason, of crossarms, pins, insulators, wires, cables, messengers, etc., but does not contemplate the addition of elements (excepting pole stubs and guy wires) which will change the identity of the structure (see Rule 12).

21.9 MESSENGER means stranded wires in a group which MAY OR MAY NOT BE part of the conducting system, its primary function being to support wires or cables of the conducting system; sometimes called "suspension strand."

21.10 PARTIAL UNDERGROUND DISTRIBUTION means a supply system of overhead primary conductors supported in vertical or triangular configuration, without crossarms, on nonclimbable, non-joint poles, and with underground secondary distribution facilities (see App. G, Fig. 87).

22.0 POLE

A. Pole Top Extension means a bracket or structure (exclusive of a pole top pin) attached to a pole and extending above its top to support conductors.

B. Spliced Pole means a wood pole comprised of two or more sections spliced end to end by means of a lap, scarf or butt joint with suitable and adequate lashing or other fastenings, the sections of pole being usually coaxial.

C. Stub Reinforced Pole means a wood pole attached by suitable and adequate fastenings to a stub (usually a short length of wood pole or timber) set in the ground, such stub being intended to provide the support originally afforded by the pole butt.

D. Non-Climbable Pole means a non-joint use pole of smooth exterior surface (not latticed), that is not equipped with pole steps or other provisions for climbing, and upon which work is performed only from aerial lifts.

22.1 PRACTICABLE means capable of being accomplished by reasonably available and economic means.

22.2 PROTECTIVE COVERING, SUITABLE, means a covering of wood, or other material as authorized by the Public Utilities Commission, having the electrical insulating efficiency and mechanical strength of 1½ inches of redwood. Materials meeting the requirements of this definition, when installed in a workmanlike manner include:

A. Impregnated Fibre Conduit, having a wall thickness of not less than one quarter of an inch, installed over rigid metal conduit as illustrated in Figure 82 of Appendix G.

B. Hardwood Moulding (oak or rock elm) three eighths of an inch in thickness, or having a cross-section as shown in Figure 81 of Appendix G, when used as a covering for ground wires and communication conductors.

C. The use of Douglas Fir Wood Moulding ½ inch in thickness or rigid polyvinyl chloride plastic moulding, not less than 1/16" thick, having dielectric strength of not less than 1000 volts per mil will be permitted as a suitable protective covering for ground wires, bond wires and lateral wires, installed on the surface of wood poles or crossarms.

For 0-750 volt cable risers, No. 14 gauge steel U cable guard covered with an impregnated fibre conduit having a wall thickness of ¼" shall be considered to meet the requirements of this rule.

D. Plastic Pipe made of rigid unplasticized polyvinyl chloride having the properties and dimensions specified as Type II, High Impact of not less than 0.20 inch wall thickness and having a dielectric strength of not less than 1000 volts per mil. Normal Chemical Resistance in United States Department of Commerce Commercial Standard No. CS 207-60.

22.3 RAILWAYS are classified as Minor, Major or Street, as in the following definitions:

A. Minor Railway means:

Spur tracks less than 2000 feet in length and not exceeding two tracks in the same crossing span.

Branches on which no regular service is maintained or which are not operated during part of the year.

Tracks used only temporarily for a period not exceeding one year.

Tracks not operated as a public utility, such as industrial railways used in logging, mining and like operations.

Tracks other than standard gage.

B. Major Railway means any railway not included above, other than street railways as defined below.

C. Street Railway means a railway by whatsoever power operated for public use in the conveyance of passengers or freight which is mainly located upon, over, above, across, through or along public thoroughfares.

22.4 RECONSTRUCTION means that work which in any way changes the identity of the pole, tower or structure on which it is performed. For exceptions see Rule 12.1.

22.5 RISERS mean conductors which extend below the ground line and are generally installed on the surfaces of poles.

22.6 RUNS mean vertical or lateral conductors supported in coverings or casings on overhead line structures, or certain insulated communication conductors supported along the surfaces of poles or crossarms.

22.7 SAG includes either Normal or Apparent, as defined in the following:

A. Normal Sag means the difference in elevation between the highest point of support of a span and the lowest point of the conductor in the span at 75° F. and no wind loading (see App. G, Fig. 4).

B. Apparent Sag means the maximum departure, measured vertically, of a wire in a given span from a straight line between the two points of support of the span at 75° F. and no wind loading. Where the two supports are at same level, this will be the normal sag. (See App. G, Fig. 5.)

22.8 SERVICE DROPS mean the conductors strung between a pole line and a building or structure.

22.9 SPAN WIRE means a wire or cable used as an auxiliary support for wires, cables, or other equipment. As applied to trolley construction it means a wire or cable used to support laterally, or which is attached to wires which support laterally, trolley contact conductors and appurtenances in electrical contact therewith, including wires commonly referred to as cross span wires, bracket span wires, pull-offs, trolley strain guys, dead ends, etc.

A. Lift Span means a wire, cable or rod used to share the load of span wires or brackets.

22.10 SWIMMING POOL means that portion of any natural or artificially contained body of water which is 24 inches or more in depth at any point below the highest water level, which is intended for use for swimming, bathing or other similar recreational purposes, and which has a surface area exceeding 100 square feet.

23.0 TENSION means either Maximum Allowable or Working as defined in the following definitions:

A. Maximum Allowable Tension for a supply conductor means one-half the ultimate tensile strength of the conductor.

B. Maximum Working Tension is that conductor tension resulting under the construction arrangement with the maximum loading conditions specified in Rule 43.

23.1 THOROUGHFARE means any public or private highway, avenue, street, road, alley, or other place generally used for vehicular travel.

A. Public Thoroughfare means any way open or intended for general vehicular use.

B. Private Thoroughfare means any vehicular way intended primarily for the use of the owners, occupants or visitors of the particular premises with which the way is associated.

23.2 VOLTAGE (OR VOLTS) means the highest effective voltage between any two conductors of the circuit concerned except where, in certain rules, the term "voltage (or volts) to ground" is used.

When one circuit is directly connected to another circuit of higher voltage (as in the case of an auto transformer) both are considered as of the higher voltage unless the circuit of the lower voltage is effectively grounded. Direct connection implies electrical connection as distinguished from connection merely through electromagnetic or electrostatic induction.

23.3 WIRE GAGE means a standard of measurement used for convenient nomenclature of the various sizes of wire.

A. American Wire Gage (AWG) otherwise known as Brown and Sharpe (B&S) for copper, aluminum and other conductors.

B. Birmingham Wire Gage (BWG) for iron and steel conductors (used principally for telephone and telegraph conductors).

C. New British Standard (NBS), a wire gage for certain copper, bronze or copper-covered steel conductors (a modification of BWG used principally for telephone conductors).

23.4 WORKING SPACE means the space, extending laterally from the climbing space, reserved for working below, above, and between conductor levels.

SECTION CONTENTS

SECTION III

REQUIREMENTS FOR ALL LINES

SECTION CONTENTS

SECTION III

SECTION III

REQUIREMENTS FOR ALL LINES

31. APPLICATION

The following rules apply to all classes of overhead lines under all conditions.

31.1 Design, Construction and Maintenance

Electrical supply and communication systems shall be of suitable design and construction for their intended use, regard being given to the conditions under which they are to be operated, and shall be maintained in a condition which will enable the furnishing of safe, proper and adequate service.

The owners and employees of such systems shall at all times exercise due care to reduce to a minimum the hazard of accidental injury to their own or fellow employees, to the public and other utilities due to the presence of overhead wires.

All work performed on public streets and highways shall be done in such a manner that the operations of other utilities and the convenience of the public will be interfered with as little as possible and no conditions unusually dangerous to workmen, pedestrians or others shall be established at any time.

31.2 Inspection of Lines

Lines shall be inspected frequently and thoroughly for the purpose of insuring that they are in good condition so as to conform with these rules. Lines temporarily out of service shall be inspected and maintained in such condition as not to create a hazard.

31.3 Avoidance of Conflicts and Crossings

In locating and constructing lines, efforts shall be made to avoid creating any conflicts with other lines. Where it is not reasonably practicable to maintain a sufficient separation of the lines, conflicts may in many cases be avoided by means of joint pole construction.

In the construction of new lines care shall be taken to avoid all unnecessary crossings. Crossing requirements are covered in Sections X and XI.

Supply and communication lines other than lines on jointly used poles, shall not occupy the same side of the road (fence line construction excluded, i.e., where the fence is used as all or part of the supporting structure) unless the consent of existing party or parties is obtained, or where both sides of the road are already occupied by the same class of line.

Class H circuits shall not occupy both sides of thoroughfares except where special permission is obtained from the Public Utilities Commission, unless, prior to such construction the pole-setting line operator shall have filed with the Commission a description of the route and configuration of the lines involved and copies of letters showing mutual consent for such occupancy by all pole using line operators having serving areas or routes in the general vicinity of the length of thoroughfare concerned.

31.4 Cooperation to Avoid Conflicts

Any party contemplating construction or reconstruction which would create a conflict with a line of another classification shall notify the party or parties owning or operating the other line, in advance of such construction, giving full information as to the location and character of the proposed construction, and the parties concerned shall cooperate with a view of avoiding or, if this is impracticable, of minimizing the hazard.

31.5 Joint Use of Poles

Joint use of poles shall be given consideration by all interested parties where construction or reconstruction is involved and where used it shall be subject to the appropriate grade of construction as specified in Section IV. Nothing herein shall be construed as requiring joint use of the same poles, or as granting authority for the use of any poles without the owner's consent. (See Rule 32.2 and Section IX.)

Each party should definitely designate its space requirements on joint poles, which space shall not be occupied without consent, by equipment of any other party.

Non-climbable poles in partial underground distribution systems (see Rules 22.0-D and 21.10) shall not be jointly used.

31.6 Abandoned Lines

Lines or portions of lines permanently abandoned shall be removed by their owners so that such lines shall not become a public nuisance or a hazard to life or property.

32. GENERAL ARRANGEMENTS OF LINES

32.1 Two or More Systems

Where two or more systems are concerned in any clearance, that owner or operator who last in point of time constructs or erects facilities, shall establish the clearance required in these rules from other facilities which have been erected previously. Relative to the clearances which it bears to older lines in the vicinity, each succeeding line erected should be constructed with a view to the requirements of such older lines when they are reconstructed to the standards which current rules have specified. Subsequent entrants into an area shall recognize the provisions for future development made by all prior entrants into the field as indicated by their installed facilities.

32.2 Relative Levels

Where supply and communication circuits or supply circuits of different voltage classifications are involved in crossings, conflicts or joint use, the higher voltage circuit shall in general be carried at the higher level. This arrangement is not feasible in all cases, for example where trolley circuits are involved or where poles are jointly occupied.

It is recommended that lines be arranged by mutual agreement of those concerned at standardized voltage levels throughout a given community in order to minimize difficulties when new crossings or extensions to existing lines are to be installed.

A. Supply Circuits of 750-20,000 Volts

Supply circuits of 750-20,000 volts should not be above supply circuits in excess of 20,000 volts.

B. Supply Circuits of 0-750 Volts

Supply circuits of 0-750 volts should not be above supply circuits in excess of 7500 volts.

C. Supply Circuits or 0-750 Volts and Class T Circuits

Supply circuits of 0-750 volts and all Class T circuits may cross under communication and railway circuits provided clearances not less than those given in Tables 1 and 2 are maintained.

D. Communication Circuits

Communication circuits should not be above supply circuits in excess of 7500 volts. Insulated single conductors, paired wire or duplex communication line conductors above supply circuits (including Class T circuits) of 750-7500 volts shall be supported on messengers or constructed in accordance with Rule 32.2-G.

E. Supply Service Drops of 0-750 Volts

Supply service drops of 0-750 volts shall not cross in a span above supply circuits (excepting Class T circuits) in excess of 750 volts, but service drops may cross above such circuits when supported on the same pole.

F. Communication Service Drops

Communication service drops should not cross in a span above supply circuits (excepting Class T circuits) of 750-7500 volts and shall not cross in a span above supply circuits in excess of 7500 volts. Where it is necessary that communication service drops cross in a span above supply circuits of 750-7500 volts, an auxiliary attachment or its approved equivalent shall be used at the service end of the service drop to insure against the drop falling across the supply circuit in the event of the failure of the usual means of attachment.

G. Exceptional Cases

Where it is not possible to conform to the usual arrangement whereby the higher voltage circuit shall be carried at the higher level, the positions may be reversed provided the lower voltage circuit, installed at the higher level, shall be erected and maintained with the same strength requirements as the higher voltage circuits would require with the usual arrangement of levels. Where neither circuit carries in excess of 750 volts this provision does not apply.

Where supply and communication circuits carrying less than 750 volts cross trolley contact conductors carrying in excess of 750 volts, they shall conform to the strength requirements for supply lines corresponding to the voltage of the trolley contact conductors.

32.3 Colinear Lines and Crossing Lines

The center-line clearance between poles and conductors which pass unattached shall be not less than 1½ times the clearance specified in Table 1, Case 8, except where the interset pole is within 10 feet of a pole to which the passing conductors are attached. Where poles of the two lines are less than 10 feet apart, clearances not less than as specified in Table 1, Case 8 shall be maintained between the center line of any pole and conductors which pass unattached. Where clearance crossarms are installed in the construction and maintenance of colinear lines or crossings, clearances not less than as specified in Table 1, Case 8 shall be maintained between all conductors on the clearance crossarms and the center line of poles to which such crossarms are attached.

The provisions of the foregoing rules for colinear lines are subject to modifications specified in Rule 84.4-D3 where communication circuits only are concerned.

32.4 Circuits of Different Classification on the Same Crossarm

A. Supply Circuits

(1) 750-7500 Volts and More Than 20,000 Volts: Supply circuits of 750-7500 volts shall not be carried on the same crossarm with circuits of more than 20,000 volts unless the higher voltage circuit is not energized when men are working at this level. Where this construction is used, circuits of different classification shall be carried on opposite ends of the crossarm with a horizontal separation of not less than pin spacing required for the highest voltage concerned, but not less than 36 inches between the nearest conductors of different classification.

(2) 0-750 Volts and More Than 7500 Volts: Supply circuits of 0-750 volts shall not be carried on the same crossarm with circuits of more than 7500 volts, except that, on transformer structures, bus conductors of 0-750 volts and bus conductors of 7500-20,000 volts may be supported on opposite ends of the same bus-supporting timbers provided the horizontal separation between conductors of different classifications supported on the same arm is not less than 36 inches, the bus conductors of 7500-20,000 volts are not extended longitudinally as line conductors, and conductors on related buck arms are not less than 4 feet vertically from such bus timbers.

Attachment of 0-750 volt service drop conductors shall be permitted on the 0-750 volt end of the 0-750 and 7,500-20,000 volt bus supporting timbers.

(3) 0-750 Volts and 750-7500 Volts: Supply circuits of 0-750 volts and 750-7500 volts may be carried on the same crossarm with the nearest conductors of the two classifications separated a horizontal distance of not less than 36 inches. For requirements applicable to buck arm construction, climbing space, and service drops on combination arms, see Rule 54.4-C2b, 54.7-A and 54.8-E respectively.

(4) More Than 750 Volts, Different Ownerships: Supply circuits of more than 750 volts and of different ownership may be carried on opposite ends of the same crossarm with the nearest conductors of different ownerships separated a horizontal distance of not less than 14½ inches.

(5) 0-750 Volts, Different Ownerships: Supply circuits of 0-750 volts and of different ownership may be carried on opposite ends of the same crossarm with the nearest conductors of different ownerships separated a horizontal distance of not less than 30 inches.

(6) Common Neutral Conductor: See Rule 59.3-E for the location of the common neutral conductor in common neutral systems.

B. Supply Circuits of 0-750 Volts and Communication Circuits

Supply circuits of 0-300 volts and Class C communication circuits of different ownership may be supported on the same crossarm, provided the two classifications of circuits are installed on opposite ends of the arm and the nearest conductors of the two classifications are separated a horizontal distance of not less than 36 inches. Where the two classes of circuits are of the same ownership, the horizontal distance may be reduced to not less than 30 inches and the supply circuit voltage may be 0-750 volts.

Services direct from such a crossarm are not permitted to cross conductors of the other classification supported on the same crossarm.

C. Supply Circuits and Private Communication Circuits (see Rules 20.5-B and 89)

(1) 7500-20,000 Volts, Same Ownership: Supply circuits of 7500-20,000 volts and private communication circuits owned (or leased) and operated and maintained by the same organization may be supported on the same crossarms as provided in Rule 89.2-A1.

(2) 750-7500 Volts, Same Ownership: Supply circuits of 750-7500 volts and private communication circuits owned (or leased) and operated and maintained by the same organization may be supported on the same crossarms as provided in Rule 89.2-A2.

(3) 0-750 Volts: Supply circuits of 0-750 volts and private communication circuits may be supported on the same crossarms as provided in Rule 89.2-A3, or Rule 89.2-A4.

33. GROUNDS AND NEUTRALS

33.1 Neutral Conductors

Neutral conductors of supply circuits, other than in distribution systems of 15,000 volts or less with common primary and secondary grounded neutrals, shall be considered as carrying the same voltage as the other conductors of the circuit. Insulators used to support neutral conductors shall meet the requirements of Rule 55, based on the nominal voltage of the circuit, but are not required to have the same insulating value as insulators actually used on the phase conductors. Where a common neutral system is installed, the neutral conductor may be considered as carrying the same voltage as any of its related system conductors, compliance with special practices and construction requirements being necessary (see Rule 59).

33.2 Ground or Earth as a Conductor

The grounding of the neutral or any other conductor in direct current supply systems or in single phase or polyphase supply systems is permitted only for the purposes of stabilization and protection, and not for use as a return conductor.

33.3 Ground Connections

A. Effective Grounds

Supply equipment of the following types, when grounded to conform to requirements of this Order or for any other reasons, shall be effectively grounded:

Neutral conductors of low voltage supply circuits, (0-750 volts, see Rule 58.3-C1);

Neutral conductors of supply circuits exceeding 750 volts;

Bond wires;

Lightning arresters;

Transformer cases grounded in accordance with Rule 58.3-C3.

B. Independent Ground Connections

Ground connections for equipment of any one of the types listed in Rule 33.3-A shall not be interconnected with ground connections for equipment of any other type listed therein, except:

In common neutral systems the neutral conductors of 0-750 volt supply circuits and of supply circuits of 750-15000 volts may be interconnected and grounded in accordance with the provisions of Rule 59; and

A ground for a set of lightning arresters may be interconnected with:

A ground for the neutral conductor of the circuit protected by the set of lightning arresters,

The cable sheath or body of the cable pothead where the cable conductors are connected to the circuit protected by the set of lightning arresters,

Metallic conduit enclosing conductors of the circuit protected by the set of lightning arresters,

Transformer cases grounded in accordance with Rule 58.3-C3 where the transformers are connected to the circuit protected by the set of lightning arresters, and

The ground connection of another set of lightning arresters, provided the circuits protected are of the same voltage classification.

Where more than two sets of lightning arresters on supply circuits of the same voltage classification are installed on a pole or structure, and their ground terminals are interconnected at the top of the ground connections, two complete and effective ground connections will be considered sufficient for the purposes of this rule. Connection to an effectively grounded cable sheath or conduit of a circuit protected by the lightning arresters will be considered as one of these two effective ground connections.

34. FOREIGN ATTACHMENTS

Nothing in these rules shall be construed as permitting the unauthorized attachment, to supply or communication poles, of radio antennas, ropes, signs, and any such equipment foreign to the purposes of overhead electric line construction.

35. TREE TRIMMING

Where overhead wires pass through trees, safety and reliability of service demand that a reasonable amount of tree trimming be done in order that the wires may clear branches and foliage.

Trees so located that they can fall into a crossing span or into any span that could communicate the trouble to a crossing span shall be removed wherever practicable.

36. POLE CLEARANCES FROM RAILROAD TRACKS

Poles or other supporting structures which are set in proximity to railroad tracks shall be so located that the clearance requirements of General Order 26-D are met. The clearance requirements of General Order 26-D, applicable to pole line construction, are contained in Appendix E.

37. MINIMUM CLEARANCES OF WIRES ABOVE RAILROADS, THOROUGHFARES, BUILDINGS, ETC.

Clearances between overhead conductors, guys, messengers or trolley span wires and tops of rails, surfaces of thoroughfares or other generally accessible areas across, along or above which any of the former pass; also the clearances between conductors, guys, messengers or trolley span wires and buildings, poles, structures, or other objects, shall not be less than those set forth in Table 1, at a temperature of 60° F and no wind.

The clearances specified in Table 1, Case 1, Columns A, B, D, E and F, shall in no case be reduced more than 5% below the tabular values because of temperature and loading as specified in Rule 43. The clearances specified in Table 1, Cases 2 to 9 inclusive, shall in no case be reduced more than 10% below the tabular values because of temperature and loading as specified in Rule 43.

The clearance specified in Table 1, Case 1, Column C (22½ feet), shall in no case be reduced below the tabular value because of temperature and loading as specified in Rule 43.

Where supply conductors are supported by suspension insulators at crossings over railroads which transport freight cars, the initial clearances shall be sufficient to prevent reduction to clearances less than 95% of the clearances specified in Table 1, Case 1, through the breaking of a conductor in either of the adjoining spans.

Where conductors, dead ends, and metal pins are concerned in any clearance specified in these rules, all clearances of less than 5 inches shall be applicable from surface of conductors (not including tie wires), dead ends, and metal pins, except clearances between surface of crossarm and conductors supported on pins and insulators (referred to in Table 1, Case 9) in which case the minimum clearance specified shall apply between center line of conductor and surface of crossarm or other line structure on which the conductor is supported.

All clearances of 5 inches or more shall be applicable from the center lines of conductors concerned.

The clearance of Rule 37, Table 1, Case 8, Column E, as specified in Rules 58.3-B7 and 58.4-B6 shall not apply to the lead wires and terminals of transformers, regulators and capacitors installed on wood poles. Provided said terminals and lead wires conform to clearances specified in Rule 37, Table 1, Case 9 and Rule 38, Table 2, Case 17.

TABLE 1

BASIC MINIMUM ALLOWABLE VERTICAL CLEARANCE OF WIRES ABOVE RAILROADS, THOROUGHFARES AND GROUND; ALSO CLEARANCES FROM POLES, BUILDINGS, STRUCTURES OR OTHER OBJECTS

(Letter References Denote Modifications of Minimum Clearances as Referred to in Notes Following this Table)

Case No.	Nature of Clearance	Wire or conductor concerned					
		A	B	C	D	E	F
		Span wires (other than trolley span wires) overhead guys and messengers	Communication conductors (incl. open wire, cables & serv. drops), supply serv. drops of 0-750 volts	Trolley contact, feeder & span wires 0-5000 volts	Supply conductors of 0-750 volts, and supply cables treated as in Rule 57.8	Supply conductors and supply cables, 750-25,000 volts	Supply conductors & supply cables, more than 25,000 volts
1	Crossing above tracks of railroads which transport or propose to transport freight cars (max. height 15 ft. 6 in.) where not operated by overhead contact wires. (a) (b) (c) (d)	25 ft.	25 ft.	22½ ft.	25 ft.	28 ft.	34 ft.
2	Crossing or paralleling above tracks or railroads operated by overhead trolleys. (b) (c) (d)	26 ft. (e)	26 ft. (e) (f) (g)	19 ft. (h) (i)	27 ft. (e) (g)	30 ft. (g)	34 ft. (g)
3	Crossing or along thoroughfares in urban districts or crossing thoroughfares in rural districts. (c) (d)	18 ft. (j) (k) (ii)	18 ft. (j) (l) (m) (ii)	16 ft. (hh)	20 ft. (ii)	25 ft. (n) (o) (ii)	30 ft. (o) (ii)
4	Above ground along thoroughfares in rural districts or across other areas capable of being traversed by vehicles or agricultural equipment.	15 ft. (k) (ii)	15 ft. (m) (n) (p) (ii)	16 ft.	16 ft.	25 ft. (n) (o)	30 ft. (o) (p)
5	Above ground in areas accessible to pedestrians only.	7 ft. (ii)	8 ft. (m) (q) (ii)	16 ft.	10 ft.	17 ft.	25 ft. (o)
6	Vertical clearance above buildings and bridges (or other structures, which do not ordinarily support conductors and on which men can walk) whether attached or unattached.	8 ft. (r)	8 ft. (r)	8 ft.	8 ft.	12 ft.	12 ft.
7	Horizontal clearance of conductor from buildings (except generating and substations), bridges or other structures (upon which men may work) where such conductor is not attached thereto. (s) (t)	----------	3 ft. (u)	3 ft.	3 ft. (u) (v)	6 ft. (v)	6 ft. (v)
8	Distance of conductor from center line of pole, whether attached or unattached. (w) (x) (y)	----------	15 in. (s) (aa)	15 in. (aa) (bb) (cc)	15 in. (aa) (dd)	15 or 18 in. (dd) (ee) (jj)	18 in. (dd) (ee)
9	Distance of conductor from surface of pole, crossarm or other overhead line structure upon which it is supported, providing it complies with Case 8 above. (x)	----------	3 in. (aa) (ff)	3 in. (aa) (cc) (gg)	3 in. (aa) (dd) (gg)	3 in. (dd) (gg) (jj)	½ pin spacing shown in Table 2 Case 15. (dd)

References to Rules Modifying Minimum Clearances in Table 1

		Rule	Page
(a)	Shall not be reduced more than 5% because of temperature or loading --------------------	37.	34
	1. Supply lines ------------------------	54.4-B1	111
	2. Communication lines -----------------	84.4-B1	227
(b)	Shall be increased for supply conductors on suspension insulators, under certain conditions ---------------------------------	37.	34
(c)	Special clearances are provided for traffic signal equipment -------------------------	58.1-C	168
(d)	Special clearances are provided for street lighting equipment ------------------------	58.2-B	169
(e)	Based on trolley pole throw of 26 feet. May be reduced where suitably protected.		
	1. Supply guys -------------------------	56.4-B2	156
	2. Supply cables and messengers ---------	57.4-B2	164
	3. Communication guys ------------------	86.4-B2	247
	4. Communication cables & messengers ----	87.4-B2	255
(f)	May be reduced depending on height of trolley contact conductors.		
	1. Supply service drops ----------------	54.8-C5	144
	2. Communication service drops ---------	84.8-D5	244
(g)	May be reduced and shall be increased depending on trolley throw.		
	1. Supply conductors (except service drops) ----------------------------	54.4-B2	111
	2. Communication conductors (except service drops) --------------------	84.4-B2	227
(h)	Shall be increased where freight cars are transported.		
	1. Trolley contact and feeder conductors-	74.4-B1	200
	2. Trolley span wires ------------------	77.4-A	205
(i)	May be reduced for trolley contact and span wires in subways, tunnels and under bridges.		
	1. Trolley contact conductors ----------	74.4-E	202
	2. Trolley span wires ------------------	77.4-B	205
(j)	May be reduced at crossings over private thoroughfares and entrances to private property and over private property.		
	1. Supply service drops ----------------	54.8-B2	138
	2. Supply guys -------------------------	56.4-A	155
	3. Communication service drops ---------	84.8-C2	240
	4. Communication guys ------------------	86.4-A	246
(k)	May be reduced along thoroughfares where not normally accessible to vehicles.		
	1. Supply guys -------------------------	56.4-A1	155
	2. Communication guys ------------------	86.4-A1	246

38. MINIMUM CLEARANCES OF WIRES FROM OTHER WIRES

The clearance between any overhead line conductor or wire and any other conductor or wire over which the former crosses, the vertical clearance between wires on different crossarms on the same pole, the horizontal clearance between wires of the same voltage classification on the same crossarm and the clearances of line wires from vertical or lateral conductors or guy wires of the same line or of conflicting lines shall not be less than the values given in Table 2, at a temperature of 60° F. and no wind, except that conductors may be dead-ended at the crossarm or have reduced clearances at points of transposition, and shall not be held in violation of Table 2, Cases 8-15, inclusive.

The clearances of Table 2 shall in no case be reduced more than 10 per cent because of temperature and loading as specified in Rule 43 or difference in size or design of the supporting pins, hardware or insulators.

Where conductors, dead ends and metal pins are concerned in any clearance specified in these rules, all clearances of less than 5 inches shall be applicable between the surfaces of conductors (not including tie wires), dead ends, or metal pins, and other conductors, dead ends, metal pins, or other objects to which the clearances are applicable.

All clearances of 5 inches or more shall be applicable from the center lines of conductors concerned.

TABLE 2

BASIC MINIMUM ALLOWABLE CLEARANCE OF WIRES FROM OTHER WIRES AT CROSSINGS AND AT SUPPORTS
(Letter References Denote Modifications of Minimum Clearancesas Referred to in Notes Following this Table)
All Clearances Are in Inches

Case No.	Nature of clearance & class & voltage of wire, cable or conductor concerned	Other wire, cable or conductor concerned								
					Supply conductors (including supply cables)					
		A	B	C	D	E	F	G	H	I
		Span wires, guys and messengers	Trolley contact conductors, 0-750 volts	Communication conductors (incl. open wire, cables & serv. drops	0-750 volts (incl. serv. drops), and trolley feeders (a)	750-7,500 volts	7,500-20,000 volts	20,000-35,000 volts	35,000-68,000 volts	Over 68,000 volts
	Clearance between wires, cables and conductors not supported on the same poles, vertically at crossings in spans, and radially where colinear or approaching crossings									
1	Span wires, guys and messengers(b)---	18(c)	48(d,e)	24(e)	24(e)	36(f)	36	72	72	72(g)
2	Trolley contact conductors, 0-750 volts------------------------	48(d,e)	----------	48(d)	48(d,h)	48	72	96	96	96(g)
3	Communication conductors------------	24(e)	48(d)	24	48(i)	48(dd)	72	96	96	96(g)
4	Supply conductors, service drops & trolley feeders, 0-750 volts------	24(e)	48(d,h)	48(i)	24	48	48	96	96	96(g)
5	Supply conductors, 750-7500 volts----	36(f)	48	48(dd)	48	48(h)	72	96	96	96(g)
6	Supply conductors, 7500-20,000 volts-	36	72	72	48	72	72	96	96	96(g)
7	Supply conductors, more than 20,000 volts----------------------------	72(g)	96(g)	96(g)	96(g)	96(g)	96(g)	96(g)	96(g)	96(g)
	Vertical separation between conductors and/or cables on separate crossarms or other supports at different levels (excepting on related line and buck arms) on the same pole									
8	Communication conductors and service drops----------------------------	----------	----------	12(j)	48(k,l,m,n, ff)	48(k,ff)	72(m,n)	72(m)	72	72
9	Supply conductors, service drops & trolley feeders, 0-750 volts------	----------	----------	48(k,l,m,n, ff)	24(h,k,m, o)	48(k,m,p)	48(k,m,q)	72(m)	72	72
10	Supply conductors, 750-7500 volts---	----------	----------	48(k,ff)	48(k,m,p)	48(m,o,r, ee)	48(m,q)	48(m,q)	48(q)	60(q)

11	Supply conductors, 7500-20,000 volts-------------------------	---------	---------	72(m,n)	48(k,m,q)	48(m,q)	48(m,o,q,r, ee)	48(m,q)	48(q)	60(q)
12	Supply conductors, 20,000-68,000 volts-------------------------	---------	---------	72(m)	72(m)	48(m,q)	48(m,q)	48(o,q)	48(o,q)	60(q)
13	Supply conductors, more than 68,000 volts------------------	---------	---------	72	72	60(q)	60(q)	60(q)	60(q)	60(o,q)
	Vertical clearance between conductors on related line arms and buck arms									
14	Line arms above or below related buck arms (s,t)----------------	---------	---------	6	12(u)	18(u)	18(u)	24	36	48(g)
	Horizontal separation of conductors on same crossarm									
15	Pin spacing of longitudinal conductors, vertical conductors & service drops (v, w) ------------------	---------	---------	3(x)	11½(h,x)	11½(x)	17½(x)	24(x)	36	48(g)
	Radial separation of conductors on same crossarm, pole or structure-incidental pole wiring									
16	Conductors, taps, or lead wires of different circuits (v,y,s)------	---------	---------	3(x)	11½(h,x)	11½(x)	17½(x)	24(x)	36	48(g)
17	Conductors, taps, or lead wires of the same circuit (v,s,ss)-------	---------	---------	3	3	6	6	12	18	24
	Radial separation between guys and conductors									
18	Guys passing conductors supported on other poles, and guys approximately parallel to conductors supported on the same poles---------------	---------	---------	9(bb)	12	18	18	30	36	36
19	Guys and span wires passing conductors supported on the same poles-	(cc)	---------	3	3	6	9	12	18	24

References to Rules Modifying Minimum Clearances in Table 2

		Rule	Page
(a)	The clearances in column D are also applicable to supply cables of any voltage under certain conditions ------------------------	57.4	163
(b)	Clearances for guys and span wires apply vertically at crossings; see Case 18 for radial clearances from conductors.		
	1. Supply guys and span wires from conductors ------------------------	56.4-C	157
	2. Supply guys and span wires from guys and span wires --------------------	56.4-D1	157
	3. Communication guys and span wires from conductors ------------------------	86.4-C	247
	4. Communication guys and span wires from guys and span wires ---------------	86.4-D1	248
(c)	Not applicable between messengers or span wires of the same system.		
	1. Supply messengers -------------------	57.4-E	165
	2. Trolley span wires ------------------	77.4-D	205
	3. Communication messengers ------------	87.4-G	258
(d)	Protection required on guys, span wires, messengers, and cables where within trolley throw.		
	1. Supply guys and span wires ----------	56.4-B2	156
	2. Supply messengers and cables ---------	57.4-B2	164
	3. Communication guys and span wires ----	86.4-B2	247
	4. Communication messengers ------------	87.4-B2	255
(e)	Not applicable to certain conductors supported on trolley span wires.		
	1. Trolley contact and feeder conductors-	74.4-G	203
	2. Trolley feeder conductors ------------	78.1	211
	3. Trolley system communication conductors ------------------------	78.2	211
	4. Foreign conductors ------------------	78.3	212
(f)	Increased clearance required over trolley contact conductors of 750-7500 volts -------	74.4-G2	203
(g)	Shall be increased for conductors of more than 68,000 volts.		
	1. Conductors not supported on the same poles ----------------------------	54.4-C7a	117
	2. Conductors supported on the same crossarm, pole or structure --------	54.4-C7b	117
(h)	May be reduced for certain conductors of Class T circuits of the same system -------------	74.4-C	201
(i)	May be reduced for service drops under special conditions.		
	1. Supply service drops and communication line conductors ------------------	54.8-C1a	142
	2. Supply service drops and communication service drops --------------------	54.8-C4	144

		Rule	Page
(x)	Shall be increased between conductors of different classification supported on the same crossarm.		
	1. Supply conductors of different voltage classifications ------------	32.4-A	30
	2. Supply circuits of 0-750 volts and communication circuits -------------	32.4-B	30
	3. Supply circuits and private communication circuits ---------------------	89.2-A	260
(y)	Special clearances for unprotected supply conductors from one level to another level--	54.6-A	125
		58.2-B3	169
		92.1-F5	269
(z)	Not applicable to the following:		
	1. Clearances between conductors at different levels specified in Cases 8 to 13 inclusive.		
	2. Supply lateral conductors, suitably protected --------------------------	54.6-C	126
	3. Supply vertical runs, suitably protected --------------------------	54.6-D	127
	4. Supply risers, suitably protected ----	54.6-E	128
	5. Communication conductors -------------	87.4-C1	256
(aa)	Not applicable between cables and their supporting messengers.		
	1. Supply -------------------------------	57.4-D	164
	2. Communication ------------------------	87.4-F	258
(bb)	May be reduced for communication guys and communication conductors supported on the same poles --------------------------------	86.4-C3	247
(cc)	Clearance required between guys.		
	1. Supply guys, crossing ----------------	56.4-D2	158
	2. Supply guys, approximately parallel --	56.4-D3	158
	3. Communication guys, crossing ---------	86.4-D2	248
	4. Communication guys, approximately parallel --------------------------	86.4-D3	248
(dd)	Shall be increased where within 6 feet of a pole ------------------------------------	103.5	275
(ee)	May be decreased in partial underground distribution ----------------------------	54.4-C4c	116
(ff)	May be reduced to 40 inches with the consent of supply and communication utilities concerned --------------------------------	84.6-C	234
		84.8-B3	240
		86.6-B2	251
		87.4C-3	256
		92.1-A	266
		92.1-B	266
		92.1-D	267

39. MINIMUM CLEARANCES OF WIRES FROM SIGNS

Clearance between any overhead line conductor and all signs, whether mounted on buildings, isolated structures or otherwise constructed shall not be less than the values given in Table 2-A at a temperature of 60° F. and no wind.

The clearances specified in Table 2-A shall in no case be reduced more than 10% because of temperature and loading as specified in Rule 43.

All clearances of more than 6 inches shall be applicable from the center lines of conductors concerned. Lesser clearances shall be applicable from conductor surfaces.

TABLE 2-A

MINIMUM CLEARANCES OF WIRES FROM SIGNS MOUNTED ON BUILDINGS AND ISOLATED STRUCTURES[a]

Case No.	Nature of Clearance Type of Sign	A Span Wires (Other than Trolley Span Wires), Overhead Guys & Messengers, Communication Cables and Communication Service Drops	B Communication Open Wire Conductors Supply Cables Treated as in Rule 57.8 and Supply Service Drops of 0-750 Volts	C Supply Conductors, Supply Cables of 0-750 Volts & Trolley Span Wires	D Supply Conductors & Supply Cables Above 750 Volts
1	Vertical clearance above all signs upon which men can walk	8 ft.	8 ft.	8 ft.	12 ft.
2	Vertical clearance above all signs upon which men cannot walk	2 ft.	2 ft.	3 ft.	8 ft.
3	Vertical clearance under signs which are illuminated	2 ft.[b]	2 ft.[d]	3 ft.	Prohibited[e]
4	Vertical clearance under signs which are nonilluminated	6 inches[c]	1 ft.	3 ft.	Prohibited[e]
5	Horizontal clearance from signs which are illuminated	3 ft.[b]	3 ft.[d]	3 ft.	6 ft.
6	Horizontal clearance from signs which are nonilluminated	6 inches[c]	1 ft.	3 ft.	6 ft.

a These clearances do not apply to service drop conductors which are attached to signs for the purpose of serving such signs.
b May be reduced to 6 inches provided illuminated sign is grounded.
c May be reduced if adequate separation is provided by means of a suitable nonconducting separator.
d May be reduced to 1 foot for communication open wire conductors only, provided illuminated sign is grounded.
e When conductors are at a level of 8 feet or more below the level of the lowest portion of the sign but not vertically under the sign, no horizontal clearance is required between the vertical planes through the conductor nearest the sign and the vertical projection of the extremities of the sign.

SECTION CONTENTS

SECTION IV

STRENGTH REQUIREMENTS FOR ALL CLASSES OF LINES

SECTION CONTENTS

SECTION IV

SECTION CONTENTS

SECTION IV

SECTION CONTENTS

SECTION IV

SECTION IV

STRENGTH REQUIREMENTS FOR ALL CLASSES OF LINES

40. GENERAL

The following rules cover mechanical strength requirements for each class of line (see Rule 20.5), either alone or involved in crossings, conflicts or joint use of poles. The rules of this section are supplemented in many instances by provisions in other sections.

41. CLASSIFICATION OF CIRCUITS AND GRADES OF CONSTRUCTION

For the purpose of recognizing relative hazards, lines are segregated into classes which are defined in Rule 20.5. These classes of lines and the relation of lines to each other and to objects over which they are constructed determine the grade of construction.

42. GRADES OF CONSTRUCTION

For all classes of lines, the relative order of grades is "A," "B," "C" and "F," grade "A" being the highest.

Supply and communication lines, where not involved in crossings, conflicts or on poles jointly used, shall be constructed and maintained so as to conform with grades of construction not less than as follows:

Class H supply ------------------------- Grade C
Class L supply ------------------------- Grade C
Class C communication ----------------- Grade F

Supply and communication lines, where involved in crossings, conflicts or on poles jointly used, shall be constructed and maintained so as to conform with grades of construction not less than as specified in Table 3.

TABLE 3

GRADES OF CONSTRUCTION

Class of circuit involved at upper level	Other facilities involved at lower level at crossings, conflicts or on poles jointly used	Grade of construction to be used at upper level
H ----------------------	Major Class C circuits ------------------------	"A"*
H or L ----------------	Major railways (steam, electric or other motive power, at crossings only) ---------------------	"A"
H or L ----------------	Minor railways (at crossings only) -------------	"B"
H ----------------------	Under all conditions not required to be Grade "A" (except supply cables treated as specified in Rule 57.8) ------------------------------------	"B"
L ----------------------	Under all conditions not required to be Grade "A" or "B" -------------------------------------	"C"
Supply cables treated as specified in Rule 57.8-	Under all conditions ----------------------------	"C"
Major Class C ----------	Class H circuits --------------------------------	"A"
Minor Class C ----------	Class H circuits --------------------------------	"B"
C ----------------------	Major railways (at crossings only) -------------	"B"
C ----------------------	Class L circuits of more than 750 volts ---------	"C"
C ----------------------	Supply cables treated as specified in Rule 57.8--	"F"
C ----------------------	Under all conditions not required to be Grade "A," "B," or "C" ----------------------------------	"F"

NOTE: Rule 57.8 specifies bonding and grounding of sheath and messenger of supply cables.

* The requirements of Grade "C" construction only will be sufficient if the supply circuits are in the voltage classification 5,000-20,000 volts.

42.1 Two or More Conditions

Where two or more conditions affecting the grade of construction exist, the grade of construction used shall be the highest required under any of the conditions.

42.2 Line Crossing Two or More Lines

Where a line crosses in one span over two or more other lines the grade of construction shall be not less than would be required if either of the lower lines crossed the other.

42.3 Line Crossing Involved Lines

Where one line crosses over another line which in turn is involved in a second crossing in the same span, the grade of construction for the highest line shall be not less than that required for the next lower line.

43. TEMPERATURE AND LOADING

The following conditions of temperature and loading shall be used for the purposes of these rules in determining the strength required of poles, towers, structures, and all parts thereof and in determining the strength and clearances of conductors. More stringent conditions may be used, if desired, in the design of lines. The use of modified conditions or modified loading district limits may be authorized by this Commission upon application and presentation of data from United States weather records or other adequate and authenticated meteorological data which in the Commission's opinion justifies such change.

43.1 Heavy Loading

Heavy loading shall apply in all parts of the State of Hawaii where the elevation exceeds 6,250 feet above sea level. (See Appendix A for map indicating the approximate location of the heavy loading district.) This loading shall be taken as the resultant stress due to wind, ice and dead weight under the following conditions:

A. Wind

A horizontal wind pressure of 6 pounds per square foot of projected area on cylindrical surfaces, and 10 pounds per square foot on flat surfaces shall be assumed. Where latticed structures are used, the actual exposed area of one lateral face shall be increased by 50% to allow for pressure on the opposite face, provided this computation does not indicate a greater pressure than would occur on a solid structure of the same outside dimensions, under which conditions the latter shall be taken.

B. Ice

A radial thickness of one-half inch of ice, weighing 57 pounds per cubic foot, on all conductors shall be assumed in computing vertical and wind loadings.

C. Temperature

Temperature shall be considered to be 0° F at the time of maximum loading. The normal temperature for computing erection conditions is 60° F. Maximum temperature shall be assumed as 130° F in computing sag under this condition.

43.2 Light Loading

Light loading shall apply in all parts of the State of Hawaii where the elevation above sea level is 6250 feet or less. (See Appendix A for map.) This loading shall be taken as the resultant of wind pressure and dead weight under the following conditions:

A. Wind

A horizontal wind pressure of 8 pounds per square foot of projected area on cylindrical surfaces, and 13 pounds per square foot on flat surfaces shall be assumed. Where latticed structures are used, the actual exposed area of one lateral face shall be increased by 50% to allow for pressure on the opposite face, provided this computation does not indicate a greater pressure than would occur on a solid structure of the same outside dimensions, under which conditions the latter shall be taken.

B. Ice

No ice loading is to be considered.

C. Temperature

For all locations in the State of Hawaii which are less than 2,000 feet above sea level, the temperature shall be considered to be 50° F at the time of maximum loading. The normal temperature for computing erection conditions shall be 75° F. Maximum temperature shall be assumed as 120° F in computing sag under this condition.

44. SAFETY FACTORS

The safety factors specified in these rules are the minimum allowable ratios of ultimate strengths of materials to the maximum working stresses, except that:

The safety factors for structural steel (towers, poles and crossarms) shall be applied as specified in Rule 48.2, and

The safety factors for wood members in bending shall be applied to longitudinal tension and compression as ratios of the moduli of rupture to the maximum working stresses.

The maximum working stresses used with these safety factors shall be the maximum stresses which would be developed in the materials under the construction arrangement with temperature and loadings as specified in Rule 43.

44.1 Installation and Reconstruction

Lines and elements of lines, upon installation or reconstruction, shall provide as a minimum the safety factors specified in Table 4 for vertical loads and loads transverse to lines and for loads longitudinal to lines except where longitudinal loads are balanced or where there are changes in grade of construction (see Rules 47.3, 47.4 and 47.5).

TABLE 4

MINIMUM SAFETY FACTORS

Element of Line	Grades of Construction			
	Grade "A"	Grade "B"	Grade "C"	Grade "F"
Conductors, splices and conductor fastenings (other than tie wires)	2	2	2	1
Pins	2	2	2	1
Pole line hardware	2	2	2	2
Line insulators (mechanical)	3	2	2	2
Guy insulators (mechanical):				
Interlocking	2	2	2	2
Noninterlocking	3	3	3	---------
Guys, except in light loading rural districts	2	2	2	1-1/4
Guys, in light loading rural districts	2	1-1/2	1-1/2	1-1/4
Messengers and span wires	2	2	2	2
Wood poles	4	3	2	1
Structural or tubular steel poles, towers, crossarms and steel members of foundations	1-1/2	1-1/4	1-1/4	---------
Foundations against uplift	1-1/2	1-1/2	1-1/2	---------
Foundations against depression	3	2	2	---------
Reinforced concrete poles	4	3	3	---------
Crossarms (wood)	2	2	2	1

44.2 Replacement

Lines or parts thereof shall be replaced or reinforced before safety factors have been reduced (due to deterioration or changes in construction arrangement or other conditions subsequent to installation) in Grades "A" and "B" construction to less than two-thirds of the construction safety factors specified in Rule 44.1 and in Grades "C" and "F" construction to less than one-half of the construction safety factors specified in Rule 44.1. Poles in Grade "F" construction shall also conform to the requirements of Rule 81.3-A.

In no case shall the application of this rule to Grades "A," "B" or "C" construction or to guys in Grade "F" construction be held to permit the use of structures or any member of any structure with a safety factor less than unity.

45. TRANSVERSE STRENGTH REQUIREMENTS

In computing the transverse strength requirements of all parts of structures and in calculating allowable stresses and allowable minimum sags for conductors under the temperature and loading conditions specified in Rule 43, safety factors at least equal to those of Table 4 shall be used. In heavy loading areas, for supporting structures carrying more than 10 wires (not including cables and supporting messengers) where the pin spacing does not exceed 15 inches, the transverse wind load shall be calculated on two thirds of the total number of such wires with a minimum of ten. In cases where, due to change of direction in conductors, an unbalanced side stress is imposed on the supporting structure, a transverse load shall be assumed equal to the resultant of all conductor tensions under the assumed loading conditions.

45.1 Special Provisions

Where it is impossible to obtain the required transverse strength except by the use of side guys or special structures and it is physically impossible to install them at the location of the transversely weak support, the strength may be supplied by side guying the line at each side of, and as near as practicable to, such weak support with a distance not in excess of 800 feet between the supports so guyed; provided that the section of line between the transversely strong structures is weak in regard to transverse loads only, that it is in a straight line and that the strength of the side guyed supports is calculated on the transverse loading of the entire section of line between them.

46. VERTICAL STRENGTH REQUIREMENTS

In computing vertical strength requirements the loads upon poles, towers, foundations, crossarms, pins, insulators and conductor fastenings shall be their own weight plus the superimposed weight which they support, including that of wires and cables under the loading conditions of Rule 43 plus that which may be added by difference in elevation of supports. The resultant of vertical and transverse loadings on conductors shall be used in determining the allowable and working tensions or sags in accordance with Rule 43.

In addition to the above a vertical load of 200 pounds at the outer pin position shall be included in computing the vertical loads on all crossarms.

All members of structures shall be constructed to withstand vertical loads as specified above with safety factors at least equal to those specified in Rule 44.

47. LONGITUDINAL STRENGTH REQUIREMENTS

In computing the longitudinal strength requirements of structures, or any parts thereof, the pull of the conductors shall be considered as that due to the maximum working tension in them under the loading conditions specified in Rule 43.

47.1 Reduction in Stress

Stresses in supporting structures due to longitudinal load may be reduced by increasing the conductor sags, provided that the prescribed conductor clearances of Section III are maintained.

47.2 Use of Guys and Braces

The longitudinal strength requirements for poles, towers and other supporting structures shall be met either by the structure alone or with the aid of guys or braces. Deflection shall be limited by guys or braces where such structures alone, although providing the strength and safety factors required, would deflect sufficiently under the prescribed loadings to reduce clearances below the required values.

47.3 Unbalanced Loads

Poles, towers or structures with longitudinal loads not normally balanced (as at dead ends or angles greater than can be treated as in Rule 45) shall be of sufficient strength, or shall be guyed or braced, to withstand the total unbalanced load with safety factors at least equal to those specified in Rule 44.

47.4 Change in Grade of Construction

Where sections of higher grade construction are located in lines of lower grade construction the longitudinal load on each end support of such sections at the level involved shall be taken as an unbalanced load in the direction of the higher grade section equal to the total pull of all conductors in that direction. For spans not exceeding 500 feet in length, where the pull in the direction of the higher grade section exceeds 30,000 lbs. the loading requirements may be modified to consider 30,000 lbs. plus one-fourth the excess above 30,000 lbs., to a maximum of 50,000 lbs. The construction of the end supports (including poles, structures, towers, crossarms, pins, insulators, conductor fastenings and guys) of such sections shall be such as to withstand at all times the load specified with a safety factor at least equal to unity.

In lieu of meeting the requirements of this rule on single poles or structures at ends of higher grade sections, the longitudinal load may be distributed over two poles or structures provided that the two poles or structures are suitably side guyed or are in a straight line with the direction of the longitudinal load of the higher grade section and that the two poles or structures comply with the requirements for the higher grade as to transverse strength and conductors between the two poles comply with the requirements for the higher grade.

47.5 End Supports in Grades "A" or "B" Construction

In Grades "A" or "B" construction the longitudinal load on each end support of crossings, conflicts or joint use, where located in lines of the same grade of construction, shall be taken as the unbalanced load equal to the tension of one-third of the total number of conductors (not including overhead ground wires), such one-third of the conductors being so selected as to produce the maximum stress in the supports. If the application of the above results in the fractional part of a conductor, the nearest whole number of conductors shall be used. The construction of the supports (including poles, structures, towers, crossarms, pins, insulators, conductor fastenings and guys) shall be such as to withstand at all times the load specified with a safety factor at least equal to unity. Excluded from the requirements of this rule, where Grade "B" construction is required, are Class L lines crossing minor railways and conductor fastenings of Class C circuits crossing major railways.

48. ULTIMATE STRENGTH OF MATERIALS

Values used for the ultimate strength of materials, in connection with the safety factors specified in Rule 44 shall be not more than as follows:

48.1 Wood

Values used for moduli of rupture for wood in bending, in conjunction with the safety factors given in Rule 44, shall not exceed those shown in Table 5.

TABLE 5

WOOD STRENGTHS

Species	Modulus of rupture in bending	
	Sawed rectangular poles, crossarms, etc. (a)	Round poles
Cedar, western red	4,700 lbs. per sq. in.	6,000 lbs. per sq. in.
Douglas fir, dense	6,300 lbs. per sq. in.	6,800 (b) lbs. per sq. in.
Douglas fir, not dense	5,800 lbs. per sq. in.	6,800 (b) lbs. per sq. in.
Fir, white or red, local	4,700 lbs. per sq. in.	5,600 lbs. per sq. in.
Pine, southern yellow, dense	6,300 lbs. per sq. in.	6,800 (b) lbs. per sq. in.
Pine, southern yellow, not dense	5,800 lbs. per sq. in.	6,800 (b) lbs. per sq. in.
Redwood, virgin	5,300 lbs. per sq. in.	6,200 lbs. per sq. in.
Redwood, second growth	3,900 lbs. per sq. in.	4,600 lbs. per sq. in.

(a) Figures given are for select structural grade of material under short time loading with the neutral plane parallel to a side. Multiply the values shown by 1.4 where the neutral plane is on the diagonal of a square. Multiply the given values by 0.55 where the loading being considered is a long time loading (continuous load for one year or more).

(b) Where poles meet specifications of American Standards Association, 05.1-1963 for Douglas Fir Poles and Southern Pine Poles, this value may be increased to not more than 8,000 lbs. per square inch. Such poles shall be given suitable preservative treatment.

48.2 Structural Steel

Steel structures, steel structural members and their connections, shall be designed and constructed so that the structures and parts thereof will not fail or be seriously distorted at any load less than the maximum working loads (developed under the construction arrangement with loadings as specified in Rule 43) multiplied by the safety factors specified in Rule 44.

The safety factors specified in Rule 44 shall be applied as follows to structural steel:

Tension and Bending: The yield point, 33,000 pounds per square inch, shall be divided by the safety factor to determine the maximum allowable working stress.

Compression: The maximum allowable working stress shall be calculated by the following formula:

$$S_{max} = \frac{1}{f_s}\left[YP - \left(\frac{YP - 12{,}000}{200}\right)\frac{l}{r}\right]$$

where S_{max} = maximum allowable working stress, lbs per sq. in.
f_s = safety factor specified in Rule 44
YP = yield point of the steel, 33,000 lbs per sq. in.
l = unsupported length of member, inches
r = radius of gyration of member, inches

Shear: The ultimate tensile strength, 60,000 pounds per square inch, shall be multiplied by 2/3 and divided by the safety factor specified in Rule 44 to determine the maximum allowable working stress.

Where the figures given are used, structural steel shall conform to Standard Specifications A7-39 of American Society for Testing Materials for carbon steel of structural quality. Other values may be used for steel of other strength provided the yield point and ultimate tensile strength are determined by test.

48.3 Reinforced Concrete

Values used for ultimate strengths of reinforced concrete, in conjunction with safety factors given in Rule 44, shall not exceed the following:

Reinforcing steel, tensile or compressive strength, pounds per square inch ---------------------------------- 55,000

Concrete, 1:2:4 mixture --	Age	Compressive Strength
	7 days	900 lbs per sq in.
	30 days	2,400 lbs per sq in.
	90 days	3,100 lbs per sq in.
	6 mos.	4,400 lbs per sq in.

If reinforced concrete is designed for higher strength values which are proven by test, such values may be used in lieu of the figures given.

48.4 Conductors, Span Wires, Guys and Messengers

Values used for ultimate strengths of wires and cable shall not exceed those given in Appendix B. The ultimate strengths given in Tables 17 to 24 of Appendix B, except for medium-hard-drawn copper, are based on the minimum ultimate strengths given in the standard specifications of the American Society for Testing Materials. The ultimate strengths given in Appendix B for medium-hard-drawn copper are based on the standard specifications of the ASTM and provide an allowance above the minimum values of one-quarter of the range between minimum and maximum values. For use of types of wires and cables of other materials not included in Appendix B, values for ultimate strengths similarly derived from specifications of the ASTM shall be used except that, if such specifications are nonexistent, maker's specifications may be used provided that tests have been made which shall justify the maker's rating for ultimate strength.

48.5 Tower or Pole Foundations and Footings

In calculating the resistance of foundations or footings of towers, poles and pole line structures to uplifts, the weight of concrete shall be taken as not more than 145 pounds per cubic foot and the weight of earth (calculated 30 degrees from the vertical) shall be taken as not more than 90 pounds per cubic foot. The resistance of soil to the depression of foundations or footings shall be calculated from the best available data on the soil in question. In lieu of calculation, the strength of foundations or footings against uplift or depression may be determined by tests under the soil conditions obtaining.

49. DETAILED STRENGTH REQUIREMENTS

49.1 Poles, Towers and Other Structures

A. Strength

Wood poles shall be of sound timber, free from defects which would materially reduce their strength or d ra-bility and they shall have sufficient strength to withstand, with safety factors not less than those specified in Rule 44, the maximum stresses to which they are subjected under the loading conditions specified in Rule 43. The modulus of rupture used in calculation of safety factors shall be not greater than the value given in Rule 48.1.

Steel and reinforced concrete poles, together with their foundations, shall be of such material and dimensions as to withstand, with safety factors not less than those specified in Rule 44, the maximum stresses to which they are subjected under the loading conditions specified in Rule 43. The fiber stress values used in calculation of safety factors shall be as specified in Rules 48.2 and 48.3. Certain poles are subject to special stresses due to angles in the line, dead-ending of conductors or other attachments, which stresses must be included in computing the loading and safety factor. Poles subject to these special stresses sometimes require the use of guys, in which case the pole below the point of guy attachment shall be considered merely as a strut, the guy taking all lateral stresses. In such cases the pole strength requirement shall apply at the point of guy attachment rather than at the ground line.

Spliced or stub reinforced poles or pole top extensions, including the attachment (joint) of the different members involved, shall meet all of the vertical, transverse and longitudinal strength requirements of these rules as if a whole pole were used. Spliced or stub reinforced poles or pole top extensions shall not be used where Grade "A" construction is required in supports of crossings or conflicts, or where Grade "B" construction is required for Class C lines crossing the main lines of major railways.

B. Dimensions

The minimum top circumference of wood poles shall be not less than the following:

	Inches
Grade "A" heavy loading district	22
Grade "A" light loading district	19
Grade "B"* heavy and light loading districts..	19
Grade "C" heavy and light loading, urban districts	19
Grade "C" circuits of 750-7500 volts, heavy loading, rural districts	19
Grade "C" supply circuits of 0-750 volts and communication circuits, heavy loading rural districts	16
Grade "C", light loading, rural districts	16
Grade "F", cable or more than 4 single wires or 8 conductors duplexed or paired, heavy loading districts	15
Grade "F". cable or more than 6 single wires or 12 conductors duplexed or paired, light loading districts	15
Grade "F" not more than 4 single wires or 8 conductors duplexed or paired, heavy loading districts	12
Grade "F" not more than 6 single wires or 12 conductors duplexed or paired, light loading districts	12

NOTE: Poles having a ground line circumference of less than 12 inches are not safe to climb unless supported by guys, pike poles, etc.

*Supply Poles in Grade "B" construction in rural, light loading districts may have a top circumference less than 19 inches but not less than 16 inches.

*Communication Poles in Grade "B" construction at crossings over major railroads may have top circumferences less than 19 inches but not less than the following, provided such poles meet the specifications of the American Standards Association, 05.2-1941, 05.4-1941 or 05.6-1941, and are butt treated if of western red cedar or are full-length pressure treated if of Douglas fir or southern yellow pine:

Number of Conductors Supported	Minimum Pole Top Circumference (inches) Heavy Loading	Light Loading
10 or less	15	15
11 - 20	17	17
21 - 40	19	17
More than 40	19	19

C. Setting of Wood Poles

The depths of pole setting given in Table 6 are applicable to wood poles set in firm soil or in solid rock. Where the soil is not firm, deeper settings or special methods of pole setting should be resorted to. Where unguyed poles are set subject to heavy strain, or at corners or curves, a greater depth should be used. Guyed poles may be set not more than one foot less than the depths specified in Table 6 provided the guys do not assume any normal working load under conditions of no wind and the resulting depths of setting are not less than 3 feet.

For communication lines, sawed poles of a cross section of 36 square inches or less may be set to a depth of 6 inches less than the specifications shown in the following table.

TABLE 6
Pole Setting Depths

Total Length of Pole (feet)	Depth in Soil (feet)	Depth in Rock (feet)
20	4	3
25	4½	3
30	5	3
35	5	3½
40	5½	3½
45	6	4
50	6½	4
55	7	4½
60	7	4½
65	7½	5
70	7½	5
75	8	5½
80	8	6

D. Gains

Gains or equivalent means shall be provided for increasing surface contact of crossarms with round wood poles. Where gains are cut, the depth shall be not less than one-half inch or more than one inch. "Slab" gains, metal gains, pole bands, or assemblies of wood or metal supports that provide suitable surface contact and adequate strength are permitted.

E. Replacements (see Rule 44.2)

49.2 Crossarms

A. Material

(1) Wood: Wood crossarms shall be of suitable grades of Douglas fir, southern yellow pine or other accepted species.

(2) Metal: Metal crossarms shall be of structural steel, cast steel, or malleable cast iron, properly galvanized or otherwise protected to resist corrosion, or may be of any corrosion-resisting metal or alloy.

B. Minimum Size

(1) Wood: Crossarms used to support or guard supply conductors shall have cross-sectional dimensions not less than the following:

One piece (homogeneous): 3-1/4 X 4-1/4 inches,
Fabricated: any single member, 1-3/4 X 4-1/4 inches,
Laminated: 3 X 4 inches.

Crossarms supporting or guarding communications conductors shall provide the strength of douglas fir having a cross section not less than 2-3/4 by 3-3/4 inches, provided that supply conductors are occupying the top position. In locations when communications conductors occupy the upper position, such crossarms shall provide the strength of douglas fir having a cross section not less than 3 by 4-1/4 inches.

(2) Metal: The physical properties as a result of dimensions, shape and cross-sectional area of metal crossarms shall be such as to result in sufficient strength to meet the requirements of Rules 46, 47 and 48.2, provided the thickness of any element shall be not less than 3/32 inch.

C. Strength

Crossarms shall be securely supported by bracing, where necessary, to withstand unbalanced vertical loads and to prevent tipping of any arm sufficiently to decrease clearances below the values specified in Section III. Such bracing shall be securely attached to poles and crossarms. Supports in lieu of crossarms shall have means of resisting rotation in a vertical plane about their attachment to poles or shall be supported by braces as required for crossarms. Metal braces or attachments shall meet the requirements of Rules 48.2 and 49.8. In computing the strength requirements to meet vertical loads the effect of such bracing may be considered.

(1) Longitudinal Loads Normally Balanced:

a) Supply Lines: Where longitudinal loads are normally balanced, crossarms supporting supply conductors shall have sufficient strength to withstand a load, applied in the direction of the conductors at the outer pin position, of 700 pounds with a safety factor of not less than unity.

b) Communication Lines, Class C: Where longitudinal loads are normally balanced, crossarms supporting Class C conductors shall have sufficient strength to withstand a load, applied in the direction of the conductors at the outer pin position, of 400 pounds with a safety factor of not less than unity.

(2) Longitudinal Loads Normally Unbalanced: Where crossarms are subjected to unbalanced longitudinal loads they shall have sufficient strength to meet the strength requirements with safety factors at least equal to those specified in Rule 44.

At unbalanced corners and dead ends in Grades "A", "B", or "C" construction, where conductors are supported on pins and insulators, single cross-arm construction with the conductor fastening made to a single insulator will be permitted provided the strength requirements of Rules 44, 47.4 and 47.5 are met and the conductor is fastened to the insulator in a manner so as to prevent slipping of the conductor.

For conductor tensions up to 2000 pounds per conductor, double pins with double wood crossarms fitted with spacing devices at each end will be considered as meeting the strength requirements of Rule 47.4 and 47.5.

D. Replacements (see Rule 44.2)

49.3 Pins and Conductor Fastenings

A. Material

(1) Pins: Insulator pins shall be of galvanized steel, galvanized iron or other corrosion-resisting metal or of locust or other suitable wood.

(2) Fastenings: Conductor fastenings shall be of galvanized steel, galvanized iron or other corrosion-resisting metal.

B. Size

(1) Wood Pins: The minimum diameter of the shank shall not be less than 1-1/4 inches.

(2) Metal Pins: The minimum diameter of the shank shall not be less than 1/2 inch.

(3) Fastenings and Tie Wires: Fastenings and tie wires shall have no sharp edges at points of contact with conductors, and shall be applied in such a manner as not to damage the conductor. The materials and minimum sizes of tie wires for the various sizes and types of conductors shall be as shown in Table 7. Flat tie wire having a cross-sectional area not less than that of round wire of the gage specified for tie wires may be used.

TABLE 7

Size and Material of Tie Wires

LINE CONDUCTOR		TIE WIRE	
MATERIAL	SIZE	SIZE	MATERIAL
Copper, bronze, copper-covered steel, or composites of any of them	6 AWG and smaller	Same as line conductor	Soft copper or annealed copper-covered steel
	4 AWG	6 AWG	
	2 AWG and larger	4 AWG	
Galvanized iron or galvanized steel	10 BWG and smaller	Same as line conductor	Soft galvanized iron or galvanized steel
	9 BWG	10 BWG	
	8 BWG	9 BWG	
	4 and 6 BWG	8 BWG	
Aluminum or ACSR	4 AWG and smaller	Same as line conductor	Soft Aluminum
	2 AWG and larger	4 AWG	

C. Strength

Insulator pins and conductor fastenings shall be able to withstand the loads to which they may be subjected with safety factors at least equal to those specified in Rule 44.

NOTE: a 1-1/2 by 9 inch locust pin will usually provide cantilever strength up to 1000 pounds tension in the conductor with the conductor 3-1/2 inches above the crossarm and a safety factor of unity.

(1) Longitudinal Loads Normally Balanced:

a) Insulator Pins: Where longitudinal loads are normally balanced, insulator pins which support conductors shall have sufficient strength to withstand, with a safety factor of not less than unity, a load at the conductor position as follows:

Pins supporting supply conductors..700 pounds
Pins supporting Class C conductors.400 pounds

b) Conductor Fastenings: Where longitudinal loads are normally balanced, tie wires or other conductor fastenings shall be installed in such a manner that they will securely hold the line conductor to the supporting insulators and will withstand without slipping of the conductor unbalanced pulls as follows:

Supply conductor fastenings --	40% of the maximum working tensions but not more than 500 pounds
Class C conductor fastenings--	15% of the maximum working tensions but not more than 300 pounds

Tie wires are not required on Class C conductors at point-type transpositions in Grade F construction.

(2) Longitudinal Loads Normally Unbalanced: At unbalanced corners and dead ends in Grades "A", "B", or "C"

construction, where the conductor tensions are held by cantilever strength in pin-type insulators and pins a single insulator and pin may be used provided the insulator strength is adequate and the conductor is fastened to the insulator so as to prevent slipping of the conductor under the maximum working tension with a safety factor of 2 under the temperature loading conditions specified in Rule 43.

At changes in grade of construction and at end supports in Grades "A" or "B" construction where the conductors are not dead-ended and are supported on pin-type insulators, double insulators and pins with tie wires, or equivalent fastenings, will be considered as meeting the strength requirements of Rules 47.4 and 47.5 for conductor tensions up to 2000 pounds per conductor.

D. Replacements (see Rule 44.2)

49.4 Conductors

A. Material

Conductors shall be of copper, copper-covered steel, bronze, stranded cable composites of any of the foregoing, aluminum, aluminum cable steel reinforced, galvanized iron, galvanized steel or of other corrosion-resisting metal not subject to rapid deterioration, except that in common neutral systems the provisions of Rule 59.3-A shall also apply.

B. Size

The minimum sizes of conductors which shall be used in spans of 150 feet or less under the several classes of construction and loadings in both urban and rural districts are specified in Table 8. Larger conductors than those specified in the table will often be necessary to maintain reasonable sag and at the same time provide the required safety factors of Rule 44, ground clearances of Table 1, and wire clearances of Table 2.

Conductors of the sizes specified in Table 8 may be used in spans longer than 150 feet, except when specifically prevented by Rule 49.4-C, provided the sags and conductor positions are so adjusted that the allowable working tensions and clearances of this Order are not violated.

The common neutral conductor in common neutral systems shall conform to the requirements of Rule 59.3-B in addition to the above requirements.

TABLE 8

Minimum Conductor Sizes (150-foot spans or less)

Loading condition and grade of construction	MATERIAL OR TYPE OF CONDUCTOR: Soft or annealed copper	Hard-drawn or medium-hard-drawn copper	Stranded aluminum	Aluminum cable, steel reinforced	Copper-covered steel, bronze or composites	Galvanized iron or galvanized steel
HEAVY LOADING	AWG	AWG	AWG	AWG	AWG	
Grade "A"	4	6	1	4	6	1/4-in. diam. strand
Grade "B" (a) (h)	4	6	1	6	8	9 BWG
Grade "C" (h)	4	6	1	6	8	9 BWG
LIGHT LOADING						
Grade "A"	4	6	1	4	8	1/4-in. diam. strand (b)
Grade "B" (a) (c) (h)	6	6	1	6	8	9 BWG
Grade "C" (c) (h)	6	8	1	6	10	9 BWG
HEAVY AND LIGHT LOADING						
Supply service drops crossing trolley wires	8	10	-----	-----	12	----------
Other supply service drops	10	10	-----	-----	12	----------
Grade "F" single conductors (d)	-----	(e)	-----	-----	(e)	14 BWG
Grade "F" paired conductors (d)	-----	14(f)	-----	-----	17(g)	----------

(a) Communication conductors crossing over major railroads may be smaller but shall be not less than as specified in Rule 113.4.
(b) Three-sixteenth-inch strand may be used upon special permission of this Commission.
(c) May be smaller but shall provide tensile strength not less than No. 8 AWG soft copper, if less than 750 volts, as per Rule 49.4-C2.
(d) Communication service drops over supply lines shall conform to Rules 32.2-F and 32.2-G.
(e) No. 12 AWG or No. 14 NBS.
(f) Paired wire may be smaller per Rule 49.4-C7b.
(g) High strength paired wire may be smaller per Rules 49.4-C7b and 49.4-C8.
(h) May be reduced per Rule 49.4-C3.

C. Strength

(1) Heavy Loading Districts: Conductors in Grade "A" construction and in spans exceeding 150 feet shall have a tensile strength not less than that of No. 4 AWG medium-hard-drawn copper and said conductors shall preferably be stranded.

(2) Light Loading Districts: The following requirements apply for various grades of construction and span lengths.

Conductors in Grade "A" construction in spans exceeding 150 feet and not exceeding 300 feet in length shall have a tensile strength not less than that of No. 6 AWG medium-hard-drawn copper.

Supply conductors of less than 750 volts in Grade "B" or "C" construction in spans not exceeding 150 feet in length shall have a tensile strength not less than that of No. 8 AWG soft-drawn copper.

(3) Heavy or Light Loading Districts: Where signal or communication lines take Grade "B" or "C" classification other than at railroad crossings, a minimum size of No. 8 AWG medium-hard-drawn copper or its equivalent in tensile strength may be used.

(4) Conductors of Voltages Exceeding 17,000 Volts: Conductors of voltages exceeding 17,000 volts crossing conductors of less than 17,000 volts or crossing a public highway shall have a strength at least equal to No. 4 AWG stranded medium-hard-drawn copper. In lieu of this, the conductors carrying more than 17,000 volts shall, at the point of crossing, be supported on poles of such height and so placed that under no circumstances can the conductor of over 17,000 volts, in case of breakage of same or otherwise come in contact with any conductor carrying less than 17,000 volts, or fall within a distance of ten feet from the surface of any public highway.

(5) Sags and Tensions: Conductor sags shall be such that under the loading conditions specified in Rule 43 the tension in the conductors shall not be more than one-half the breaking strength of

the conductor, other than communication circuits. The use of sags greater than the allowable minimum may be desirable in order to reduce working tensions.

Where the minimum size pins are used, the conductor tensions shall be limited to 2000 pounds when applying the double arm, pin and conductor fastening provisions of Rules 49.2 and 49.3.

(6) Splices: Splices in line conductors shall be in accordance with the requirements of Table 4 except as provided in Rules 103.1-A and 113.1-A.

(7) Service Drops:

a) Supply: The minimum sizes shall apply only where the span does not exceed 150 feet. The minimum for supply lines of like voltage and grade shall apply when the service drop is in excess of 150 feet.

Multiple conductor cable with a bare neutral is permissible provided that the attachment of such a cable at the pole and building ends shall be by means of an insulator. Supply service drops of 0-750 volts shall have a weather resistant covering equivalent to a standard double braid weatherproofing.

b) Communication: Paired wire communication service drops of high strength bronze or high strength copper-covered steel of No. 18 AWG in heavy loading areas and of No. 20 AWG in light loading areas may be used provided the breaking strength of the pair is not less than 340 lbs. in heavy loading areas and 200 lbs. in light loading areas.

Communication service drops of No. 16 AWG paired copper wire may be used in both heavy and light loading areas, provided they do not cross over supply lines, trolley contact or feeder conductors, or railways.

(8) Communication Line Conductors: Paired wire of high strength bronze or high strength copper-covered steel of No. 18 AWG in heavy loading areas and of

No. 20 AWG in light loading areas may be used as communication line conductors provided the breaking strength of the pair is not less than 340 lbs. in heavy loading areas and 200 lbs. in light loading areas.

D. Replacements (see Rule 44.2)

E. Connections

All electrical connections shall be of suitable electrical and mechanical design.

49.5 Insulators

A. Line

Insulators, supports, clamps and other miscellaneous attachments shall be designed to withstand, with at least the safety factors specified in Rule 44, the mechanical stress to which they are subjected by conductors, wires or structures, under the loading conditions as specified in Rule 43. Pin insulators shall effectively engage the thread of the pin for at least two and one-half turns.

B. Guy

Guy insulators, including insulators in messengers, shall have mechanical strength at least equal to that required of the guys in which they are installed.

C. Replacements (see Rule 44.2)

49.6 Guys and Anchors

A. Material

The exposed surface of all guys and guy rods shall be of corrosion-resisting material.

B. Size

The size and ultimate strength of guys crossing in spans over Class H, L, T or C circuits shall be not less than as specified in Table 9 and shall also be such as to provide safety factors not less than those specified in Rule 44 for the loads imposed by the construction involved under the loading conditions specified in Rule 43.

TABLE 9

Minimum Size and Strength of Guys Crossing over Class H, L, T or C Circuits

MATERIAL OF STRAND	MINIMUM SIZE	
	Anchor Guys	Overhead Guys
Galvanized steel:		
Common or Siemens-Martin	5/16 in. diam.	1/4-in. diam.
High strength or extra-high strength	1/4-in. diam.	3/16 in. diam.
Copper-covered steel	3 No. 9 AWG	3 No. 10 AWG
Bronze	1/4-in. diam.	3 No. 10 AWG
Minimum allowable ultimate strength of guys	3,200 pounds	1,900 pounds

C. Strength

Where guys are used with poles or similar structures, capable of considerable deflection before failure, they shall be able to support the entire load, the pole below the point of guy attachments acting merely as a strut. Stranded wires shall be used when the ultimate strength of the guy exceeds 1800 pounds. Anchor rods and their appurtenances shall meet the same strength requirements as the guy wire or strand. (See Rule 44.)

D. Replacements (see Rule 44.2).

49.7 Messengers and Span Wires

A. Material

Messengers and span wires shall be stranded and of galvanized steel, copper-covered steel or other corrosion-resisting material not subject to rapid deterioration.

B. Strength

Messengers and span wires shall be capable of withstanding, with safety factors as specified in Rule 44, the tension developed because of the load they support combined with the loading conditions specified in Rule 43. An allowance of 200 pounds of vertical load for a man and cable chair shall be made in computing tensions in messengers and span wires which support cables except in the case of short spans which are not required to support workmen or where the ice loading specified in Rule 43.1-B would exceed the allowance for the man and cable chair.

The strength of guys supporting messenger loads shall be such that the safety factor of such guys is not less than the safety factor required of the messenger as specified in Rule 44. It is recommended that overhead guys shall be the same size as the suspension strand and that anchor guys shall be enough larger than the suspension strand to compensate for the angle between the plane of the horizontal load of the suspension strand and the line of the guy.

Messenger cables installed as part of a secondary aerial cable shall be designed according to this rule except the 200 pounds vertical load allowance may be reduced to 50 pounds to allow for the load of workmen on ladders provided a cable chair will not be used to work on these circuits.

C. Supports

Messengers supporting cables shall be attached to poles or crossarms with hardware which provides safety factors at least equal to those specified in Rule 44, based on the weight of the cable plus an allowance of 200 lbs. for the man and cable chair. If in heavy loading areas the specified ice load exceeds in weight the 200 lbs. allowance, such ice load shall be used in making the calculations in preference to the weight of the man and cable chair. All hardware subject to injurious corrosion shall be protected by galvanizing, painting or other suitable treatment.

Messenger cables installed as part of a secondary aerial cable shall be designed according to this rule except the 200 pounds vertical load allowance may be reduced to 50 pounds to allow for the load of workmen on ladders provided a cable chair will not be used to work on these circuits.

D. Replacements (see Rule 44.2)

49.8 Hardware

All pole line hardware shall be galvanized, otherwise protected by a corrosion-resisting treatment, or shall be composed of material which is corrosion resisting.

SECTION CONTENTS

SECTION V

DETAILED CONSTRUCTION REQUIREMENTS FOR SUPPLY LINES

(CLASS H, L AND T CIRCUITS)

SECTION CONTENTS

SECTION V

RULE PAGE

SECTION CONTENTS

SECTION V

SECTION CONTENTS

SECTION V

RULE | PAGE

SECTION CONTENTS

SECTION V

SECTION CONTENTS

SECTION V

SECTION CONTENTS

SECTION V

SECTION CONTENTS

SECTION V

SECTION CONTENTS

SECTION V

SECTION CONTENTS

SECTION V

SECTION CONTENTS

SECTION V

SECTION CONTENTS

SECTION V

SECTION CONTENTS

SECTION V

SECTION CONTENTS

SECTION V

SECTION CONTENTS

SECTION V

SECTION V

DETAILED CONSTRUCTION REQUIREMENTS FOR SUPPLY LINES

(CLASS H, L AND T CIRCUITS)

50. GENERAL

The following rules cover certain special details for the construction of supply lines. These rules are supplemented, in certain cases, by rules in other sections. See Section VII for special rules applicable to Class T circuits; see Section IX for special rules applicable to supply lines on poles jointly used; see Section X for special rules applicable to line crossings or conflicts; see Section XI for special rules applicable to lines crossing railroad.

51. POLES, TOWERS AND STRUCTURES

51.1 Definition (see Rules 21.7-C and 22.0)

51.2 Maintenance and Inspection (see Rules 31.1 and 31.2)

51.3 Material and Strength (see Section IV)

51.4 Clearances

A. From Railroad Tracks (see Rule 36; also Appendix E)

51.5 Dimensions and Settings (see Rules 49.1-B and 49.1-C)

51.6 Marking and Guarding

A. Marking of Poles Where Conductors Are Not on Crossarms

Wood or metal poles which support conductors of more than 750 volts in vertical configuration and not on crossarms shall have bands of bright yellow color not less than one foot in width painted around them. The top of such a band shall be neither less than 2½ feet nor more than 3 feet below the lowest conductor of each circuit of more than 750 volts so supported.

In lieu of the paint required by this rule, similarly located signs, showing the words "High Voltage" in letters not less than 3 inches in height, shall be used. The letters on such signs shall be white on a green or black background, or such signs shall be plastic or other weather and corrosion-resisting material, with the letters cut out therefrom and clearly legible.

The provisions of this rule, 51.6-A, shall not apply to the marking of poles at the levels of supply circuits of more than 20,000 volts in rural districts.

See Rule 65 for the marking of towers.

B. Guarding of Latticed Metal Poles and Other Latticed Structures

Where the pole or structure is of latticed metal or of similar construction and supports supply conductors in excess of 750 volts and is located in urban districts, or in rural areas adjacent to schools, dwellings, permanent or seasonal camps, or in orchards, or near roads or trails which are frequently traveled, a barrier shall be so located on the structure as to prevent easy climbing. If the bottom of the barrier is within 12 feet of the ground line, the top shall be not less than 15 feet above the ground line but in no event shall the barrier be less than 8 feet in length. If the bottom of the barrier is more than 12 feet above the ground line, it shall be not less than 6 feet in length.

The provisions of this rule, 51.6-B, shall not apply to poles or structures on which all conductors have 5 feet or more horizontal clearance from the supporting structure, nor to poles or structures within fenced substation yards.

Note. It is the intent of Rule 51.6-B to require such guarding as will prevent easy climbing of these poles by young persons who do not realize the danger of contact with live conductors supported thereon. It is not intended that such guarding will be required in sparsely settled districts, mountainous and desert areas, and similar locations.

51.7 Stepping

The lowest step on any stepped pole, tower or structure shall be not less than 7 feet 6 inches from the ground line and above this point the spacing between steps on the same side of pole, tower or structure shall not exceed 36 inches.

52. CROSSARMS

52.1 Definition (see Rule 20.9)

52.2 Maintenance and Inspection (see Rules 31.1 and 31.2)

52.3 Material and Strength (see Rule 49.2)

52.4 Marking

Crossarms supporting conductors of more than 750 volts and arms supporting equipment connected to or containing conductors of more than 750 volts shall be marked, by the methods described in Rule 52.4-A, as specified in Rules 52.4-B, 52.4-C, and 52.4-D with the exceptions specified in Rule 52.4-E.

A. Methods

Crossarms which are required by these rules to be marked as high voltage shall be painted a bright yellow color, or in lieu thereof signs showing the words "High Voltage" (or pairs of signs showing the words "High" and "Voltage") in letters not less than 3 inches in height shall be placed on the face and back of such crossarms, unless either face or back is exempted by provisions of the following Rules (52.4-B, C, D, and E). The letters on such signs shall be white on a green or black background or such signs shall be of weather and corrosion-resisting material including plastic with the letters cut out therefrom and clearly legible.

The letters of signs and the color of paint specified above shall be maintained in such condition that letters are legible and color is distinguishable.

B. Crossarms Supporting Conductors of More Than 750 Volts and No Conductors of 0-750 Volts

The crossarms treated in this Rule 52.4-B may also support certain equipment in addition to conductors of more than 750 volts, and when so utilized the provisions of Rule 52.4-D will also apply.

(1) In Urban Districts: All crossarms supporting conductors of more than 750 volts in urban districts shall be marked as high voltage, except as provided in Rule 52.4-B3.

(2) In Rural Districts: Crossarms supporting only conductors of more than 750 volts in rural districts shall be marked as high voltage in accordance with the following:

a) Supporting Conductors of 750-7500 Volts: All crossarms supporting conductors of 750-7500 volts shall be marked as high voltage.

b) Supporting Conductors of Constant Current Circuits of More Than 750 Volts: All crossarms supporting conductors of constant curcurent circuits of more than 750 volts shall be marked as high voltage, except as provided in Rule 52.4-B3.

c) Supporting Conductors of 7500-20,000 Volts at Certain Locations: At all crossings over public thoroughfares and at locations adjacent to structures such as water tanks, windmills and buildings, adjacent to wells, and at similar locations, crossarms supporting conductors of 7500-20,000 volts shall be marked as high voltage.

d) Supporting Conductors of More Than 7500 Volts At or Below the Level of Conductors of 7500 Volts or Less: In rural districts, all crossarms supporting conductors of more than 7500 volts at or below the level of conductors of 7500 volts or less supported on the same structure shall be marked as high voltage.

e) Supporting Conductors of 7500-20,000 Volts on the Same Structure With Conductors of 750 Volts or Less: Where, on the same structures in rural districts, crossarms supporting conductors of 7500-20,000 volts are above conductors of 750 volts or less, the crossarm supporting conductors of 7500-20,000 volts next above the conductors of 750 volts or less shall be marked as high voltage. All crossarms supporting conductors of 7500-20,000 volts below conductors of 750 volts or less supported on the same structures shall be marked as high voltage.

(3) On Guarded Metal Poles: On latticed metal poles which are guarded with barriers as required in Rule 51.6-B, the following crossarms shall be marked as high voltage:

Crossarms supporting conductors of 750-7500 volts;

Crossarms supporting conductors of 7500-20,000 volts next above the level of conductors of 7500 volts or less;

Crossarms supporting conductors of 7500-20,000 volts below the level of conductors of 7500 volts or less; and

Crossarms supporting any conductor of more than 7500 volts within 15 feet of walls, fire escapes, exits, windows and similar objects.

Where all conductors on a latticed metal pole which is guarded carry more than 7500 volts and the lowest crossarm supporting them is not required to be marked in accordance with the foregoing provisions of this rule, the entire pole shall be marked as high voltage by means of signs placed on any two opposite sides of the pole at a point above the barrier and below the lowest conductor level.

(4) On Systems Using Combination Arms: On systems where conductors of 0-750 volts and conductors of 750-7500 volts are usually carried on the same crossarms, any crossarm supporting conductors of 750-7500 volts on both sides of a pole shall be marked as high voltage on both portions to show that the entire crossarm carries high voltage conductors.

C. Crossarms Supporting Conductors of 750-7500 Volts and Conductors of 750 Volts or Less. (Combination Arms)

(1) High Voltage Marking: Combination arms shall be marked as high voltage on the portions supporting conductors of 750-7500 volts. Where painting is used as the method of marking on such portions of combination arms, the painting shall extend from the ends of the arms to the center line of pole, or to a position approximately midway between the nearest conductors of different voltage classifications on alley arms or bridge arms.

(2) Marking of Conductors of 750 Volts or Less: On systems where the use of combination arms is so unusual that the requirements of Rule 52.4-B4 are not applied, all combination arms shall be marked as high voltage as specified in Rule 52.4-C1 and in addition thereto a readily legible designation shall be placed on the portions supporting conductors of 750 volts or less. Such designation shall read "0-750 Volts" or shall indicate the nominal voltage of the circuits of 750 volts or less and shall not read "Low Voltage."

The requirements of this rule do not apply to conductor supporting timbers on transformer structures on systems where no other combination arms are used.

Note. The gradual expansion of the use of combination arms on a system will cause the requirements of Rule 52.4-B4 to become applicable to the entire system.

D. Crossarms Supporting Miscellaneous Equipment

Included in this group are arms supporting transformers, cutouts, regulators, oil switches, air switches, capacitors, series controllers, and similar apparatus which are connected to or are a part of a circuit in excess of 750 volts. These arms shall be marked in accordance with methods specified in Rule 52.4-A.

(1) Hanger Arms, Cutout Arms, Etc.: Where yellow paint is used as the method of marking, such arms shall be fully painted except as provided in Rule 52.4-C1.

Where high voltage signs are used as the method of marking, they are required on the face toward the climbing space of hanger arms or of arms supporting cutouts, excepting that signs are not required on any arm supporting cutouts only where such cutout arm is within 30 inches vertically from either a line arm or a hanger arm which is marked as high voltage.

Where high voltage signs are used as the method of marking, they are not required on the face away from the climbing space of hanger arms which do not support line conductors or of arms supporting cutouts only or of line arms which are not combination arms and which are used as hanger arms, under any of the following conditions:

Where two or more transformers, regulators, or similar pieces of apparatus are supported on the same arm;

Where one or more transformers and one or more oil switches or air switches are supported on the same arm;

Where one or more constant current transformers or regulators and the accompanying series controller are supported on the same arm;

Where one transformer and one or more primary cutouts used in connection therewith are supported on the same arm providing the conductors leading to these pieces of apparatus are supported on crossarms immediately adjacent thereto (maximum vertical separation of 30 inches) which are marked as high voltage; or

Where a separate arm used to support cutouts only is within 30 inches vertically from either a line arm or a hanger arm which is marked as high voltage.

(2) Heel Arms: Heel arms, while treated in these rules as supporting high voltage equipment, are not required to be marked as high voltage.

E. Exceptions

(1) Double Arms: Where high voltage signs are used as the method of marking, they are not required on the inside faces of double arms.

(2) Brackets: Where extension brackets or clearance brackets are used to extend or supplement crossarms, and support conductors of more than 750 volts, such supplementary supports are not required to be marked as high voltage.

52.5 Metal Arms

Metal crossarms on wood poles shall not be used to support conductors of both 750-7500 volts and more than 7500 volts.

A. Supporting Conductors of 0-7500 Volts

Metal crossarms installed on wood poles and supporting conductors of 0-7500 volts shall not be permanently grounded and shall be proven by test to be nonenergized immediately preceding each period of work at that location. Metal crossarms at the location of work on de-energized conductors shall be temporarily and securely grounded and securely connected to any de-energized conductors involved during the time of all work at that location.

B. Supporting Only Conductors of More Than 7500 Volts

Metal crossarms installed on wood poles and supporting conductors of more than one circuit of more than 7500 volts shall be effectively grounded or, in lieu of this requirement, such crossarms supporting such energized conductors at the location of work on other de-energized conductors shall be connected to the de-energized conductors and securely grounded during the period of work.

52.6 Clearance Arms (see Rules 20.9-C, 32.3 and 54.8-C2)

52.7 Hardware

A. Protection Against Corrosion (see Rule 49.8)

B. Metal Braces

(1) For Wood Crossarms: Metal crossarm braces on wood crossarms shall be not less than 1½ inches from lead wires, ground wires, and bond wires (except as provided in Rule 53.4), metal pins and other insulator hardware, switch and cut-out hardware, conduits and fittings of riser cables and cable runs, and metal braces which extend to a crossarm at another conductor level; except that on wood crossarms supporting conductors of only one circuit of more than 7500 volts, metal crossarm braces may contact bond wires, metal pins and other insulator hardware where such contact is intentionally and securely made and the lower extremity of such metal braces is not less than 3 feet above the next conductor level below such braces.

Metal crossarm braces attached to wood arms shall clear transformer cases and hangers by not less than 1 inch of air space and by not less than 1½ inches of creepage distance along wood or insulating surfaces.

(2) For Metal Crossarms: The lower extremities of metal crossarm braces attached to metal crossarms on wood poles shall be not less than 3 feet above the next conductor level below such braces. See Rule 52.5 for the grounding of metal arms.

C. Separation From Bond Wires and Ground Wires

Bond wires and ground wires shall have a clearance of not less than 1½ inches from metal pins, bolts, and other hardware on wood crossarms except where the hardware is intended to be connected to the bond or ground wires, and in being so connected does not violate other rules of this Order, in which case suitable electrical contact shall be made.

D. Separation From Metal Pins and Dead-End Hardware

Through bolts, metal signs, conduits, metal braces, mounting bolts and hardware for cutouts or other apparatus, metal street light fixtures, metal pole top extensions and metal arm extensions supported by or attached to the surfaces of wood poles and wood crossarms shall have a clearance of not less than 1½ inches from metal pins and dead-end hardware. Guys and space bolts shall have a clearance of not less than 1½ inches from metal pins and dead-end hardware unless contact is intended, in which case a positive electrical contact shall be made. Any guy contacting or connected to a metal pin or part of dead-end hardware shall not be placed in the climbing space.

Bolts and hardware of line equipment and bolts and hardware of insulators, all of which are associated with the same circuit, and on the same crossarm may be metallically interconnected provided positive electrical contact is made.

This rule 52.7-D shall not be held to apply to:

(1) Through bolts, metal braces or space bolts and dead-end hardware associated with circuits of 0-750 volts in any configuration at any level on a pole or structure;

(2) Through bolts or space bolts and dead-end hardware associated with circuits of 750 to 7,500 volts in any configuration at any level on a pole or structure, provided that the end of such bolts which project into a climbing space are covered with a suitable non-conducting shield or cover having the insulating efficiency and mechanical strength of impregnated fibre 5/16 inches thick;

(3) Through bolts or space bolts and dead-end hardware associated with circuits of more than 7,500 volts in any configuration at any level on a pole or structure provided that the ends of such bolts which project into a climbing space are covered with a suitable non-conducting shield or cover as described above: with this exception that no covers shall be required if the bolts are associated with a single circuit constructed in vertical, flat, or triangular construction at the top level of a pole.

E. Metal Back Braces

The use of metal back braces is not recommended. (See Rule 54.7-A3 for climbing space requirements.)

F. Grounding

(1) Circuits of 0-7500 Volts: On wood crossarms, wood poles, or wood structures, hardware which is less than 3 feet above or 6 feet below unprotected conductors of 0-7500 volts shall be nongrounded. Excepted from the requirements of this rule are the following:

Hardware of riser terminals treated as specified in Rule 54.6-F;

Hardware associated with grounded cables and messengers supported on crossarms with vertical clearances and pole clearances as specified in Tables 1 and 2 for such cables and messengers; and

Hardware associated with guarded cables and messengers which are treated as specified in Rule 57.4-F.

(2) Circuits of More Than 7500 Volts: Hardware of circuits of more than 7500 volts shall be securely and permanently grounded where such hardware can act as a bond between metal parts of the insulating supports of an energized conductor and of a de-energized portion of the same conductor or of the de-energized portion of another conductor where work is to be performed on the de-energized conductor. Such hardware includes the bases of air-break switches and the tanks of oil switches. Bond wires are excepted from this requirement, and are not required to be grounded.

The permanent grounding specified in this rule will not be required provided the regular written operating (safety) rules of the utility concerned require that:

Conductors of circuits exceeding 7500 volts which are de-energized for work thereon shall be securely grounded during all periods of such work, and

When work is to be performed at the location of hardware described in this rule, such hardware shall be temporarily and securely grounded and securely connected to any de-energized conductors involved during all work at that location, or in lieu of temporary grounding such hardware shall be proven by test to be nonenergized immediately preceding each period of work at that location.

(3) Transformer Cases and Hardware: See Rule 58.3-C3.

53. PINS, DEAD ENDS, CONDUCTOR SUSPENSIONS AND FASTENINGS

53.1 Maintenance and Inspection (see Rules 31.1 and 31.2)

53.2 Material and Strength (see Rule 49.3)

53.3 Pin, Dead End, and Suspension Spacing (Table 1, Case 8, and Table 2, Case 15)

53.4 Bonding

Bonding is not required by these rules. Bonding is not recommended for circuits of 7500 volts or less but it is recognized that under certain conditions it may be deemed necessary.

Where bonding is used the bond wire or strap shall have a conductivity of not less than No. 10 AWG copper wire, shall in no case be installed on the top surface of any crossarm, and the bonding shall comply with the following requirements:

A. Circuits of More Than 7500 Volts

(1) At Top of Pole:

a) Single Circuit: The bond wire of a single circuit in horizontal, triangular or vertical configuration at the top circuit position of the pole may be installed on the face, back or underside of wood crossarms and on the surface of pole without a protective covering. Such bond wire on the surface of a wood pole shall be covered by a suitable protective covering (see Rule 22.2) where within 3 feet vertically of the next conductor level below the top circuit. Crossarm braces may be connected to such bond wire only where positive electrical contact is made and the brace is not less than 3 feet vertically above the next conductor level below the top circuit.

b) More Than One Circuit: The bonding of any circuit where more than one circuit is installed at the top position of pole shall be in accordance with the provision of Rule 53.4-A3 below.

(2) Below Top of Pole: Bond wires of any circuit below the top circuit position of the pole shall be covered by a suitable protective covering (see Rule 22.2) except where such bond wires are installed on the underside of crossarms or where bonds (wires or straps) are installed vertically between crossarms at a distance of not less than 30 inches from center line of pole. Metal braces shall clear such bond wires by not less than 1½ inches (see Rules 52.7-B1 and 52.7-C) and in order to clear braces, an uncovered bond wire carried on the under side of crossarm may be placed on the face or back of a limited portion of crossarms and need not be covered for this limited distance of its run.

The requirement that portion of bond wire, which extend from the under side of one crossarm of a double arm to the underside of a companion arm of the double arm, be covered by a suitable protective covering may be omitted provided such portions of bond wires are approximately perpendicular to the arms, extend directly between arms and are not less than 30 inches from center line of pole.

(3) Conductors of More Than One Circuit at Same Level: Where conductors of more than one circuit are at the same level, bond wires shall be covered by a suitable protective covering (see Rule 22.2) except where such bond wires are installed on the

under side of crossarms or where bonds (wire or straps) are installed vertically between crossarms at a distance of not less than 30 inches from center line of pole. Metal braces shall clear such bond wires by not less than 1½ inches (see Rules 52.7-B1 and 52.7-C) and in order to clear braces, an uncovered bond wire carried on the under side of crossarms may be placed on the face or back of a limited portion of crossarms and need not be covered for this limited distance of its run.

Bond wires, that extend from the under side of one arm to the companion arm of a double arm, shall be exempt from the required protective covering specified by this rule provided such wires are substantially perpendicular to the arms, extend directly between the arms, and are not less than 30 inches from the center of the pole.

a) Separately Bonded Circuits: Where conductors of more than one circuit are at the same level and separately bonded, such bond wires shall be separated on crossarm and on surface of pole by not less than 6 inches. Neither circuit shall be worked on while de-energized unless the de-energized conductors are shorted and securely grounded and the bond wire of the de-energized circuit is connected to the de-energized and grounded conductors on the pole where work is done.

b) Commonly Bonded Circuits: Where conductors of more than one circuit are at the same level and a common bonding system is used, neither circuit shall be worked on de-energized unless the de-energized conductors are shorted and securely grounded and connected to the bonding system on the poles where work is done.

B. Circuits of 7500 Volts or Less

The bonding of circuits of 7500 volts or less shall comply with the following:

Bond wires on wood poles and wood crossarms shall be fully covered by a suitable protective covering;

Bond wires shall be not less than 1½ inches from metal braces and all other hardware except the metal pins and dead ends which are bonded; and

Bond wires of separate circuits shall be separated on crossarm and poles by not less than 3 inches.

54. CONDUCTORS

54.1 Definition (see Rule 20.8)

54.2 Maintenance and Inspection (see Rule 31.1 and 31.2)

54.3 Material and Strength (see Rule 49.4)

54.4 Clearances

Allowable variations in clearances due to side swing of suspension insulators, temperature, loading, etc., are given in Rules 37 and 38.

A. Above Ground

The minimum vertical clearances shall be those specified in Rule 37, Table 1, with the following modifications:

(1) Across Arid or Mountainous Areas: Across arid or mountainous areas supply circuits carrying 20,000-30,000 volts, inclusive, may have a clearance of less than 30 feet (Table 1, Case 4, Column F) but not less than 25 feet above ground subject to a reduction of not more than 10 per cent because of temperature and loading as specified in Rule 43. Upon special permission from this Commission, a minimum clearance of 25 feet above ground may be applied in similar areas to circuits in excess of 30,000 volts, in which case no reduction of the 25 feet will be permitted for conditions less than maximum loadings or temperature specified in Rule 43.1 and 43.2.

(2) In Rural Districts, Conductors of 750-20,000 Volts:

a) Crossing Roads or Driveways: In rural districts the minimum clearance of 25 feet specified in Table 1, Case 3, Column E may be reduced to 22 feet above ground for conductors crossing or overhanging traversable portions of public or private roads or driveways. This modified minimum clearance of 22 feet shall in no case be reduced because of temperature or loading at conditions less than the maximum loadings or temperature specified in Rules 43.1 and 43.2.

b) Above Agricultural Areas and Along Roads: In rural districts the minimum clearance of 25 feet specified in Table 1, Case 4, Column E may be reduced to 18 feet above ground for lines across areas capable of being traversed by agricultural equipment and along roads where no part of the line overhangs any traversable portion of a public or private roadway. This modified minimum clearance of 18 feet shall in no case be reduced because of temperature or loading at conditions less than maximum loadings or temperature specified in Rules 43.1 and 43.2. Care should be exercised in using this minimum clearance along roads, above or along ditches where mechanical devices are used for maintenance, near trees in orchards, near trees or structures which can be climbed and in other similar situations.

(3) Lead Wires for Transformers: Transformer lead wires shall have clearances above ground as specified in Table 1 except as modified by the provisions of Rule 58.3-B1a.

(4) Above Swimming Pools: Crossings of conductors above swimming pools shall be avoided where practicable. Unprotected line conductors shall have radial clearances from the top edge of the swimming pool walls and vertical clearances above the highest water level of the pool surface not less than the clearances specified in Table 1, Case 3, Columns D, E and F.

B. Above Railways and Trolley Lines

(1) Which Transport Freight Cars: The clearances specified in Table 1, Case 1, are based upon a maximum height of standard freight cars of 15 feet 6 inches from top of rail to top of running board. The clearance specified in Table 1,Case 1, Column C shall not be reduced because of temperature or loading. The clearance specified in Table 1, Case 1, Columns A, B, D, E and F, shall not be reduced more than 5%, because of temperature or loading.

(2) Operated by Overhead Trolley: The clearances specified in Table 1, Case 2, Columns D, E, and F are based upon a trolley pole throw of 26 feet, the usual maximum height of a free trolley pole

above the top of rails or surface of streets used by trolley cars or coaches. Above trolley lines having a maximum trolley pole throw at variance to 26 feet, the specified clearances shall be increased or may be reduced accordingly provided that the clearances specified in Column F shall not be reduced to less than 30 feet and the clearances specified in Columns D and E shall not be reduced to less than 25 feet. See Rule 57.4-B2 for the clearances required for grounded cables and messengers.

Where railways operated by overhead trolley transport freight cars, the clearance requirements of Rule 54.4-B1 also apply.

C. Between Conductors

The minimum allowable clearances between conductors are specified in Rule 38, Table 2, with the following modifications for supply conductors: These modifications, like the tabular values, are also subject to the allowable variations specified in Rule 38.

(1) On Different Crossarms on the Same Pole:

a) Conductors of 750-7500 Volts: The 4-foot vertical clearance between conductors of 750-7500 volts, as specified in Table 2, Case 10, Column E, may be reduced to not less than 2 feet, provided all of the following conditions are met:

The conductors involved are of one ownership and the circuits are operated and maintained by the same crews of workmen;

Under no conditions is this reduced clearance to be applied in new construction involving new poles;

Buck arm construction, transformers, or capacitors are not involved;

More than one reduced clearance of 2 feet shall not be used on any pole; and

It is not practicable to obtain the normally required 4-foot clearance.

b) Conductors of 7500-20,000 Volts: The 4-foot vertical clearance between conductors of 7500-20,000 volts, as specified in Table 2, Case 11, Column F, may be reduced to not less than 3 feet, provided all of the following conditions are met:

The conductors involved are of one ownership and the circuits are operated and maintained by the same crews of workmen;

Under no conditions is this reduced clearance to be applied in new construction involving new poles;

Buck arm construction, transformers, or capacitors are not involved;

More than one reduced clearance of 3 feet shall not be used on any pole; and

It is not practicable to obtain the normally required 4-foot clearance.

c) Triangular and Vertical Configuration: Crossarms used to support conductors of a circuit at different levels (as in triangular or vertical configuration) need not be spaced as in Table 2, Cases 9 to 13, but may be arranged so that the vertical separation of conductors of the same circuit shall be not less than the pin spacings of Table 2, Case 15.

Rule 54.4-D8 applies for pole-top triangular construction involving one circuit.

Where circuits are installed in vertical or triangular configuration with vertical conductor separations less than as specified in Table 2, Cases 9 to 13, not more than two circuits shall be installed on the same crossarms and the conductors of both circuits shall be arranged in identical physical configuration on opposite sides of pole except at points of transposition. In the event different voltage classifications are involved, the vertical separation of the conductors shall be not less than the pin spacing for the highest voltage concerned.

(2) On Related Line and Buck Arms:

a) One Voltage Classification*: The clearances of Table 2, Case 14 (and clearances less than as specified in Cases 9 to 13) shall not be applied consecutively both above and below the same conductor. The foregoing provisions of this rule do not apply to conductors in triangular or vertical configuration, the clearances of Table 2, Case 14 being directly applicable.

Where conductors of one voltage classification only are supported on the same crossarms, the vertical clearances specified in Table 2, Case 14, are not required between conductors on line arm and conductors on related buck arm provided no conductors on the line arm cross conductors of different phase or polarity on the buck arm.

*Voltage classifications for this purpose are:
0-750 volts,
750-7500 volts,
7500-20,000 volts, and
20,000 volts and above.

b) Combination Arms: Where conductors of 0-750 volts and conductors of 750-7500 volts are supported on the same crossarms with the nearest conductors of the two classifications separated a horizontal distance of not less than 36 inches (plus any necessary vacant pin spaces required by Rule 54.7-A3c) the vertical separation between conductors on such a line arm and conductors on a related buck arm shall be not less than 4 feet. This vertical separation may be less than 4 feet but not less than 2 feet provided the horizontal separation of conductors of the two classifications is not less than 42 inches (plus any necessary vacant pin spaces required by Rule 54.7-A3c) and all conductors of the same voltage classification are supported on the same ends of the crossarms.

Where this vertical separation of 2 feet (or less than 4 feet but more than 2 feet) between conductors on a line arm and related buck arm is utilized, any conductor on such line or buck arm shall have a vertical clearance from any other conductor level of not less than clearances specified in Table 2, Cases 8 to 13.

(3) On the Same Crossarms:

a) Different Voltage Classifications: Supply conductors of different voltage classifications may be supported on the same crossarms in conformity with the requirements of Rule 32.4.

b) On Brackets Attached to Crossarms: Line conductors supported on brackets or extensions attached to crossarms shall be maintained outside of the outer pin position on the crossarm with a radial separation not less than the minimum pin spacing specified in Table 2, Case 15, from any other line conductors supported by the same arm. Line conductors supported on such brackets or crossarms extensions shall be of the same voltage classification as the conductors supported on the same side of pole by the crossarm to which the bracket or arm extension is attached. The vertical clearances specified in Table 2, Cases 1 to 14 shall be provided between the conductor on the bracket and the conductor level of any other conductors not supported on the crossarm to which the bracket is attached.

c) Same Phase or Polarity: The clearances specified in Table 2, Cases 15 and 17, are not required between conductors of both the same potential and the same phase or polarity.

(4) Dead Ended on Pole in Vertical Configuration:

a) Conductors of 750 Volts or Less: Where conductors of 750 volts or less are supported in vertical configuration directly on a pole without the use of crossarms, the requirements for rack construction, Rule 54.9, shall apply.

b) Conductors of More Than 750 Volts Supported on Climbable Poles: Where conductors of more than 750 volts are supported in vertical configuration directly on a climbable pole without the use of crossarms at line terminations, angles or corners, the following requirements apply:

The vertical separation between conductors of the same circuit shall be not less than the pin spacings specified in Table 2, Case 15;

The vertical separation between conductors of different circuits shall be not less than the clearances specified in Table 2, Cases 8 to 13, inclusive;

Not more than two conductors of a circuit of 750-5000 volts shall be supported directly on a pole in vertical configuration without the use of crossarms. The number of conductors of a circuit of more than 5000 volts so supported is not limited. Branch circuits may be taken from such construction without the use of crossarms provided a climbing and working space as specified in Rule 54.7 is maintained; and

The clearance of conductors from surface of pole shall be not less than as specified in Rule 54.4-D6b.

See Rule 54.7-A1 for climbing space requirements for conductors dead ended on poles in vertical configuration.

c) Conductors of More Than 750 Volts Supported on Non-Climbable Poles: Where conductors of more than 750 volts are supported in vertical configuration on non-climbable poles in partial underground distribution at line terminations, angles, or corners, the following requirements apply:

Not more than three conductors of a single circuit of 750-20,000 volts shall be supported directly on the pole in vertical configuration without the use of crossarms. Branch circuits may be taken from such construction without the use of crossarms provided that conductors are supported on not more than three sides of the pole, there being four sides (see App. G, Fig. 88);

The vertical separation between conductors shall be not less than the pin spacings specified in Table 2, Case 15;

The clearance of conductors from surface of pole shall be not less than as specified in Rule 54.4-D2.

(5) Rack Construction: See Rule 54.9

(6) From Lead Wires and Drip Loops to Other Conductors: The vertical clearances between the lowest point of lead wires (to conduit runs, transformers or other equipment), excepting drop wires to street lights, and the next supply conductor level below such lead wires may be less than the clearances specified in Table 2, Cases 9 to 12, Columns D, E, F and G, provided the vertical separation is maintained as great as practicable and in no case less than the following:

Voltage of lead wires	Minimum distance above other conductor level
0-750	12 inches
750-7500	18 inches
7500-20,000	24 inches
20,000-35,000	36 inches

(7) Voltages of More Than 68,000 Volts:

a) Crossing or Colinear with Wires or Cables of Other Lines: The clearances specified in Table 2, Column I, Cases 1 to 7 inclusive, for conductors of more than 68,000 volts crossing or colinear with conductors, guys and messengers which are not supported on the same poles, shall be increased by ½ inch for each kilovolt above 68 kv.

b) Supported on the Same Structure: The vertical separation between conductors on line arms and conductors on related buck arms (Table 2, Column I, Case 14) and the horizontal separation of conductors on crossarms (Table 2, Column I, Case 15) shall be increased ½ inch for each kilovolt above 68 kv.

D. From Poles

The basic minimum clearances of conductors from center line and surface of poles are specified in Table 1, Cases 8 and 9. Modifications of these basic clearances are specified in Rule 37 and by the following provisions:

(1) Center Line Clearance At Angles In Lines: The clearance specified in Table 1, Case 8 may be reduced at angles in lines where it is necessary to support conductors on the side of insulators placed on pole-pins, provided the distance between the center of any such pole-pin and the center line of the crossarm through bolt is not less than the distance specified in Table 1, Case 8. This Rule 54.4-D1 shall not be held to permit any greater reduction of climbing space widths than that specified in Rule 54.7-A2 for line angles.

(2) Center Line Clearances For 750 Volts and Above: The clearances referred to in Table 1, Case 8, Columns E and F, apply as follows with respect to voltage:

750-7500 volts	15 inches
7500-46,000 volts	18 inches
46,000 volts and above	18 inches plus ¼-inch per kv in excess of 46 kv.

These clearances from center line of pole need not apply to conductors of 750-7500 volts and 7500-20,000 volts supported in vertical or triangular configuration in partial underground distribution provided: a) such conductors have clearances from surface of pole of not less than 6 inches, and b) in dead-end construction conductors so supported are not attached to more than three sides of a pole (there being four sides, see App. G, Fig. 88).

(3) Conductors Passing and Unattached: The center-line clearance between poles and conductors which pass unattached shall be not less than 1½ times the clearance specified in Table 1, Case 8, except where the interset pole is within 10 feet of a pole to which the passing conductors are attached. Where poles of the two lines are less than 10 feet apart, clearances not less than as specified in Table 1, Case 8, shall be maintained between the center line of any pole and conductors which pass unattached.

This rule will often necessitate the use of clearance crossarms with conductor clearances as specified in Table 1, Case 8, or the alternate increased clearances for service drops as provided in Rule 54.8-C3.

(4) Longitudinal Cables and Messengers: Messengers and longitudinal supply cables, treated as required in Rule 57.4-F, may be attached to the surface of pole and thus have clearances less than as specified in Table 1, Cases 8 and 9, Column D.

(5) Rack Construction For 0-750 Volts: Conductors of 0-750 volts in rack construction may be attached to poles with clearances less than 15 inches and 3 inches as specified in Table 1, cases 8 and 9 respectively, provided such construction complies with the provisions of Rule 54.9 and such conductors, not including their tie wires, shall have a clearance of not less than 2½ inches from surface of pole.

(6) Dead Ended on Pole:

a) 0-750 Volts: Where conductors of 0-750 volts are dead ended on a pole in vertical configuration, the clearances specified for rack construction, Rule 54.9-B1, shall apply.

b) More Than 750 Volts Supported on Climbable Poles: Where conductors are dead-ended on a climbable pole in vertical configuration, the energized portions of such conductors shall have clearances of not less than 15 inches from the surface of pole for voltages between 750 and 7500 volts and 18 inches from surface of pole for voltages in excess of 7500 volts. Where conductors of more than one circuit are dead-ended on a pole in vertical configuration, increased pole clearances are required as follows:

All energized portions of conductors of a circuit dead ended in vertical configuration below any other circuit on a pole shall be maintained at a clearance of not less than 2 feet from the surface of the pole for conductors of 750-7500 volts and not less than 3 feet from the surface of the pole for conductors of more than 7500 volts; and

Not more than two conductors of a circuit of 750-5000 volts shall be attached directly to a pole in vertical configuration without the use of crossarms. The number of conductors of a circuit of more than 5000 volts so supported on a pole is not limited. Branch circuits may be taken from such construction without the use of crossarms provided a climbing and working space as specified in Rule 54.7 is maintained.

The clearance of not less than 18 inches between surface of pole and conductors in excess of 7500 volts, specified in Rule 54.4-D6b, and the climbing space specified in Rule 54.7-A1, need not apply to supply circuits in excess of 7500 volts supported in vertical configuration in the top circuit position on poles where conductors of such circuits are not supported on crossarms and where no branch circuit exists at this level, provided the energized portion of such circuits have clearances from center line of pole which are not less than those specified in Rule 54.4-D2, and provided climbing spaces of not less than the minimum dimensions of those in Exhibits E and C of First Supplemental Application are maintained, and further provided that a minimum vertical clearance of 6 feet shall be maintained between the lowest conductor of the top circuit and the nearest conductor of the next circuit below.

c) More Than 750 Volts Supported On Non-Climbable Poles: Where conductors are dead-ended on a non-climbable pole in partial underground distribution, the energized portions of such conductors shall be not less than 6 inches from surface of pole (see Rule 54.4-D2).

(7) Dead Ended In Horizontal Configuration: The basic clearance of Table 1, Case 8, Column D, and clearances specified in Rule 54.4D7a shall not be held to apply to the middle conductor of a single three wire 0-750 volt circuit dead ended in horizontal configuration.

a) 750-7500 Volts (see App. G, Figs. 13 and 14): A conductor of a circuit of 750-7500 volts in horizontal configuration on a crossarm may be dead ended (at conductor terminations, angles, corners and for change in conductor size) in line with the center line of pole or in line with a distance from center line of pole less than the 15 inches specified in Table 1, Case 8, provided:

Where the circuit concerned is supported on a line arm only (with no related buck arm present) a conductor is so dead ended in one direction only with climbing space maintained on the opposite side of the pole and with the energized portions of the conductor so dead ended maintained at a clearance of not less than 15 inches from center line of pole;

In corner construction a conductor is so dead ended in one direction only from the line arm and one direction only from the buck arm with the energized portions of conductors so dead ended maintained at a clearance of not less than 15 inches from the surface of the pole and required climbing space maintained (see Rule 54.7); and

Where a conductor is so dead ended with a line arm and related buck arm present, no transformer or other apparatus carried on the pole is connected to the circuit concerned.

b) More Than 7500 Volts (see App. G, Fig. 14): A conductor of a circuit of more than 7500 volts in horizontal configuration on a crossarm may be dead ended (at conductor terminations, angles, corners and for change in conductor size) in line with the center line of pole or in line with a distance from center line of pole less than the 18 inches specified in Table 1, Case 8, provided:

Where the circuit concerned is supported on a line arm only, except at the top of a pole under the provisions of Rule 54.4-D8b, a conductor is so dead ended in one direction only with climbing space maintained on the opposite side of the pole and with the energized portions of the conductor so dead ended maintained at a clearance of not less than 18 inches from the center line of pole;

In corner construction a conductor is so dead ended in one direction only from the line arm and one direction only from the buck arm with the energized portions of conductors so dead ended maintained at a clearance of not less than 18 inches from the surface of the pole and required climbing space maintained (see Rule 54.7); and

Where a conductor is so dead ended with a line arm and related buck arm present, no transformer or other apparatus carried on the pole is connected to the circuit concerned.

(8) At Top of Pole:

a) 0-7500 Volts in Triangular Configuration: A single conductor of a circuit of 0-7500 volts may be attached at the top of a pole provided the other conductors of the same circuit are on a crossarm and are not less than 2 feet vertically below the level of such single conductor, except that such a 2-foot vertical separation is not required for dead-ended conductors conforming to provisions of Rule 54.4-D7a.

Where this triangular configuration is used, all conductors of other circuits on crossarms on the pole shall be not less than 4 feet below the level of the lower conductors of the pole-top circuit and conductors of 0-750 volts in rack construction shall conform to the requirements of Rule 54.9-E.

b) More Than 7500 Volts: A single conductor of a circuit of more than 7500 volts may be attached directly to the top of a pole or to a crossarm at the top of a pole at a distance less than as specified in Table 1, Case 8, provided no transformer or other apparatus (excepting pole-top switches or lightning arresters) carried on the pole is connected to the circuit so arranged.

Where this construction is used, all conductors of other circuits on the pole shall be not less than 6 feet below the pole-top conductor except that in rural districts the conductors of a 0-750 volt secondary circuit may be not less than 4 feet below the conductor level of such a primary circuit by means of which the secondary is supplied.

The dead ending of a conductor at top of pole under these provisions is optional with dead ending under the requirements of Rule 54.4-D7b.

(9) Lateral and Vertical Conductors: Unprotected lateral and vertical conductors (excepting ground wires installed as specified in Rule 54.6-B, bond wires installed as specified in Rule 53.4, and suitably insulated conductors of 0-750 volts entering terminal fittings mounted on the surface of poles as specified in Rule 54.6-F) shall not be attached to the surface of poles, but shall be

supported on crossarms or other supports and arranged to maintain the specified clearances from poles, towers or structures and other conductors (Table 1, Cases 8 and 9, and Table 2, Cases 15, 16, and 17), and to maintain the climbing and working spaces as required in Rule 54.7. In lieu of the foregoing, lateral and vertical conductors may be installed on the surface of poles provided the conductors are suitably insulated and protected as specified in Rule 54.6.

E. From Crossarms

The minimum distances of unprotected conductors from the surface of crossarms are specified in Table 1, Case 9. These clearances from the surface of crossarms are not required for suitably insulated conductors in runs which are protected as specified in Rule 54.6-C or for suitably insulated conductors where entering such protected runs.

Lead wires of 0-5000 volts may be less than 3 inches, but shall be not less than 1 inch, from the surface of crossarms where equipment (cutouts, switches, etc.) mounted on the crossarms is so constructed that clearances of less than 3 inches are necessary for the entrance of such leads to the equipment.

F. From Guys and Messengers (see Table 2, Column A, Rule 56.4-C and Rule 57.4)

G. From Grounded Metal Boxes and Equipment

On wood poles or structures, all grounded metal boxes and grounded metal cases for equipment shall be not less than 3 feet above or 6 feet below the level of unprotected supply conductors, excepting street light drop wires which are not less than the distances specified in Rule 92.1-F5 from the messengers, conductors or metal boxes therein mentioned. Where it is impracticable to obtain a clearance of at least 6 feet below unprotected supply conductors of 750 volts or less, a clearance of not less than 4 feet below such conductors will be permitted if a protective covering or guard is provided above such metal box or case.

This requirement does not apply to bends and terminals of risers or runs, which shall be treated as specified in Rule 54.6-F, nor to certain transformer cases as provided in Rule 58.3-C3, nor to the cases of oil switches treated as specified in Rule 52.7-F2.

Metal conduit boxes and fittings of runs or risers shall be treated in accordance with the provisions of Rules 54.6-D, E and F.

H. Above or Along the Sides of Buildings, Bridges and Other Structures

(1) Unattached Conductors: Conductors shall be so arranged as to hamper and endanger firemen and workmen as little as possible in the performance of their duties. The basic clearances of conductors from buildings are specified in Table 1, Cases 6 and 7. The requirements of Table 1, Case 7, also apply at fire escapes, exits, windows, etc., at which human contact may be expected.

Where the vertical distance above ground of conductors of 7500 volts or less is in excess of 35 feet, the horizontal clearance from buildings may be less than 6 feet (Table 1, Case 7, Column E) but shall be not less than 4 feet. See Rule 54.8-B4 for service drop clearance requirements.

For special treatment of bus and lead wires of transformer installations in alleys, etc., see Rule 58.3-B2.

(2) Attached Conductors: Unprotected conductors not exceeding 20,000 volts may be supported by attachments to buildings, bridges and other structures. To conductors of 0-750 volts so supported, the clearances of Table 1, Case 7, Column B, C and D shall apply. To conductors of 750-20,000 volts so supported a minimum horizontal clearance of 8 feet shall apply.

In lieu of these requirements for unprotected conductors, supply conductors may be installed on the surface of buildings, bridges and other structures in grounded metal conduit or other grounded sheath or grounded shield suitably protected from mechanical injury.

I. Under or Through Bridges, Viaducts or Similar Structures

Unprotected supply conductors which pass unattached under bridges, viaducts or other structures shall be maintained at clearances above ground and walkways as specified in Table 1, Cases 1 to 6 incl.; at clearances from walls and underneath parts of such structures as specified in Table 1, Case 7; and at clearances from conductors of other classifications as specified in Table 2, Case 3.

Conductors of 0-20,000 volts, passing under or through bridges, viaducts or similar structures, may be attached thereto in accordance with the provision of Rule 54.4-H2. Warning signs of a substantial character with letters not less than 3 inches in height reading "High Voltage" for voltages in excess of 750 volts shall be placed conspicuously on each crossarm or structural member supporting the conductors.

In lieu of these requirements for unprotected conductors, supply conductors which cross under bridges, viaducts or other structures shall be enclosed in grounded metal conduit or in other effectively grounded sheath or grounded shield suitably protected from mechanical injury.

54.5 Sags

Minimum conductor sags shall be such that, under the loading conditions specified in Rule 43, the safety factor specified in Table 4, Rule 44, shall be met. See Charts in Appendix C for suggested sags at normal temperatures.

54.6 Vertical and Lateral Conductors

A. Unprotected Conductors (see Rule 20.8-D for definition)

Unprotected conductors from one level on a pole or structure to another level shall not pass within the climbing space; shall not pass within the working space, except as permitted by Rule 54.7-B2; shall not pass between the conductors of any other circuit; except between pole pin conductor positions; and shall clear the conductors of other circuits by distances not less than the following:

Highest voltage classification of conductors concerned	Minimum radial distance between conductors
0-5000 volts	11½ inches
5000-7500 volts	17½ inches
7500-20,000 volts	24 inches
20,000 volts and above	36 inches

Where the distance between levels is in excess of 12 feet and unprotected conductors pass between the pole-pin conductor positions of any other circuit, additional supports shall be installed so that the maximum length of conductor between supports is not more than 12 feet.

The clearances in the above tabulation do not apply between taps in buckarm construction, the clearances specified in Table 2, Case 16 being directly applicable.

For clearances between street light drop wires and cables, other conductors and metal boxes, see Rules 58.2-B3 and 92.1-F5.

B. Ground Wires

Ground wires shall have a conductivity and mechanical strength at least equal to that of No. 8 AWG medium-hard-drawn copper wire; they shall not be installed on the top surfaces of crossarms; and they shall have clearances of not less than 1½ inches from hardware in accordance with the provisions of Rules 52.7-B and 52.7-C.

Ground wires attached to or run on the face, back or underside of wood crossarms or on the surface of wood poles and structures shall be covered throughout their length by a suitable protective covering (see Rule 22.2), excepting that ground wires of 0-750 volt circuits or equipment are not required to be covered where installed on the underside of crossarms or the portions of crossarms supporting 0-750 volt conductors.

Ground wires of common neutral systems are specially required to comply with the provisions of Rules 59.3-C and 59.4 in addition to the provisions of this Rule 54.6-B.

Ground wires connected to overhead lightning-protection wires installed on poles or crossarms supporting only circuits of more than 35,000 volts need not be covered by a suitable protective covering above the level of 8 feet from the ground provided (1) said lines are situated in rural areas; (2) the ground wires have mechanical strength not less than that of #4 solid soft-drawn bare copper wire; and (3) the ground wires conform to the requirements of Rule 49.4-A with respect to the use of corrosion-resisting material.

C. Lateral Conductors

(1) Conductors of 0-750 Volts: Lateral runs of conductors of 0-750 volts may be less than the clearances from center line and surface of pole, and from the surface of crossarm, as specified in Table 1, Cases 8 and 9, provided such conductors are suitably insulated and placed along the bottom surface of crossarms and are protected by wood moulding or impregnated fiber conduit of thicknesses not less

than as specified in Rule 22.2 or are protected by plastic pipe having the properties of the material designated as Type II in the standard specified in Rule 22.2-D. The plastic pipe shall have a minimum wall thickness of 0.10 inch. Except that the neutral conductor of a 0-750 volt lateral run need not be suitably insulated.

(2) Conductors of More Than 750 Volts: Lateral runs of conductors of more than 750 volts may be less than the clearances from center line and surface of pole, and from the surface of crossarm, as specified in Table 1, Cases 8 and 9, provided such conductors are suitably insulated and are protected by the impregnated fiber conduit or plastic pipe specified in Rule 54.6-C(1), such conduit or pipe being placed along and attached to the bottom surface of crossarm.

(3) Extent of Run: The wood moulding, fiber conduit, or plastic pipe required for protection by this Rule 54.6-C shall extend substantially under and along the arm to the outer position of any conductor in the run and in no case shall the covering be terminated within 15 inches from center line of pole.

(4) Conductor Clearances: The radial clearances between conductors, specified in Table 2, Cases 16 and 17, are not required between the suitably insulated conductors in the same lateral run.

D. Vertical Runs

Conductors installed in the form of vertical runs on the surface of poles or not more than 18 inches from the center line of a pole shall be suitably insulated and covered throughout by a suitable protective covering (See Rule 22.2 for the definition of a suitable protective covering). The plastic pipe specified in Rule 22.2-D shall have a minimum wall thickness of 0.15 inch. This protective covering is not required over vertical runs in metal conduit attached to metal poles, towers or other structures provided pipe and structure are metallically connected and effectively grounded.

Conductors in the form of vertical runs more than 18 inches from the center line of any pole shall be suitably insulated and covered by a suitable protective covering or by securely supported impregnated fiber conduit without metal pipe as specified in Rule 22.2-D.

Vertical runs, where encased in grounded non-climbable metal poles, grounded metal conduit, plastic pipe, sheath, or shield, shall be treated as risers.

Conductors installed in the form of vertical runs which extend within 8 feet of the ground shall be treated as risers. Runs which terminate in the top of enclosures which afford ample mechanical protection to the runs may extend within 8 feet of the ground but not less than 6 feet of the ground without being treated as risers.

The radial clearances between conductors, specified in Table 2, Cases 16 and 17, are not required between suitably insulated conductors in the same vertical run.

E. Risers

Risers from underground cables or other conductors shall be encased in securely grounded iron or steel pipe (or other covering of equal strength) from the ground line to a level not less than 8 feet above the ground line (see App. G, Fig. 61.) A cable U guard made of No. 14 gauge steel shall be considered of sufficient strength for 0-750 volt risers. Plastic pipe is permitted in lieu of the grounded iron or steel pipe required by this rule, provided that risers of circuits in excess of 750 volts shall have an effectively grounded metallic shield. Such plastic pipe shall be of material as specified in Rule 22.2-D having a wall thickness not less than 0.2 inch.

Any riser on the surface of a pole or not more than 18 inches from the center line of a pole shall be covered by a suitable protective covering where within a vertical distance of 8 feet from the level of communication conductors (including cables) or unprotected supply conductors (including the leads from the terminal) supported by the same pole or where within a radial distance of 6 feet from conductors not supported by the same pole.

Any riser more than 18 inches from the center line of a pole shall be covered by a suitable protective covering, or by securely supported impregnated fiber conduit without metal pipe, where within a vertical distance of 8 feet from the level of communication conductors (including cables) or unprotected supply conductors (including the leads from the terminal) supported by the same pole or within a radial distance of 6 feet from conductors not supported by the same pole.

The portion of any riser between the insulating covering required on the upper section and the metal or plastic covering required on the lower section by the foregoing shall be covered by the extension of either or both of such coverings. Where fiber conduit over metal pipe is used as a protective covering, the fiber conduit shall not extend within 8 feet of the ground line and shall be installed in a workmanlike manner and securely supported in order to prevent it from slipping downward and exposing any upper sections of the metal pipe.

The radial clearances between conductors, specified in Table 2, Cases 16 and 17, are not required between suitably insulated conductors in the same riser.

Protective covering (suitable) is not required over risers encased in effectively grounded non-climbable metal poles or in iron or steel pipe attached to a steel pole, tower or other metal structure, provided the iron or steel pipe is effectively grounded and is metallically connected to such metal structure.

F. Terminals of Encased Risers and Runs

Terminals of risers or runs shall not extend above the level of line conductors to which terminal leads are connected except as follows:

Where the line conductors are installed in vertical or triangular configuration in partial underground distribution, or where the line conductors are dead-ended on the opposite side of crossarms from the terminals and no line conductors supported on the same crossarm and the same side of pole extend past the terminals and no buckarm construction is involved, or

Where conductors in excess of 7500 volts are installed in vertical configuration on crossarms, and the terminals are mounted on the same arms which support the conductors to which the terminals are connected.

At the upper end of vertical runs or risers on wood poles, any terminal or terminal fitting within distances from center line of pole less than as specified in Table 1, Case 8, shall be protected by a crossarm or wood block placed above it at a distance not exceeding 4 inches. The wood block may be omitted if the terminal or terminal fitting at the upper end of a vertical run or riser of 750 volts or less is on the same side of a pole as, and not more than 1 foot below, a transformer.

Cable or conduit bends and the terminals of risers or runs of conductors of more than 750 volts supported on climbable poles or structures shall be arranged with as little exposed surface as practicable but are not required to be covered by a protective covering provided that no portion of the terminal or associated unprotected conductors are within the climbing space or within the clearance from center line of pole specified in Table 1, Case 8 (15 or 18 inches). All exposed grounded surfaces of such terminal fittings and bends of risers and runs shall be not less than 18 inches vertically above the conductor level, and not less than 2 feet radially from any conductor at the next conductor level, of unprotected conductors of another circuit which is entirely below the level of the circuit to which the riser is connected.

In partial underground distribution (750-20,000 volts in vertical or triangular configuration on non-climbable poles), energized portions of the terminals may be less than the clearances from center line of pole specified in Table 1, Case 8, Column E (15 or 18 inches) but shall be not less than 6 inches from the surface of the non-climbable metal pole and grounded metal surfaces associated therewith.

The terminal fittings of risers or runs of conductors of 0-750 volts installed on the surfaces of poles shall not be within the climbing space and unprotected leads to or from such terminals shall not pass within the climbing space but may have a clearance of less than 15 inches from center line of pole (Table 1, Case 8) and less than 3 inches from the surface of pole or crossarm (Table 1, Case 9). It is recommended that conductors from such terminal fittings be suitably insulated and, where practicable, carried as protected lateral runs on the bottom surface of crossarms (see Rule 54.6-C).

The vertical clearances between the lowest point of lead wires of a riser or run (vertical or lateral) and the next conductor level below shall conform to the requirements specified in Rule 54.4-C6. See App. G, Fig. 61.

G. Clearance From Hardware on Wood Poles or Structures

On wood poles or structures, all ground wires, conductor sheaths (metallic or nonmetallic braids, tapes or coverings), metal conduits of risers or runs, and hardware used for attaching such risers or runs to structures, shall be not less than 1½ inches from guy shims, bolts, braces, pole steps, and other hardware not associated with the risers or runs. In cases where it is not practicable to obtain at least 1½ inches of air-gap and creepage distance, suitable insulating sheet fiber or fiber conduit or other suitable means shall be used to provide a creepage distance of not less than 1½ inches.

H. Attachment of Protective Covering

Protective covering shall be attached to poles, cross-arms, or structures by means of corrosion-resisting metal straps or staples which are adequate to maintain such covering in its proper position. The distance between straps or staples shall not exceed 3 feet where such covering is a hardwood moulding. Due care shall be exercised to avoid the possibility of nails protruding through any inner surface of any wood casing used as a protective covering.

54.7 Climbing and Working Space

A. Climbing Space

Climbing space, measured from center line of pole, shall be provided on one side or in one quadrant of all poles or structures, with dimensions as specified in Rules 54.7-A1, 54.7-A2 and 54.7-A3.

The climbing space shall be maintained in the same position for a distance of not less than 4 feet vertically both above and below each conductor level through which it passes. Compliance with this requirement necessitates that the position of the climbing space shall not be changed through conductor levels which are less than 4 feet apart. Where the vertical distance between consecutive conductor levels is 4 feet or more, and less than 8 feet, the position of the climbing space through such consecutive levels may be shifted not more than one-quarter of the distance around the pole. Where a conductor is installed at the top of a pole under the provisions of Rule 54.4-D8, the climbing space shall extend up to the level of such pole-top conductor but need not be provided through and above such level.

The requirements of Rule 54.7-A that climbing space shall be maintained for a distance of not less than 4 feet vertically both above and below each conductor level through which it passes and the requirements of Rule 54.7-A3b which relate to leaving certain pin holes in line arms and/or buck arms vacant, shall not be held to apply to a single circuit of more than 750 volts in flat construction at the top of the pole, provided:

No portion of any conductor of such a circuit shall have clearances from the center line of pole, less than that required by Rule 37, Table 1, Case 8.

Climbing space as required by Rule 54.7-A2 shall be maintained through the level of the conductors on the lower arm, and where a related buck arm is involved said climbing space need not extend above the level of the conductors on the upper arm, but shall extend to such level.

Allowable obstructions of these climbing spaces, where necessary, are specified in Rule 54.7-A4.

On poles having 0-750 volts secondary aerial cable with the supporting messenger attached to the surface of the pole, the climbing space shall be measured from the center line of pole on the side of the pole opposite the cable. The center line of the pole shall be approximately midway on one side of the climbing space which shall have minimum dimensions of 30 inches by 30 inches. On corner or dead end poles, the climbing space shall be a square of 30 inches by 30 inches horizontal dimensions. One side of such climbing space shall be bounded by a vertical plane through the dead-ended cable with the center line of pole bisecting each side. (Similar to Fig. 15 of Appendix G) or climbing space may be in a quadrant.

This Rule 54.7-A need not apply to non-climbable poles in partial underground distribution.

(1) Dimensions Where Crossarms Are Not Involved: Climbing space through the levels of conductors in vertical configuration on tangent, angle and dead-end poles shall be a square of the horizontal dimensions tabulated below. For dead-end construction, one side of the climbing space shall be bounded by the vertical plane of the dead-ended conductors with the center line of pole bisecting such side (see App. G, Fig. 15):

Voltage of conductors	Dimensions of square
750-7500 volts	30 inches
7500-46,000 volts	36 inches
More than 46,000 volts	36 inches plus ½ inch per kv in excess of 46 kv.

For climbing space dimensions for low voltage rack construction see Rule 54.9-F. The clearance of not less than 18 inches between surface of pole and conductors in excess of 7,500 volts, specified in Rule 54.4D6b and the climbing space specified in Rule 54.7-A1 need not apply to supply circuits in excess of 7,500 volts supported in vertical configuration in the top circuit position on poles, provided the energized portion of such circuits have clearances from center line of pole which are not less than those specified in Rule 54.4D2, and provided climbing space is maintained.

(2) Dimensions Where Line Arms Only Are Involved: The climbing space through levels where line arms without related buck arms are present on poles or structures shall be on one side or face of the pole, with the center line of pole approximately midway on one side of the climbing space (see App. G, Fig. 16), and shall have the following dimensions:

For conductors of 0-7500 volts, the climbing space shall be not less than 30 inches square except that for combination arm construction the climbing space shall be not less than 36 inches square. (See Rule 54.8-E for additional requirements where service drops from combination line arms are involved.)

For conductors of 7500-46,000 volts the climbing space shall be not less than 36 inches square.

For conductors of more than 46,000 volts the climbing space shall be a square the sides of which shall be not less than 36 inches plus ½ inch per kv in excess of 46 kv.

The above dimensions may be reduced not more than 2 per cent because of line angles.

(3) Dimensions Where Buck Arms Are Involved: The climbing space where line arms and related buck arms are involved on poles or structures shall be in a quadrant and shall have at least the dimensions, determined according to voltage classification, as given below. These dimensions are based on the minimum clearance from center line of pole (Table 1, Case 8) and the minimum pin spacings (Table 2, Case 15) for the voltages involved, with the pin positions numbered outward from the pole on the climbing side.

Where metal back braces are used they shall be considered as one of the arms of double arm construction.

a) For Conductors of 0-750 Volts: Where single line arm and single buck arm construction is involved and the climbing space is left open on the opposite side of the pole from the arms, the No. 1 pin position shall be left vacant in one arm. (See App. G, Fig. 17)

Where double line arm and single buck arm, or vice versa, construction is involved and the climbing space is left open on the side of the pole opposite the single arm, the No. 1 pin position shall be left vacant in the single arm. (See App. G, Fig. 18.)

Where double line arm and double buck arm construction is involved, the No. 1 pin position shall be left vacant in each double arm. (See App. G, Fig. 19.)

b) For Conductors of More Than 750 Volts: Where single line arm and single buck arm construction is involved and the climbing space is left open on the opposite side of the pole from the arms, the No. 1 pin position shall be left vacant in both line arm and buck arm (see App. G, Fig. 20). As an alternative, where the conductors are of 750-7500 volts, the No. 1 and No. 2 pin positions in one arm may be left vacant provided the arms involved are in the top positions on the pole.

Where double line arm and single buck arm, or vice versa, construction is involved and the climbing space is left open on the side of the pole opposite the single arm, the No. 1 pin position shall be left vacant in both line arm and buck arm (see App. G, Fig. 21). As an alternative, where the conductors are of 750-7500 volts, the No. 1 and No. 2 pin positions may be left vacant in the single arm provided the arms involved are in the top positions on the pole.

Where double line arm and double buck arm construction is involved the No. 1 pin position shall be left vacant in one double arm and the No. 1 and No. 2 pin positions shall be left vacant in the other double arm. (See App. G, Fig. 22.)

The requirements of Rule 54.7-A that climbing space shall be maintained for a distance of not less than 4 feet vertically both above and below each conductor level through which it passes and the requirements of Rule 54.7-A3b which relate to leaving certain pin holes in line arms and/or buck arms vacant, shall not be held to apply to a single circuit of more than 750 volts in flat construction at the top of the pole, provided:

No portion of any conductor of such a circuit shall have clearances from the center line of pole, less than that required by Rule 37, Table 1, Case 8.

Climbing space as required by Rule 54.7-A2 shall be maintained through the level of the conductors on the lower arm, and where a related buck arm is involved said climbing space need not extend above the level of the conductors on the upper arm, but shall extend to such level.

c) For Combination Arm Construction With Line Arm and Line Buck Arm or Service Buck Arm: (See Rule 54.8-E for additional requirements where service drops are involved.)

Where the vertical separation between conductor levels on line and buck arms is not less than 4 feet and the climbing space is in a 0-750 volt quadrant, the climbing space dimensions shall be not less than those prescribed in Rule 54.7-A3a for 0-750 volt conductors provided that the required vacant pin spaces shall be in addition to the 36-inch horizontal conductor separation required in Rule 54.4-C2b. (See App. G, Figs. 23, 24 and 25.)

Where the vertical separation between conductor levels on line and buck arms is not less than 4 feet and the climbing space is in a 750-7500 volt quadrant, the climbing space dimensions shall be not less than those prescribed in Rule 54.7-A3b for 750-7500 volt conductors provided that the required vacant pin spaces shall be in addition to the 36-inch horizontal conductor separation required in Rule 54.4-C2b. (See App. G, Figs. 26, 27 and 28.)

Where the vertical separation between conductor levels on line and buck arms is less than 4 feet such separation shall be not less than 2 feet and the climbing space dimensions, in any quadrant, shall be not less than those prescribed in Rule 54.7-A3b for 750-7500 volt conductors, provided that the required vacant pin spaces shall be in addition to the 42-inch horizontal conductor separation required in Rule 54.4-C2b. (See App. G, Fig. 29, 30 and 31.)

d) Alternatives: Where a single line arm or single buck arm is involved and it is impractical to locate the climbing space in the quadrant on the opposite side of the pole from the single arm, it may be located in another quadrant provided that any single arm or arms within the climbing space shall be treated as a double arm.

In applying the pin position spacings as prescribed in Rule 54.7 not less than the minimum spacings of Table 2, Case 15 shall be used. In the event the crossarms used are not bored for the minimum spacings, a spacing of conductors to give equivalent dimensions will be considered as meeting the requirements.

(4) Allowable Climbing Space Obstructions: Crossarms and their supporting members are allowed in climbing spaces provided that, where buck arms are involved, any arms within climbing spaces are treated as double arms.

Suitably protected vertical conductors attached to the surfaces of poles, and guys, (except those guys contacting metal pins or dead-end hardware as specified in Rule 52.7-D) are allowed in climbing spaces provided that not more than one guy and one vertical riser, run, or ground wire are installed in any 4-foot vertical section of climbing space. The terminals or terminal fittings of risers or runs shall not be installed within climbing spaces.

Pin-type insulators which support line conductors of 20,000 volts or less may extend not more than one-half of their diameter into the climbing space. Dead-end or strain type insulators which support line conductors of 0-750 volts may extend not more than one-half of their diameter into the climbing space.

Dead end or strain type insulators which support line conductors of a single circuit of 750-20,000 volts located at the top circuit level of a pole may extend not more than one half of their diameter into the climbing space at that level.

Modifications of these requirements for rack construction are specified in Rule 54.9-F. Pin type or post type insulators which support line conductors of more than 20,000 volts in vertical configuration at the top circuit position may extend into the climbing space provided the conductors clear the surface and center line of pole as specified in Table I.

B. Working Space

Working spaces, unobstructed by conductors or other equipment except as provided in Rule 54.7-B2, of the dimensions as specified in Rule 54.7-B1, shall be provided between conductor levels on all poles and in such positions that the working spaces include the climbing space.

(1) Dimensions of Working Space: The vertical dimensions of the working space above and below any conductor level shall be equal to the vertical clearances between conductors specified in Table 2, Cases 8 to 14 inclusive, for the voltages involved.

The width of the working space where crossarms are involved shall be the distance between outside pin positions of the crossarms involved. The depth of the working space where crossarms are involved shall be equal to the width of the climbing space and shall be measured perpendicularly from the face of crossarm.

(2) Allowable Working Space Obstructions: Taps from conductors on line arms to conductors on related buck arms may pass through the working space between the levels of conductors on related line and buck arm.

Service drops of 0-750 volts may pass through the working space of conductors supported on the same crossarm with the drop conductors and may pass through working space of 750-7500 volt conductors provided not less than the clearance between service drop and line conductors specified in Rule 54.8-C6 are maintained.

Cutouts and their leads may be installed in the working space (but not in the climbing space).

Switches and their leads may extend into the working space (but not into the climbing space).

Lead wires to transformers or capacitors may pass through the working space adjacent to the line conductors to which such leads are attached.

Terminal fittings of risers and runs, and their taps, may extend into the working space provided these fittings are the only obstruction of the working space at their level on the same side of the climbing space.

54.8 Service Drops, 0-750 Volts

A. Material and Size

Supply service drops of 0-750 volts shall be of material and size as specified in Table 8 and Rule 49.4-C7a and shall have a weather-resistant covering at least equivalent to double-braid weatherproofing except to bare neutral may be used as specified in Rule 49.4-C7a.

B. Clearances Above Ground, Buildings, Etc.

The vertical clearances of supply service drops above ground, buildings, etc., shall be not less than the minimum clearances specified in Rule 37, Table 1, Column B, with the following modifications:

(1) Above Public Thoroughfares: Service drop conductors shall have a vertical clearance of not less than 18 feet above public thoroughfares, except that this clearance may grade from 18 feet at a position not more than 12 feet horizontally from the curb line to a clearance of not less than 16 feet at the curb line, provided the clearance at the center line of any public thoroughfare shall in no case be less than 18 feet. Where there are no curbs the foregoing provisions shall apply using the outer limits of possible vehicular movement in lieu of a curb line.

(2) Above Private Thoroughfares and Other Private Property:

a) Industrial or Commercial Premises: Over private driveways, lanes, or other private property areas accessible to vehicles on premises used for industrial or commercial purposes, service drops shall have a vertical clearance of not less than 16 feet.

b) Residential Premises: Over private driveways or lanes or other private property areas accessible to vehicles on premises used for residential purposes only, service drops shall have a vertical clearance of not less than 12 feet. If the building served does not permit an attachment which will afford a clearance of at least 12 feet over such areas without the installation of a structure on the building to provide additional height, the vertical clearance of service drops of 0-300 volts only may be less than 12 feet but shall be maintained as great as possible and shall be not less than 10 feet.

(3) Above Ground in Areas Accessible to Pedestrians Only:

a) Industrial and Commercial Premises: Over areas accessible to pedestrians only on premises used for industrial or commercial purposes, service drops shall be maintained at a vertical clearance of not less than 12 feet.

b) Residential Premises: Over areas accessible to pedestrians only on residential premises, service drops shall be maintained at a vertical clearance of not less than 8 feet.

(4) From Buildings and Structures: Service drops shall be so arranged as to hamper and endanger workmen and firemen as little as possible in the performance of their duties.

a) Industrial and Commercial Premises: On premises used for industrial or commercial purposes service drops shall be maintained at a vertical clearance of not less than 8 feet over all or any portions of buildings and structures, except that service drops of 0-300 volts may be less than 8 feet, but not less than 12 inches, above the cornice, decorative appendage, eave, roof or parapet wall of the building served provided:

The cornice, decorative appendage, eave, roof or parapet wall less than 8 feet below such service drops is non-metallic;

The point of attachment of the service drops is not more than 18 inches back of the front face of the building wall facing the pole line from which the service drops criginate; and

The cornice or decorative appendage which is less than 8 feet below such service drops does not extend more than 12 inches from said front face of the building wall.

Service drops are not required to clear buildings any specified horizontal distance but shall be so installed that they clear fire escapes, exits, windows, doors and other points at which human contact might be expected, a horizontal distance of not less than 3 feet.

b) Residential Premises: On premises used for residential purposes only, service drops of 300-750 volts shall be maintained at a vertical clearance of not less than 8 feet over all buildings and structures.

The clearance above buildings of service drops of 0-300 volts shall be not less than the distance specified in Table 10.

TABLE 10

Minimum Allowable Clearance of Service Drops of 0-300 Volts Above Buildings

Type of Roof	Minimum Clearance Above Building Served	Other Buildings On Premises Served	Buildings On Other Premises
Metal roof, 3/8 pitch or less (a)	8 ft.	8 ft.	8 ft.
Metal roof, more than 3/8 pitch	2 ft.	2 ft.	8 ft.
Nonmetallic roof, 3/8 pitch or less	(b)	2 ft.	8 ft.
Nonmetallic roof, more than 3/8 pitch	(b)	2 ft.	2 ft.

(a) 3/8 pitch is approximately 37 degrees from the horizontal.
(b) No limit specified but the greatest practicable clearance should be obtained.

Service drops are not required to clear buildings on residential premises any specified horizontal distance, but shall be so installed that they clear fire escapes, exits, windows, doors, and other points at which human contact might be expected, a horizontal distance of not less than 3 feet.

(5) Above Swimming Pools: Installations of service drops above public and private swimming pools shall be avoided where practicable. Where service drop conductors are installed above a swimming pool, the conductors shall have a radial clearance of not less than 20 feet from the top edge of the pool walls and shall have a vertical clearance of not less than 18 feet above the highest water level of the pool surface. Service drops having coverings of materials specially approved by the Commission for installation above swimming pools may have vertical clearances above the pool and radial clearances from the top edge of the pool wall of not less than 16 feet for public and commercially operated pools and not less than 12 feet for residential pools.

No service drop may be installed less than 16 feet vertically above the horizontal plane through a diving board or platform, the area of such plane being within 8 feet radially of the diving board or platform and over the water surface of the pool.

No service drop may be installed less than 12 feet vertically above the horizontal plane through a diving board or platform, the area of such plane being the area within 3 feet radially of the diving board or platform and not over the water surface of the pool.

The following conductor covering materials are authorized for 0-300 volt service drop installations above swimming pools at the reduced clearances permitted in Rule 54.8B(5):

a) Abrasion-resistant cables having a grounded metallic sheath, designated as armored service drop cable.

b) Neutral-Supported Service Drop Cable manufactured in accordance with Standard No. WC-5-1961 or Standard No. WC-3-1959 of the National Electric Manufacturers Association.

C. Clearances Between Supply Service Drops and Other Conductors

The clearances of supply service drop conductors from other conductors shall be not less than the minimum clearances specified in Rule 38, Table 2, Column D, with the following modifications:

(1) From Fire Alarm or Other Communication Line Conductors:

a) Crossings in Spans: At crossings in spans, supply service drop conductors may have a clearance of less than 48 inches (Table 2, Case 3, Column D; and Case 4, Column C) but not less than 24 inches above any communication line conductors or below communication line conductors not supported on a messenger, provided the crossing is 6 feet or more from any pole which does not support both conductors involved in the crossing (see App. G, Fig. 42).

b) Supported on the Same Pole: Supply service drop conductors, other than those on a pole-top clearance attachment, may have a clearance of less than 48 inches (Table 2, Case 8, Column D; and Case 9, Column C) above or below communication line conductors supported by the same pole and not on a messenger provided such clearance is 6 feet or more from any pole which does not support both conductors involved, and provided clearances at least equal to those shown in Table 11 are maintained.

TABLE 11

Minimum Radial Clearance Between Supply Service Drop Conductors and Communication Line Conductors Not on Messengers

Radial distance of Crossing from supporting pole (feet)	Minimum radial clearance (inches) From police and fire alarm conductors	Minimum radial clearance (inches) From other communication conductors
5 or less	6	12
10 or less, but more than 5	9	18
15 or less, but more than 10	15	24
20 or less, but more than 15	21	24
More than 20	24	24

Supply service drop conductors may have a clearance of less than 48 inches (as specified in Table 2, Case 8, Column D; and Case 9, Column C) but not less than 24 inches above and laterally from communication line conductors supported on a messenger by the same pole provided such clearance is 6 feet or more from any pole which does not support both conductors. The vertical clearances of not less than 24 inches above or 48 inches below communication conductors supported on messengers are not required where the supply service drop conductors are 24 inches or more horizontally from the vertical plane of the communication messenger. (See App. G, Fig. 42.)

(2) On Clearance Crossarms: Supply service drops may be supported on a clearance crossarm at a vertical distance less than 48 inches (specified in Table 2, Case 8, Column D, and Case 9, Column C) but not less than 24 inches above or below either supply circuits of 0-750 volts or communication circuits not supported on a messenger, or above communication or supply circuits which are supported on a messenger, provided the supply service drop unprotected conductors are at least 25 inches horizontally from the center line of the pole or are attached to suitable brackets (at least 25 inches from center line of pole) on each end of the clearance arm and carried on the underside of the clearance arm from end to end in fiber or plastic conduit or under wood protective covering as specified in Rule 54.6-C.

The installation of service drops in accordance with this rule will not entail any change in the communication conductors supported on the pole. (See App. G, Fig. 40)

(3) On Pole Top Extensions: Supply service drops may be carried in a clearance crossing on pole top extensions or brackets above either supply circuits of 0-750 volts or communication circuits, with a vertical conductor clearance less than 48 inches (Table 2, Case 8, Column D; Case 9, Column C) but not less than 2 feet provided the service drop conductors clear the center line of the pole (projected) not less than 25 inches horizontally, and also provided the service drop conductors clear the outside pin position conductors of the other circuit not less than 2 feet. Where, in addition to the pole top bracket

or extension, the supply service drop conductors are supported on a bracket on the end of the other line crossarm, a clearance of not less than 12 inches will be permitted at the points of crossing of line conductors in the outside pin positions. In such construction the crossarm of the extension shall be of wood. The installation of service drops in accordance with this rule will not entail any change in the communication conductors supported on the pole. (See App. G, Fig. 41.)

(4) From Communication Service Drops: The radial clearance between supply service drop conductors and communication service drop conductors may be less than 48 inches as specified in Table 2, Column C, Cases 4 and 9; Column D, Cases 3 and 8, but shall be not less than 24 inches. Where within 15 feet of the point of attachment of either service drop on a building, this clearance may be further reduced but shall be not less than 12 inches.

(5) Above Trolley Contact Conductors: Service drops may be installed above trolley contact conductors, including messenger in catenary construction, at a vertical distance of not less than 4 feet, provided the service drops clear the top of rails a vertical distance of not less than 26 feet where the railroad crossed transports standard freight cars, or not less than 23 feet where the railroad does not transport standard freight cars. (See Rule 74.4-B1.)

(6) From Conductors of 750-7500 Volts: Service drops may cross above or below line conductors of 750-7500 volts supported on the same pole at clearances less than specified in Table 2, Case 10, Column D, provided such drops shall be not less than 2 feet vertically or 1 foot horizontally from the supply line conductors.

D. Clearance From Other Poles

The clearance between service drop conductors and the center line of any pole not supporting them shall be not less than 22½ inches (Rule 32.3). In case the pole involved in this clearance is within 10 feet of a pole supporting the service drop, this clearance may be less than 22½ inches but shall be not less than 15 inches.

E. Clearances From Conductors on Combination Arms

In combination arm construction the following clearances are required between service drop conductors of 0-750 volts and the conductors of 750-7500 volts:

(1) 36-Inch Minimum Pole Pin Position Separation: Where conductors of the two voltage classifications are supported on opposite ends of a crossarm with a minimum horizontal separation of 36 inches between pole pin positions, service drops which are run directly from such crossarm shall not cross conductors of the 750-7500 volt classification on the same arm.

(2) 42-Inch Minimum Pole Pin Position Separation:

a) Services from Line Arms: Where conductors of the two voltage classifications are supported on opposite ends of the crossarm with a minimum horizontal separation of 42 inches between pole pin positions, service drops may be run directly from the 0-750 volt portion of a line arm and may cross below conductors of 750-7500 volts on the same arm. Under these conditions the vertical separation at the point of crossing shall be not less than 2 feet, and the point of crossing shall be not less than 6 feet radially from the center line of pole.

b) Services from Buck Arms: Where conductors of the two voltage classifications are supported on opposite ends of the buck arm with a minimum horizontal separation of 42 inches between pole pin positions and not less than 2 feet vertical separation between line arm conductor level and buck arm conductor level, service drops may be run from line buck arms or service buck arms, provided:

Such service drops shall clear conductors of 750-7500 volts by not less than 2 feet vertically at the point of crossing;

Such service drops shall not pass through the climbing space specified in Rule 54.7-A3c;

Such service drops shall not cross under the 750-7500 volt end of the line arm within the third pin position; and

Where such service drops are run from double buck arms, or from single buck arms installed on the side of the pole below the 750-7500 volt portion of the related line arm, the pole-pin position on the 750-7500 volt end of the line arm shall be left vacant.

F. From Racks

Service drops may be run directly from low voltage racks on poles. Where multiple conductor service cable is used, the cable grip shall be attached to the neutral insulator of the rack on the pole or suitable insulation shall be used between the point of attachment on the rack or pole and the surface of the cable, except where the rack hardware is effectively grounded through the medium of a metal pole.

54.9 Low Voltage Racks, 0-750 Volts

A. General

Conductors of not more than 750 volts may be attached to poles by means of vertical racks of insulators or individual supports in rack configuration and, where so attached, the following rules shall apply.

B. Pole Arrangement and Clearance

(1) Clearance From Poles: Conductors of 0-750 volts in rack construction may have clearances less than 15 inches from center line and 3 inches from the surface of pole, as specified in Table 1, Column D, Cases 8 and 9, respectively, but shall have a clearance of not less than 2½ inches from the surface of pole. (For interpretation of this 2½-inch clearance see Appendix G, Figure 60.)

(2) Conductor Arrangement: Not more than 7 conductors of not more than 2 circuits shall be attached to any pole in a continuous rack group. In a rack group the conductors shall be of one ownership and the vertical separations between line conductor attachments shall be uniform.

Conductors, both line and service drop, in rack configuration shall not be attached to more than 2 sides (there being 4 sides) of any pole at the level of any one rack group. Climbing space in conjunction with these attachments shall be maintained as specified in Rule 54.9-F.

C. Conductor Material

All conductors of a rack group in the same vertical plane shall be of the same material.

(1) Urban Districts: Conductors in rack construction in urban districts shall have a covering not less than the equivalent of double braid weather-resistant covering.

(2) Rural Districts: Line conductors in rack construction in rural districts may be bare conductors provided the vertical separation between conductors is not less than 12 inches and conforms to the requirements of Rule 54.9-D where greater separation is specified.

D. Conductor Spacing and Span Length

The vertical separation between conductors supported as a group in rack construction shall be not less than the following for span lengths as indicated:

Length of span (feet)	Minimum vertical separation (inches)
150 or less	6
200 or less, but more than 150	8
330 or less, but more than 200	12
More than 330	16

E. Vertical Clearance Between Conductor Levels

A vertical clearance of not less than 6 feet shall be maintained between the top conductor supported in rack construction at one level and conductors supported on the same pole at the next level above except as provided in Rule 54.4-C6 for lead wires and as modified below:

(1) With Guard Arm Below Conductors of 750-20,000 Volts: The vertical clearance between the top conductor in a rack group and conductors of 750-20,000 volts at the next conductor level above, may be less than 6 feet but shall be not less than 4 feet. If a clearance of less than 6 feet is used, all of the following requirements shall be met:

A wood guard arm not less than 48 inches long shall be installed directly above and parallel to the top line conductor of such a rack group;

Conductors in such a rack group, which are so guarded, shall not be attached to more than one side (there being four sides) of any pole; and

No service drop conductors supported on such rack shall pass between the surface of pole and the vertical plane of the line conductors. Any service drop conductors attached to and supported by the line conductors shall have a clearance of not less than 15 inches from surface of pole. (See App. G, Fig. 43.)

Each guard arm and its pole attachments are required by Rule 46 to withstand a vertical load of 200 pounds at either end.

(2) With Guard Arm Below Conductors of 0-750 Volts: The vertical clearance between the top conductor in a rack group and conductors of 0-750 volts at the next conductor level above may be less than 6 feet but shall be not less than 4 feet. If a clearance of less than 6 feet is used, a wood guard arm not less than 48 inches long shall be installed directly above and parallel to the top line conductor of such a rack group.

(3) Under a Transformer: No guard arm will be required over line or service drop conductors attached in rack construction to the surface of a pole directly below a transformer installation provided that at that level all attachments to the pole shall be approximately in the vertical plane through the center lines of pole and transformer installation and no conductor so attached makes an angle greater than 60 degrees with that plane. The top conductor so supported shall have a vertical clearance of not less than 48 inches below the level of conductors on the hanger arm; a vertical clearance not less than as specified in Rule 54.4-C6 below the lowest point of the drip loop of primary leads to the transformer; and a vertical clearance of not less than 10 inches below the lowest part of the transformer case or hangers. (See App. G, Fig. 33.)

(4) In Rural Districts: In rural districts (see definition, Rule 21.0-B) where one circuit only of 7500-20,000 volts is supported on the poles above conductors in rack construction, the vertical clearance between the top conductor in rack construction and the nearest 7500-20,000 volt conductor level may be less than 6 feet but not less than 4 feet and no guard arm is required.

(5) Related Rack and Crossarm: Where conductors supported in rack construction are connected to conductors supported on a crossarm on the same pole, the vertical clearance between the level of conductors of 0-750 volts on the crossarm and the nearest conductor in rack construction shall be not less than 2 feet and climbing space shall be maintained in the same quadrant or on the same side of pole through both conductor levels in accordance with climbing space requirements in Rules 54.7 and 54.9-F. This provision is not applicable where the crossarm is a combination arm.

F. Climbing Space in Rack Construction (See App. G, Fig. 32)

A climbing space shall be maintained through the levels of conductors supported in rack construction and for a vertical distance of not less than 4 feet above the top conductor and not less than 4 feet below the bottom conductor so supported.

The width of the climbing space measured horizontally through the center line of pole shall be not less than 5 inches plus the diameter of the pole and the extremiites of such width shall be equidistant from the center line of pole. The depth of the climbing space shall be not less than 30 inches measured perpendicularly to this climbing space boundary through the center line of pole. The width of the climbing space, perpendicular to and at the extremity of this 30-inch depth dimension, shall be not less than 38 inches and neither of the other two side boundaries shall make an angle of less than 90 degrees with the boundary through the center line of pole. (See App. G, Fig. 32.)

The position of the climbing space through the levels of conductors in rack construction shall be related to climbing spaces through the levels of conductors on crossarms in accordance with the requirements of Rule 54.7-A. The climbing spaces through the levels of conductors of two or more rack groups which are separated less than 6 feet shall be maintained in the same quadrant or on the same side of pole.

Guys, vertical conductors attached to the surfaces of poles, and terminals, which are listed in Rule 54.7-A4 as allowable climbing space obstructions, are not permitted in climbing spaces through conductors in rack construction.

54.10 Low Voltage Multiconductor Cable with Bare Neutral, 0-750 Volts

A. General

(1) The following rules cover requirements for 0-750 volt multiconductor cable having a bare neutral and are supplemental to the other rules of this order.

(2) The term "messenger" as defined in Rule 21.9 of this order when used in Rule 54.10 of this order includes the bare neutral conductor whenever such conductor serves both as a conductor and also as a principal supporting member of the cable.

B. Pole Arrangement and Clearances

(1) Clearance From Poles: Multiconductor cables having a bare neutral may have clearances less than 15 inches from center line and three inches from surface of pole, as specified in Table 1, Column D, Cases 8 and 9, respectively.

(2) Between Conductors in Cables: No specified clearance is required between the insulated phase conductors and the bare neutral (see Rule 57.4C).

(3) Conductor Arrangement: In parallel construction, cables shall not be attached to more than one side of a pole (there being four sides).

(4) At Cable Terminations: The clearances required by Rule 54.10E of this order between a cable and unprotected line conductors shall not be held to apply between a cable (and its grounded messenger) and unprotected conductors of the same circuit on poles where unprotected conductors enter (or leave) a cable. On such poles no grounded messenger shall be less than 15 inches from center line of the pole.

(5) Dead-End Construction: On poles with the messenger dead-ended in more than one direction, the grounded messenger or insulated phase conductors of the cable shall not be attached to more than two sides of the pole. On the climbing space side, service drops shall not be supported within 15 inches of the surface of the pole. The climbing space shall be determined by Rule 54.10-F(3) of this order.

C. Conductor Material and Strength

(1) Insulation: The phase conductors including jumper connections shall be covered with an insulation suitable for the voltage involved and shall conform with the standards established by the Insulated Power Cable Engineers Association, in Part 7, Section 7.3 of "Thermo-plastic--Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy," Insulated Power Cable Engineers Association Standard S-61-402, approved January 12, 1961, and National Electrical Manufacturers Association Standard WC5-1961, approved May 15, 1961.

(2) Messenger: Where cables are not maintained from a cable chair, the addition of the 200 pounds of vertical load specified in Rule 49.7C may be reduced to 50 pounds to allow for the load imposed by workmen on ladders.

D. Conductor Spacing

A vertical separation between individual conductors when supported in individual clevises or a multiconductor rack shall be not less than 6 inches.

E. Vertical Clearance Between Conductor Levels

When attached to poles or wood crossarms at less than 15 inches from center line of pole, bare neutral multiconductor cable shall be not less than 6 feet vertically above or 6 feet vertically below unprotected conductors except as modified below:

(1) With Guard Arm Below Conductors of 0-750 Volts: Where a guard arm is placed above bare neutral multiconductor cable in accordance with the provisions of Rule 57.7, the clearance of 6 feet may be reduced to not less than 4 feet below unprotected conductors of 0-750 volts.

(2) Above Conductors of 0-750 Volts More Than 15 Inches From Center Line of Pole: The vertical clearance between protected conductors of 0-750 volts attached at more than 15 inches from the center line of pole and bare neutral multiconductor cable above may be less than 6 feet but not less than 4 feet and no guard arm is required.

(3) Under a Transformer: No guard arm will be required over bare neutral multiconductor cable attached to the surface of a pole directly below a transformer installation provided that at that level all attachments to the pole shall be approximately in the vertical plane through the center lines of pole and transformer installation and no cable so attached makes an angle greater than 60 degrees with that plane. The cable so supported shall have a vertical clearance of not less than 48 inches below the level of conductors on the hanger arm; a vertical clearance not less than as specified in Rule 54.4-C(6) below the lowest point of the drip loop of primary leads to the transformer; and a vertical clearance of not less than 6 inches below the lowest part of the transformer case or hangers.

(4) Related Bare Neutral Multiconductor Cable and Crossarm: Where bare neutral multiconductor cable is connected to conductors supported on a crossarm on the same pole, the vertical clearance between the level of conductors of 0-750 volts on the crossarm and the bare neutral multiconductor cable shall be not less than 2 feet and climbing space shall be maintained in the same quadrant or on the same side

of pole through both conductor levels in accordance with climbing space requirements in Rules 54.7 and 54.10-F. This provision is not applicable where the crossarm is a combination arm.

F. Climbing Space

(1) A climbing space shall be maintained through the level of conductors supported in bare neutral multiconductor cable construction and for a vertical distance of not less than 4 feet above and below such cable. The position of the climbing space through the levels of conductors in such cable construction shall be related to climbing space for conductor levels above and below the cable in accordance with Rules 54.7-A and 93. The depth of the climbing space shall be measured from the center line of the pole.

(2) The dimensions of the climbing space shall be 30 inches square, and shall be provided on one side of the pole with the extremities of such width equidistant from the center line of pole. On poles on which transformers are pole bolted in line with primary conductors, a 30-inch square climbing space shall be provided.

(3) On poles with the messenger dead-ended and on corner poles, a 30-inch climbing space shall be provided in one quadrant or on one side of the pole. Suitably protected vertical runs or risers and ground wires attached to the surface of poles, and guys, are allowed in climbing spaces provided that no more than one guy or one vertical riser, run or ground wire are installed in any 4-foot vertical section of climbing space. The terminals or terminal fittings of risers or runs shall not be installed within climbing spaces.

G. Service Drops

Phase conductors of service drops taken from bare neutral multiconductor cables shall have insulation equivalent to that specified in Rule 54.10-C(1). Where service drops are supported on ACSR or aluminum messenger, the messenger shall be protected against abrasion. Services supported on the messenger shall be attached not less than 15 inches from the surface of the pole.

H. Fastenings

In the application of Rule 57.5, where cables are not maintained from a cable chair, the addition of 200 pounds vertical load, specified in Rule 49.7-C may be reduced to 50 pounds to allow for the load imposed by workmen on ladders.

I. Extended Messenger

Messengers may be extended in bare neutral multiconductor cable construction provided the messenger is sectionalized as a guy.

J. Sags

In the application of Rule 57.9 the 200-pound additional vertical loading specified for a man and cable chair may be reduced to 50 pounds where the cable is not maintained from a cable chair.

55. CONDUCTOR INSULATORS

55.1 Material

Insulators used on supply lines shall be porcelain, glass or other equally suitable material.

55.2 Strength (see Rule 49.5)

55.3 Voltage Requirements

Insulators used on supply lines shall be so designed that their dry flashover voltage is not more than 75% of their puncture voltage at operating frequencies.

A. Pin Type

All pin type insulators used on supply lines shall have a dry flashover voltage as specified in Rule 55.3-C for the nominal line voltage at which they are used.

B. Suspension and Strain Types

Suspension and strain type insulators used on supply lines shall have a dry flashover voltage as specified in Rule 55.3-C for the nominal line voltage at which they are used when tested with their attaching fittings or harness and under the mechanical loading to which they are to be subjected.

C. Flashover Voltage

The insulator flashover voltages required by Rules 55.3-A and 55.3-B shall be not less than as shown in Table 12 and shall be determined in accordance with the Standards of the American Institute of Electrical Engineers for Insulator Tests, Standard Number 41 dated March 1930.

TABLE 12

Insulator Flashover Voltages

Nominal line voltage	Dry flashover voltage	Nominal line voltage	Dry flashover voltage
750	5,000	55,000	140,000
2,300	20,000	66,000	170,000
4,000	30,000	88,000	220,000
6,600	40,000	110,000	315,000
11,000	50,000	132,000	390,000
22,000	75,000	150,000	420,000
33,000	100,000	200,000	560,000
44,000	125,000		

For intermediate voltages above 750 volts the value for flashover voltages may be obtained by interpolation.

D. Additional Insulation

Insulators used in territories where fog or lightning conditions prevail should be given more liberal factors of safety than those indicated in Table 12.

Insulators used at crossings or conflicts shall conform to Rules 104 and 114.

56. OVERHEAD GUYS, ANCHOR GUYS AND SPAN WIRES

56.1 Definition (see Rule 21.3 and 22.9)

56.2 Use

Where mechanical loads imposed on poles, towers or structures are greater than can be supported with safety factors as specified in Rule 44, additional strength shall be provided by the use of guys or other suitable construction.

Where guys are used with poles or similar structures capable of considerable deflection before failure, the guys shall be able to support the entire load, the pole below the point of guy attachment acting merely as a strut.

Guys shall be attached to structures, as nearly as practicable, at the center of load. They shall be maintained taut and of such strength as to meet the safety factors of Rule 44.

56.3 Material and Strength (see Rule 49.6)

56.4 Clearance

The basic minimum clearances of guys above the ground and from other wires or cables are specified in Tables 1 and 2. Modifications of these basic clearances are specified in Rules 37 and 38 and by the following provisions.

A. Above Ground

(1) Across or Along Public Thoroughfares: Guys over or across public thoroughfares in urban districts shall have a clearance of not less than 18 feet above ground (Table 1, Case 3, Column A) except that a clearance of not less than 16 feet is permitted for the portions of guys over that part of the public thoroughfare which is an entrance to or exit from industrial or commercial premises; and not less than 14 feet in cases where private residential premises are involved.

Overhead guys along public thoroughfares may have clearances above ground which is not normally accessible to vehicles, less than as specified in Table 1, Column A, Cases 3 and 4 (18 feet and 15 feet respectively) but sections of such guys between insulators shall have a clearance of not less than 8 feet above the ground, and sections of guys between insulators and poles shall have a clearance of not less than 7 feet above ground, and such guys without insulators shall be not less than 7 feet above ground.

(2) Over Private Property: Those portions of guys over private roadways or areas normally accessible to vehicles may have a clearance above ground less than 18 feet (Table 1, Case 3, Column A) but not less than 16 feet in rural districts and not less than 14 feet in urban districts.

(3) Above Swimming Pools:

a) Ungrounded portions of guys shall have radial clearances from the top edge of the swimming pool wall and vertical clearances above the highest water level of the pool of not less than 18 feet.

No ungrounded portion of guys may be installed less than 18 feet vertically above the horizontal plane through a diving board or platform, the area of such plane being within 8 feet radially of the diving board or platform and over the water surface of the pool.

No ungrounded portion of guys may be installed less than 12 feet vertically above the horizontal plane through a diving board or platform, the area of such plane being the area within 6 feet radially of the diving board or platform and not over the water surface of the pool.

b) Grounded portions of guys shall have vertical clearances above the highest water level of the pool of not less than 16 feet.

No grounded portion of guys may be installed less than 16 feet vertically above the horizontal plane through a diving board or platform, the area of such plane being within 8 feet radially of the diving board or platform and over the water surface of the pool.

No grounded portion of guys may be installed less than 8 feet vertically above the horizontal plane through a diving board or platform, the area of such plane being the area within 3 feet radially of the diving board or platform and not over the water surface of the pool.

B. Above Railways and Trolley Lines

(1) Which Transport Freight Cars: The clearance specified in Table 1, Case 1, Column A (25 feet) is based upon the maximum height of standard freight cars, 15 feet 6 in. from top of rail to top of running board. This clearance shall in no case be reduced more than 5% because of temperature, wind or mechanical loading.

(2) Operated by Overhead Trolley: The clearance of 26 feet specified in Table 1, Case 2, Column A is based upon a trolley pole throw of 26 feet. Guys and span wires may have clearances of less than the trolley throw distance (26 feet) above the running surfaces, top of rail or surface of street, used by trolley cars or coaches provided the guys and span wires are not less than 4 feet above the trolley contact conductors and are encased in wood boxing or moulding 7/8-inch or more in thickness for distances of at least 2 feet horizontally from the vertical plane through each trolley contact conductor.

C. From Conductors

(1) Crossing in Spans: Vertical clearances at points of crossing not less than as specified in Table 2, Case 1, and radial clearances not less than as specified in Table 2, Case 18, shall be maintained between guys or span wires and conductors supported on other poles.

(2) On Colinear Lines: The radial clearances between guys on a line and conductors on a colinear line shall be not less than as specified in Table 2, Case 18. Vertical clearances not less than as specified in Table 2, Case 1, shall also be maintained at points of crossing between guys on a line and conductors supported on other poles of a colinear line.

(3) Parallel on Same Poles: The radial clearances between guys and conductors which are approximately parallel and supported by the same poles shall be not less than as specified in Table 2, Case 18.

(4) Passing on Same Poles: The radial clearances between guys and conductors supported by or attached to the same poles or crossarms shall be not less than as specified in Table 2, Case 19.

a) Overhead Guys: Overhead guys passing through the level of conductors of different ownership shall do so only between pole pin positions or outside of the cuter pin position on the crossarm.

b) Anchor Guys: Ungrounded portions of anchor guys which pass through the level of communication conductors at positions other than between pole pin positions or outside of the outer pin position shall be sectionalized by insulators neither less than 6 inches nor more than 18 inches above the level of the communication conductors (see App. G, Fig. 49b) and the guys shall clear such conductors by not less than 3 inches (Table 2, Case 19, Column C).

D. From Guys or Span Wires

(1) Crossing in Spans: Vertical clearances at points of crossing not less than 18 inches as specified in Table 2, Case 1, Column A and radial clearances of not less than 12 inches shall be maintained between guys or span wires and other guys or span wires which are not attached to the same poles.

(2) Passing and Attached to Same Pole: The radial clearance between different guys, different span wires, or different guys and span wires, attached to the same pole shall be not less than 3 inches.

(3) Approximately Parallel and Attached to Same Poles:

a) Overhead Guys or Span Wires: Where two or more overhead guys or two or more span wires are approximately parallel and attached to the same poles, either or both of which poles support supply conductors, such guys or span wires shall have a vertical separation of at least 1 foot between the points of attachment on the pole, or poles, which support the supply conductors. In cases where such separation is not practicable, other means to insure the effectiveness of the guy or span wire insulators shall be employed, but in no case shall the distance between any guy or span wire and the surface of the insulator in any other guy or span wire be less than 3 inches, measured perpendicularly at the insulator. This rule shall not prohibit the contact of such guys or span wires to the same shims and shall not apply to guys or span wires acting in different directions, nor to guys or span wires in which insulators are not required.

b) Anchor Guys: Where two or more guys attached to a pole supporting supply conductors are attached to the same grounded anchor, either directly or through the medium of a stub, they shall be separated at the pole by a vertical distance of at least 1 foot, provided any guy wire shall be not less than 3 inches from the surface of the insulator in any other guy. In lieu of securing this 3 inch minimum separation by means of the 1 foot minimum separation of guy attachments at the pole, it shall be afforded by separation of the grounded anchors or by other practicable means which shall insure the minimum clearance of 3 inches. The provisions of this rule do not apply to guys which act in different directions from the pole or to guys attached to grounded metal structures or to guys which do not require insulators.

E. From Poles

Where passing guys are less than 15 inches from surface of pole and less than 8 feet below supply conductors of less than 20,000 volts supported on the same pole, such guys shall be sectionalized, in addition to the normal sectionalization required by Rule 56.6, by means of insulators in accordance with Rule 56.6-A as though attached to the pole or structure.

F. From Transformer Cases

All portions of guys 6 inches or more from the surface of poles or crossarms at the guy attachments shall be not less than 4 inches from transformer cases and hangers. Portions of guys within 6 inches of the surface of poles or crossarms to which they are attached shall be not less than 1-1/2 inches from transformer cases and hangers.

G. Above Buildings

The minimum vertical clearance of 8 feet specified for guys above buildings (Table 1, Case 6, Column A) may be reduced over roofs of 3/8 pitch (37 degrees from the horizontal) or greater to a clearance of not less than 2 feet.

56.5 Fastenings

Guy wires shall be protected by the use of guy thimbles or their equivalent where attached to anchor rods or through bolts.

Cedar and other soft-wood poles, around which any guy having an ultimate strength of 5000 pounds or more is wrapped, shall be protected by suitable guy shims. Hooks, lag screws or other equivalent means shall be used where necessary to prevent the guy from slipping along the pole.

56.6 Requirements for Sectionalizing with Insulators

A. Guys in Proximity to Supply Conductors of Less Than 20,000 Volts (see Rule 21.3-D for definition of proximity and Fig. 45 of App. G)

All portions of guys within both a vertical distance of 8 feet from the level of supply conductors of less than 20,000 volts and a radial distance of 6 feet from the surface of wood poles or structures shall not be grounded, through anchors or otherwise. Where necessary to avoid the grounding of such portions, guys shall be sectionalized by means of insulators installed at locations as specified in Rule 56.7.

B. Guys to Arms Supporting Conductors of Less Than 20,000 Volts

All portions of arm guys within 6 feet of points of attachment to wood crossarms, or metal crossarms on wood poles, shall not be grounded if the crossarm support supply conductors of less than 20,000 volts. Where necessary to avoid the grounding of such portions, arm guys shall be sectionalized by means of insulators at locations as specified in Rule 56.7.

C. Ungrounded Overhead Guys

All overhead guys which are not grounded (by means of ground wires, grounded anchor guys, attachment to grounded metal poles, or otherwise) shall be sectionalized at the locations measured from each attachment to poles or structures, as specified in Rule 56.7-A (6 feet to 9 feet from attachments).

D. Guys Exposed to 20,000 Volts or More

Guys exposed to conductors of 20,000 volts or more (see Appendix G, Fig. 52) shall not be sectionalized and shall be securely grounded (by means of ground wires, anchor guys, or attachments to securely grounded metal poles or structures). Excepted from the above requirements are:

Guys, all or any portions thereof, which are required to be sectionalized in accordance with Rule 56.6-A because of proximity of wood poles and supply conductors of less than 20,000 volts or in accordance with Rule 56.6-B; and

Guys which are sectionalized by wood strain insulators equipped with arcing horns and designed to provide impulse insulation for lightning conditions.

E. Guys Attached to Grounded Poles or Structures

Guys attached to securely grounded metal poles or structures are not required to be sectionalized except as required by Rule 56.6-A because of proximity to supply conductors of less than 20,000 volts supported on wood poles, or by rule 56.6-B.

56.7 Location of Sectionalizing Insulators

A. Overhead Guys

Insulators installed in overhead guys to sectionalize such guys as required by any portion of Rule 56.6 shall be located at a distance of not less than 6 feet and not more than 9 feet, measured along the guys, from the points of attachment of the guys to poles, crossarms or structures (see App. G, Fig. 46). In such overhead guys which are less than 17 feet in length with no section grounded, insulation at one location, approximately equidistant from each support will be sufficient.

Overhead guys attached to wood poles, crossarms or structures and to grounded anchor guys or metal poles shall be sectionalized at not less than one location, 6 to 9 feet (measured along the guys) from the attachment at the wood pole or structure (see App. G, Fig. 46).

Branched guys, sometimes referred to as bridle guys, which are attached at two or more positions to the same crossarm or pole line structure, and which are required under the provisions of Rule 56.6 to be sectionalized, shall be sectionalized by means of insulators in each branch or by means of insulators in the main guy and all branches except one, so that no two branches of such a guy constitute a continuous metallic path between separate points of attachment to crossarms or structures (see App. G, Fig. 50). In conforming with these requirements, insulators in branches of guys should be placed as far as practicable from attachments at pole or crossarm but not more than 9 feet therefrom.

All insulators in overhead guys shall be not less than 8 feet vertically above the ground.

B. Anchor Guys

An insulator shall be installed in each anchor guy which is required to be sectionalized by Rule 56.6-A or 56.6-B, so that such insulator is located not less than 8 feet above the ground and either 8 feet below the level of the lowest supply conductor or not less than 6 feet from surface of pole and not less than one foot below the level of the lowest supply conductor (see App. G, Fig. 49). These sectionalizing requirements for anchor guys can normally be met by insulation at one location; however, short guys or other conditions may require insulation at two locations, one location being not less than 8 feet above the ground and the other location either not less than 8 feet below the lowest supply conductor, or not less than 6 feet horizontally from pole and not less than one foot below the level of the lowest supply conductor. In order to prevent trees, buildings, messengers, metal-sheathed cables or other similar objects from grounding portions of guys above guy insulators, it is suggested that anchor guys be sectionalized, where practicable, near the highest level permitted by this Rule 56.7-B.

Ungrounded portions of anchor guys which pass through the level of communication conductors at positions other than between pole pin positions or outside of the outer pin position shall be sectionalized by insulators placed neither less than 6 inches nor more than 18 inches above the level of the communication conductors (see App. G, Fig. 49b).

Any anchor guy which enters the ground less than 8 feet below the lowest level of supply conductors on the pole or structure shall be treated as an overhead guy which is grounded by means of a grounded anchor guy or metal pole.

A grounded horizontal brace of a "sidewalk" guy shall in no case be less than 8 feet below the level of the lowest unprotected supply conductor on the same pole (see App. G, Fig. 51b).

C. Truss Guys

An insulator shall be installed in each truss guy which is required to be sectionalized by Rule 56.6-A, so that such insulator is located not less than 8 feet above the ground and not less than 8 feet below the level of the lowest supply conductor passing within 8 feet of the guy (see App. G, Fig. 51). These requirements can normally be met by insulation at one position; however, in certain unusual conditions the two 8-foot distances may overlap, in which case insulation will be necessary at two positions.

56.8 Guy Insulators

Insulators which sectionalize guys shall conform to the following specifications based on the highest voltage carried at the level on the pole, tower, structure or crossarm nearest which the guy is attached and also based on the voltage of higher voltage circuits through which the guy passes.

A. Material

Insulators used in guys on supply lines shall be porcelain, glass or other suitable material.

B. Strength (see Rule 44, Table 4 and Rule 49.5-B)

C. Voltage Requirements

Insulators used in guys on supply lines shall be so designed that their dry flashover voltage is not more than 75% of their puncture voltage at operating frequencies.

Insulators used in guys on supply lines shall have a dry flashover voltage not less than as specified in Table 13 when tested in accordance with the Standards (No. 41, March 1930) of the American Institute of Electrical Engineers under the maximum mechanical loadings specified by this Order for the guy construction involved.

TABLE 13

Guy Insulator Flashover Voltage

Nominal voltage of circuits nearest point of attachment	Dry flashover voltage of insulators
0-7500 volts	15,000 volts
7500-17,500 volts	Double the circuit voltage
Over 17,500 volts	35,000 volts

56.9 Protection

A substantial wood guard (preferably painted white), or metal guard, or a plastic guard of suitable materials, not less than 8 feet in length, shall be securely attached to each anchor guy which is exposed to traffic. Such a guard will not be required where the anchor rod is 1¼ inches or greater in diameter, has an overall length above the ground of not less than 8 feet, and extends to a height of not less than 6 feet vertically above ground.

57. MESSENGERS AND INSULATED CABLES

57.1 Definition (see Rules 20.3 and 21.9)

57.2 Use of Messenger

Where a cable is of such weight that it would not meet the safety factors of Table 4 when self-supported, attachment to stranded messenger shall be made for supporting said weight.

57.3 Material and Strength (see Rule 49.7)

57.4 Clearances

Basic minimum clearances for messengers and insulated cables are specified in Rules 37 and 38, Tables 1 and 2 respectively and shall be measured to the nearest surfaces of the cable and messenger assembly, including cable rings and messenger supports. The basic clearances specified for conductors as modified by provisions of Rule 54.4 are applicable to insulated cables. These clearances for messengers and cables are also subject to the following modifications. The clearances required for supply conductors of 0-750 volts shall be applied to suitably insulated cables of any voltage having a metallic sheath which is bonded and grounded as specified in Rule 57.8.

A. Above Ground (see Rule 54.4-A)

B. Above Railways and Trolley Lines

(1) Which Transport Freight Cars: The clearances specified in Table 1, Case 1, Columns A, B and D are based upon the maximum height of standard freight cars, 15 feet 1 inch from the top of rail to top of running board. These clearances shall in no case be reduced more than 5% because of temperature, wind or mechanical loading.

(2) Operated by Overhead Trolley: The clearances specified in Table 1, Case 2, Columns A and D are based upon a maximum trolley pole throw of 26 feet.

Messengers, and cables, which are bonded and grounded as specified in Rule 57.8, may have clearances above the rails or running surfaces used by trolley cars or coaches less than the distance specified in Table 1, Case 2, Columns A and D for trolley-throw clearance, provided the messengers and cables are not less than 4 feet above the trolley contact conductor and are encased in wood boxing or moulding 7/8-inch or more in thickness for distances of at least 2 feet horizontally from the vertical plane through each trolley contact conductor.

C. Between Conductors in Cables

No specified clearance is required between the individual conductors of suitably insulated cables, whether single or grouped, and therefore the clearances specified in Table 2, Cases 15, 16, and 17 do not apply between such conductors. Any such multiple-conductor group shall be treated as a single conductor in the application of other clearance requirements.

D. Between Cables and Messengers

Cables supported by messengers are not required to be any specified distance from their supporting messengers.

E. Between Messengers

The clearance specified in Table 2, Case 1, Column A does not apply and no clearance is required where messengers of the same electrical system branch or cross.

F. From Poles, Crossarms and Other Conductors

Messengers, and metal sheathed cables, which are bonded and grounded as specified in Rule 57.8 shall have clearances not less than the minimum clearances required for conductors of 0-750 volts with all of the following provisions being applicable:

Such grounded messengers and cables may be attached to the surfaces of poles or wood crossarms at less than the clearance specified in Table 1, Column D, Cases 8 and 9. When attached to pole or wood crossarm at less than 15 inches from center line of pole such grounded messenger or cable shall be not less than 4 feet vertically above or 6 feet vertically below any unprotected supply conductor except that where a guard arm (or arms) is placed above messenger and cable as specified in Rule 57.7, the clearance of 6 feet may be reduced to not less than 4 feet below unprotected conductors of 0-750 volts (see App. G, Fig. 53).

Such grounded messenger and cable when supported on the same crossarm with unprotected conductors in excess of 750 volts shall be placed on the side of pole opposite the unprotected conductors (see App. G, Fig. 54).

Such grounded messenger and cable when supported on the same arm with unprotected conductors of 0-750 volts, shall be placed at not less than pin spacing (Table 2, Case 15, Column D) beyond the outermost unprotected conductor on the same side of pole (see App. G, Fig. 54).

The clearances required in this Rule 57.4-F between a cable and unprotected conductors shall not be held to apply between a grounded cable (and its messenger) and unprotected conductors of the same circuit on poles where unprotected conductors enter (or leave) a cable. On such poles no grounded section of messenger or cable shall be less than 15 inches from surface of pole.

Where two or more cables are attached to the surface of the same wood pole in accordance with the provisions of this Rule 57.4-F, they shall be placed on the same side of pole when their vertical separation is less than 8 feet but in no case shall the vertical separation be less than 1 foot.

G. From Buildings and Other Structures

Messengers, and metal sheathed cables, which are bonded and grounded as specified in Rule 57.8 are not required to clear buildings and other structures any specified horizontal distance and the clearance specified in Table 1, Case 7, Column D does not apply in such instances. Such cables, and messengers, shall be installed so that they do not interfere with the free use of fire escapes, exits, etc., and shall be so arranged as to hamper and endanger workmen and firemen as little as possible in the performance of their duties.

57.5 Fastenings

Hardware used in connection with messengers shall meet the strength requirements of Rule 49.7-C. Dead-end attachments used on messengers or reinforced cables shall have a strength not less than that of the messenger or reinforced cable.

Cedar and other soft-wood poles around which any messenger having an ultimate strength of 5,000 pounds or more is wrapped shall be protected by suitable shims. Hooks, lag screws, or other equivalent means to prevent the messenger from slipping along the pole shall be provided where necessary.

57.6 Sectionalizing of Messengers with Insulators

The grounding of an extended messenger, as specified in Rule 57.8, is not required provided such extended messenger is sectionalized as a guy by means of insulators.

57.7 Use of Guard Arms and Coverings

Any guard arm which is required to be installed by the provisions of Rule 57.4-F shall be at least 4 feet in length (Rule 20.9-D) and parallel to and not more than 4 inches above the top of the cable or messenger. In lieu of the guard arm, suitable protective covering of wood at least 4 feet in length may be placed around the cable and messenger.

Double guard arms shall be used where such a messenger or cable is dead ended on or wrapped around a wood pole, at a vertical separation of less than 6 feet below unprotected supply conductors of other circuits of 750 volts or less. Portions of cables which take the form of a riser or a grounded lateral or vertical run shall be covered as specified in Rule 54.6-E for risers.

57.8 Bonding and Grounding

The provisions of Rules 57.4, 57.6 and 57.7 for grounded cables, and grounded messengers, are applicable only to cables having metallic sheaths, and to messengers which are effectively grounded at both ends of each run and at intermediate points not exceeding 800 feet apart. Where such a metal sheathed cable is supported on a messenger, each section of cable between splices shall be permanently bonded to the messenger at not less than two locations.

Cables not bonded and grounded as specified above shall conform to the requirements for unprotected supply conductors with the modifications provided in the several parts of Rule 57. The cables of circuits supported by a messenger and where covered in accordance with Rule 57.4-C are not required to have metallic sheaths.

57.9 Sags

The sags of messengers which support cables shall be such that under the maximum loading conditions the tensions in the messengers shall not exceed the safe working stresses specified in Rule 49.7-B.

58. MISCELLANEOUS EQUIPMENT

58.1 Traffic Signals

Traffic signals supported on overhead suspensions shall be treated as specified in the following rules:

A. Messenger and Span Wire Clearances

The suspension messenger or span wire of all traffic signals shall be installed to afford the clearances prescribed for span wires; Table 1, Column A, and Table 2, Column A.

B. Lead Wires

Lead wires of 0-750 volts to traffic signals supported on messengers may be less than the clearances above ground specified in Table 1, Column D, Cases 2 and 3 provided they are maintained at a clearance above ground as specified in Table 1, Column A, Cases 2 and 3 for the messenger on which they are supported.

C. Clearance Above Thoroughfares

Traffic signals supported by span wires and supplied from circuits of 0-750 volts shall have a clearance of not less than 14 feet vertically above thoroughfares over which they are suspended (see App. G, Fig. 55) except that where any thoroughfare is used by railroads, street railways, trolley coach lines and double deck motor coaches, clearance not less than the following shall be maintained:

Conveyance using thoroughfare	Minimum clearance of signal above thoroughfare
Street railways and coach lines operated by overhead trolley --	Height of trolley conductor plus 1 foot (a)
Railroads which transport freight cars ------------------------	25 feet (b)
Double deck motor coaches -------	18 feet

(a) May be reduced to 14 feet if signal is more than 8½ feet from nearest trolley contact conductor and if signal is maintained not less than 1 foot radially from trolley span wires.
(b) May be reduced to 14 feet if signal is more than 8½ feet from center line of track.

Traffic signals supplied directly (without protective transformers) from circuits classified in excess of 750 volts shall be installed with clearances as prescribed for street lighting equipment.

58.2 Street Lighting Equipment

A. Circuit Voltage

Constant current series lighting circuits supplied from transformers or devices having an open circuit output voltage of more than 750 volts, except those circuits supplied from transformers or devices having a normal full-load output voltage of 750 volts or less which transformers are equipped with effective protective devices to prevent the continued existence of open-circuit voltage on the circuit, shall be classified as circuits of more than 750 volts.

Constant current series lighting circuits which conform to the specifications for circuits of 0-750 volts may be installed and treated as circuits of more than 750 volts provided any circuit so treated in any respect is consistently so treated throughout its entirety.

B. Clearances

(1) Above Ground: No part of street lighting equipment shall be less than 20 feet above thoroughfares except for lamps supported on brackets or fixtures which do not extend more than 48 inches from the face of pole or street side of curb, in which case the clearance may be reduced to 15 feet, provided the voltage does not exceed 750 volts (see App. G, Fig. 56).

(2) Above Railways and Trolley Lines: No part of street lighting equipment which is less than 8½ feet horizontally from center line of tracks of railroads not operated by overhead trolley shall be less than 25 feet above such tracks.

No part of street lighting equipment which is less than 8½ feet horizontally from the center line of tracks or from the nearest trolley contact conductor shall be less than 4 feet above the level of the trolley contact conductor or less than 23 feet or 26 feet above running surfaces used by trolley cars or coaches depending upon the location of the contact conductors as required by Rule 74.4-B1.

Those parts of street lighting equipment which are 8½ feet or more horizontally from the center line of any railroad track or any trolley contact conductor shall be not less than 20 feet above the surface of the thoroughfare, except as provided in Rule 58.2-B1 (see App. G, Fig. 56).

(3) From Conductors

a) Messengers and Cables: All parts of street light drop wires, street lamps, and their supporting fixtures (including rods, braces and guys) shall be not less than 1 foot above or 2 feet below the level of messengers or conductors supported by messengers. These vertical clearance requirements shall not apply to those parts of such street lighting equipment which are 2 feet or more horizontally from the vertical plane of messengers, conductors supported by messengers, and metal boxes.

b) Conductors Not Supported by Messengers: All parts of street light drop wires, street lamps, and their supporting fixtures (including rods, braces and guys) shall be not less than 1 foot radially from all unprotected conductors not supported on messengers (including lead wires and taps) except the lead wires supplying the street lamps within 24 inches of their points of entrance to the street lighting equipment.

(4) From Poles: All exposed metal parts of lamps and all such parts of their supports, unless insulated from the parts carrying current, shall be maintained not less than 20 inches from the surface of wood poles, except at pole tops. This rule shall not apply if the voltage of the circuit from which the lamp is supplied does not exceed 750 volts.

C. Lead Wires

Unprotected conductors from one level on a pole or structure to another level or to street lighting equipment shall not pass within a climbing or working space, and shall not pass through any other circuit except between pole pin positions.

Such unprotected conductors shall clear the conductors of other circuits by distances as specified in Rule 54.6-A.

Where the distance between levels is in excess of 12 feet and such unprotected conductors pass between the pole pair of conductors of any other circuit, additional supports shall be installed so that the maximum length of conductor between supports is not more than 12 feet.

Unprotected leads to street lighting equipment shall be maintained at not less than the clearances above railroads, thoroughfares and ground specified for street lighting equipment in Rule 58.2-B.

D. Insulators In Supports

Where a street lighting fixture is supported by a span wire, strain insulators shall be inserted in the span wire on both sides of the fixture not more than 9 feet nor less than 6 feet from the structures supporting the span wire; except that, where such span wire is used as a trolley for the purpose of drawing the fixture to the pole, the strain insulator at the service end may be located a distance of not less than 15 inches from the center line of pole.

Where metallic ropes or chains are used for the suspension of street lamps, said ropes or chains shall be effectively insulated from current carrying parts of equipment and of such length that when the lamp is in its normal position the lower end of the chain or rope will be not less than 8 feet from the ground, or a strain insulator shall be inserted in the free end of the rope or chain at a point not less than 7½ feet from the ground when the lamp is in its normal position. Metallic ropes or chains shall be arranged so that they do not establish a metallic conducting path around a span-wire sectionalizing insulator. In case this construction will not permit the lamp to be lowered sufficiently for trimming purposes, a nonmetallic rope shall be used.

See App. G, Fig. 56.

E. Lighting Units on Transformer Poles

Where a lamp is installed above a transformer or switch, a minimum vertical separation of 4 feet from any portion of the transformer or switch and the lighting unit shall be maintained.

Where a lamp is installed below a transformer, any portion of the lighting equipment shall clear all supply equipment a minimum distance of 1 foot.

Where a lamp is installed to one side of a transformer, any portion of the lighting equipment, shall clear the transformer case a minimum distance of 6 inches.

F. Cutouts

Suitable devices shall be provided by which each street lamp on series circuits of more than 750 volts may be safely and entirely disconnected from the circuit, before the lamps are handled, unless the lamps are worked on from wood poles or from suitable insulating stools, platforms or tower wagons. Exempted from this provision are lamps such as incandescent lamps which in themselves present a noncurrent-carrying surface which may be utilized as a handle in removing them from their support.

G. Exceptions

Lighting units supported on ornamental posts and supplied from underground sources are not included herein.

58.3 Transformers

A. Position on Pole

Where more than one transformer is installed on a pole, all transformers shall be placed on the same side of pole.

Transformers shall not be supported on pole top extensions.

B. Case and Lead Wire Clearances

(1) Above Ground:

a) Lead and Bus Wires: The clearances above ground specified in Table 1 are applicable to unprotected lead and bus wires of transformer installations except as modified by the following provisions.

Clearances above ground of unprotected lead and bus wires of transformer installations may be less than 25 feet as specified in Table 1, Column E, Cases 3 and 4, but shall be not less than 22½ feet except where a clearance of not less than 18 feet above ground is permitted by the provisions of Rule 54.4-A2b in which case the clearance above ground of such lead and bus wires shall be not less than 18 feet.

Clearances above ground of unprotected lead and bus wires of transformer installations may be less than 30 feet as specified in Table 1, Column F, Cases 3 and 4, but shall be not less than 27 feet.

Clearances above ground of unprotected lead and bus wires of transformer installations on structures of two or more poles may be less than 22½ feet or 27 feet as specified above, or less than 25 feet as specified in Table 1, Column F, Case 5, but shall be not less than 20 feet above ground, provided such lead or bus wires are guarded by transformer platform flooring which extends not less than 1 foot horizontally outside the vertical planes of all such lead and bus wires on the structure.

b) Cases: Cases of transformers supported on poles or structures shall be not less than 17 feet above the ground except that in areas which are not in any way accessible to vehicles, the clearance of cases above ground may be less than 17 feet provided all cases which are less than 8 feet above ground shall be effectively grounded.

(2) From Buildings: Transformers on poles shall be so located that normally unenergized parts clear the surfaces of buildings by not less than 3 feet horizontally or by not less than 8 feet vertically. Lead and bus wires carried as unprotected conductors shall have the clearances from buildings as specified in Table 1, Cases 6 and 7.

In situations where the foregoing clearances of cases and lead and bus wires from walls of buildings (not windows, fire escapes, etc.) are impracticable to obtain, such as the location of transformers on poles in alleys, these clearances will not be held applicable provided wood barriers authorized by this Commission are used.

(3) Cases From Conductor Levels Above and Below: Transformers shall be so installed that normally unenergized metal parts clear unprotected conductors, except the transformer connecting leads, by distances specified in the following provisions:

a) From 0-750 Volt Conductors Below: The vertical clearance of transformer cases and hangers from the level of 0-750 volt conductors below (whether such conductors are supported on crossarms or racks) shall be not less than 6 inches except for certain conductors as provided in Rule 58.3-B4.

b) From 0-750 Volt Conductors Above: The vertical clearance of unenergized metal parts of transformers from 0-750 volt conductors supported on crossarms above shall be not less than 3 inches or, in lieu of such vertical clearance, the unenergized parts of transformers shall be not less than 6 inches horizontally from such conductors. The vertical clearance of unenergized metal parts of transformers from 0-750 volt conductors supported on racks above shall be not less than 4 feet.

c) From 750-7500 Volt Conductors Below: The vertical clearance of unenergized metal parts of transformers from the level of 750-7500 volt conductors below shall be not less than 12 inches.

d) From 750-7500 Volt Conductors Above: The clearance between unenergized metal parts of transformers and 750-7500 volt conductors above or alongside shall be not less than 12 inches vertically or 12 inches horizontally, except that conductors of the circuit to which the transformer is connected may be less than the 12-inch vertical clearance from such unenergized parts but shall be not less than 6 inches vertically from the transformer case and not less than 3 inches radially from the hanger provided no line conductor which is less than 12 inches horizontally from the case or hanger is less than 3 inches (Table 1, Case 9) above the level of the top surface of the crossarm.

(4) Transformer Cases From Certain Conductors Less Than 6 Inches Below the Cases:

a) Transformer Leads on Heel Arms: Heel arms shall not be used to support lead wires or taps except where necessary to clear the lower voltage transformer leads from the transformer case or other conductors.

b) Line Conductors Less Than 6 Inches Below Cases: Where a transformer case is unusually long, a crossarm supporting line conductors of 0-750 volts may be used as a heel arm or such conductors on an arm may be less than 6 inches below the transformer case (or the hangers) provided all of the following conditions are met:

No more than a single transformer with lower voltage of 0-750 volts is supported on the pole at the same level;

The vertical clearances between conductors on the hanger arm and such line arm below shall be not less than as specified in Table 2, Cases 9 to 13;

It is not practicable to obtain the clearance of at least 6 inches specified in Rule 58.3-B3;

Such 0-750 volt conductors clear the transformer case by not less than 15 inches horizontally;

Service drops are not run from the crossarm supporting 0-750 volt conductors at that location; and

The vertical clearance of 0-750 volt conductors below the lowest point of the transformer primary leads is not less than

18 inches for primary leads of 750-7500 volts,
24 inches for primary leads of 7500-20,000 volts, and
36 inches for primary leads of 20,000-35,000 volts.

(5) From Hardware: Transformer cases, hangers, and other metal parts in contact therewith shall clear through bolts, arm braces and other hardware by not less than 1½ inches; except that transformer cases and hangers shall clear crossarm braces and crossarm through bolts by not less than 1-inch air-gap distance and 1½-inch creepage distance.

The minimum clearance of 1½ inches from transformer cases hanger and other transformer metal parts to through bolts, arm braces, and other hardware, specified in Rule 58.3-B5, need not apply to through bolts in metallic contact with transformer cases or metal parts thereof nor to through bolts supporting heel arms, provided the portion of such through bolts extending into the climbing space is covered with a wood protective covering of well-seasoned douglas fir (Oregon pine) and are installed in a workmanlike manner or in the alternative, with impregnated fiber bolt covers 5/16 inches thick.

(6) From Guys: Transformer cases and hangers shall be not less than 4 inches from all portions of guys which are 6 inches or more from the surface of poles or crossarms at the guy attachment. Transformer cases and hangers shall be not less than 1½ inches from all portions of guys which are within 6 inches of the surface of poles or crossarms at the guy attachments.

(7) Treatment of Lead Wires: Vertical and lateral leads between line conductors and transformers shall comply with Rules 54.6 and 54.4-C6; and with the clearances specified in Table 1, Cases 8 and 9; and Table 2, Cases 15, 16 and 17. Where such leads enter cutouts or switches, Rule 58.5-C shall also apply. Such lead wires may be installed in the working space but shall not be installed in the climbing space.

All lead wires shall clear braces, bolts and other line hardware a distance of not less than 1½ inches.

C. Grounding

(1) Grounding of Windings: Transformer windings not exceeding 250 volts (except those used exclusively for energizing street lighting circuits and those used exclusively for energizing signal and track circuits) shall be effectively grounded as follows:

a) Single-Phase Systems: In two-wire (nominal 120-volt) systems one wire shall be grounded; in two-wire (nominal 240-volt) systems where the mid-point or some intermediate point of the winding is not available, one wire shall be grounded; in two-wire (nominal 240-volt) systems where the mid-point or some intermediate point of the winding is available, that point shall be grounded; in three-wire (nominal 120/240-volt) systems, the mid-point of the winding shall be grounded. (See App. G, Fig. 57.)

b) Two-Phase Systems: In three-wire (nominal 240-volt) systems, the point common to both windings shall be grounded; in four-wire (nominal 120/240-volt) systems, the mid-point of the winding on one phase shall be grounded; in four-wire (nominal 240-volt), and five-wire (nominal 120/240 volt) systems, the mid-points of both windings shall be connected and grounded. (See App. G, Fig. 58.)

c) Three-Phase Systems: In three-wire delta (nominal 120 or 240 volt) systems the mid-point of one transformer winding shall be grounded, or if the midpoint is not available on any of the transformer windings, a point common to two windings (one phase wire) shall be grounded; in three-wire star (nominal 120, 208, or 240 volt) systems, the point common to all windings shall be grounded or, if the common point is not available on a three-phase star-connected transformer of such a system, one of the phase wires shall be grounded; in four-wire star (nominal 120/208 volt) and three-wire T or Scott (nominal 240 volt) systems, the common point shall be grounded. (See App. G, Fig. 59.)

(2) Location of Transformer Winding Grounds: Transformer ground connections shall be provided at one of the following locations:

At the transformer pole,
At a pole adjacent to the transformer pole, or
At the load end of each service supplied from the transformer, separate from the usual house ground, except that where three or more services are supplied from one transformer or bank of transformers, ground connections at the two services nearest the transformer pole and one ground connection at services at approximately 500-foot intervals will suffice.

Transformer ground connections other than those occurring on common primary and secondary grounded neutral systems shall have a conductivity not less than that of No. 6 AWG copper wire.

Where a common primary and secondary grounded neutral system is used, ground connections shall conform to the requirements of Rule 59.4-A.

(3) Transformer Case Grounding or Bonding: Cases of transformers and metal parts in contact therewith shall not be grounded where supported on wood poles or wood structures.

Except in the case of partial underground distribution systems (see Rule 21.10), the hanging or placing of transformers on metal poles or structures is not recommended, particularly with respect to transformers connected to circuits of less than 14,000 volts. Transformers shall not be supported on metal poles or metal supports in contact with the ground unless the cases are securely bonded to the metal poles or parts of structures in contact with the ground and such poles or structures are effectively grounded. No transformer case shall be in contact with a metal crossarm or a metal beam attached to a wood pole or a wood structure, excepting a metal heel arm or rest which does not extend beyond the sides of any transformer case.

Transformers equipped with discharge gaps between windings and case shall be treated as above, and any discharge gap connected between case and ground shall be so arranged that the transformer case is grounded only during periods of arc-over of the gap.

The bonding of cases of transformers whose high voltage windings are connected to circuits of less than 20,000 volts is not recommended but where such cases are bonded the case bonding system shall not be electrically connected to any unassociated hardware or to other bonds.

Excepted from the provisions of this Rule 58.3-C3 applying to the grounding of transformer cases supported on wood poles or structures are the following:

Any transformer whose high-voltage winding is connected to a circuit of more than 14,000 volts, which may have its case grounded provided all such transformer installations on the system are so grounded, warning signs calling attention to the case grounding condition are posted on the structure so as to be readily legible from the climbing space or spaces, and no such grounded transformer case is less than 8 feet vertically or 4 feet horizontally from the unprotected conductors of any other supply-line circuit than those to which the transformer windings are connected;

Any transformer whose high-voltage winding is connected to a circuit of 750-14,000 volts, which may have its case grounded provided no unprotected conductors (including lead wires) of 750-14,000 volts shall be less than 8 feet vertically or 4 feet horizontally from the nearest part of such grounded case; and

Any transformer the case of which is less than 8 feet above the ground.

Transformer cases which are grounded in accordance with any provision of this rule shall be effectively grounded (see Rule 33.3).

D. Cutouts or Other Disconnecting Devices

Transformer cutouts, fuses, disconnects or switches shall be located so that they are readily accessible from climbing and working spaces. Such devices or their connecting leads shall not extend into the climbing space but may extend wholly or in part into the working space.

The vertical clearances of transformer cutouts, fuses, etc. above the levels of conductors of other circuits shall be not less than the clearances required between conductors as specified in Table 2, Cases 8 to 13.

The provisions of this rule shall not apply to partial underground distribution systems.

58.4 Capacitors and Voltage Regulators

A. Position on Pole

Where more than one capacitor or regulator is installed on a pole, all capacitors or regulators shall be placed on the same side of the pole. Excepted from this requirement are capacitors which may be installed on opposite sides of a pole between the two arms of a double arm provided no transformers, regulators, or oil switches are installed on the same pole.

Capacitors or regulators shall not be installed on pole top extensions.

B. Case and Lead Wire Clearances

(1) Above Ground: Any capacitor or regulator shall be so located that the bottom of the case and associated metal parts shall be not less than 17 feet above ground. The clearance above ground of leads to such apparatus shall conform to the requirements of Rule 58.3-Bla.

(2) From Buildings: Capacitors or regulators shall be so located that normally unenergized parts clear the surfaces of buildings by not less than 3 feet horizontally or by not less than 8 feet vertically. Lead and bus wires carried as unprotected conductors shall have the clearances from building specified in Table 1, Cases 6 and 7.

(3) Cases From Conductor Levels Below:

a) From 0-750 Volt Conductors Below: The vertical clearance of capacitor and regulator cases and their hangers from the level of 0-750 volt conductors below (whether such conductors are on crossarms or racks) shall be not less than 10 inches.

b) From Conductors in Excess of 750 Volts Below: The vertical clearance of capacitor and regulator cases and their hangers from the level of conductors in excess of 750 volts below shall be not less than

12 inches for conductors of 750-7500 volts,
18 inches for conductors of 7500-20,000 volts, and
24 inches for conductors of 20,000-35,000 volts.

(4) From Hardware: Capacitor or regulator cases, hangers, and other metal parts in contact therewith shall clear through bolts, arm braces of metal, and other hardware elements, by not less than 1½ inches; except that such cases shall clear crossarm braces by not less than 1-inch air-gap distance and 1½-inch creepage distance.

(5) From Guys: Capacitor or regulator cases and their hangers shall be not less than 4 inches from all portions of guys which are 6 inches or more from the surface of poles or crossarms at the guy attachments. Such cases and hangers shall be not less than 1½ inches from all portions of guys which are within 6 inches of the surface of poles or crossarms at the guy attachment.

(6) Treatment of Lead Wires: Vertical and lateral leads between line conductors and capacitors or regulators shall comply with Rules 54.6 and 54.4-C6; and with the clearances specified in Table 1, Cases 8 and 9; and Table 2, Cases 15, 16 and 17. Where such leads enter cutouts or switches, Rule 58.5-C shall also apply. Such lead wires may be installed in the working space but shall not be installed in the climbing space.

All lead wires shall clear braces, bolts and other line hardware a distance of not less than 1½ inches.

The clearance of Rule 37, Table 1, Case 8, Column E, as specified in Rules 58.3-B7 and 58.4-B6 shall not apply to the lead wires and terminals of transformers, regulators and capacitors installed on wood poles, provided said terminals and lead wires conform to clearances specified in Rule 37, Table 1, Case 9 and Rule 38, Table 2, Case 17.

C. Grounding and Bonding of Capacitors or Regulators

Cases of capacitors or regulators may be bonded together but shall not be bonded to cutouts, metal pins or dead-end hardware.

Cases of capacitors shall not be grounded where such cases or any parts thereof are within 8 feet vertically below, 4 feet vertically above or 4 feet horizontally from any unprotected conductors.

Any capacitor or regulator which may be grounded in accordance with any provision of this rule shall be effectively grounded (see Rule 33.3).

D. Cutouts or Other Disconnecting Devices

Cutouts, fuses, disconnects or switches used in connection with capacitors or regulators shall be located so that they are readily accessible from climbing and working spaces. Such devices or their connecting leads shall not extend into the climbing space, but may extend wholly or in part into the working space.

The vertical clearances of capacitor or regulator cutouts, fuses, etc., above the levels of conductors of other circuits shall be not less than the clearances required between conductors as specified in Table 2, Cases 8 to 13.

58.5 Line Switches and Disconnects

A. Clearance Between Energized Parts

Unenclosed switches supported on poles or pole structures shall be arranged with clearances not less than as specified in Table 2, Case 15 between the center lines of the separate phase units.

Unenclosed switches supported on poles or pole structures shall be arranged with clearances not less than as specified in Table 2, Case 17 between exposed parts which are energized from the same circuit from different phases or polarities.

B. Clearance Between Unenergized Parts and Unprotected Conductors

Metal switch cases and normally unenergized metal parts in contact therewith shall clear all unprotected conductors, except the connecting leads, by distances as specified in Rule 58.3-B3 for unenergized metal parts of transformers from unprotected conductors.

C. Lead Wires

Lead wires shall be suitably insulated from metal or wood cases of cutouts and switches at points of entrance thereto.

All unprotected lead wires including miscellaneous wiring shall clear braces, bolts and other line hardware a distance of not less than 1½ inches.

Where necessary at points of entrance to cutouts and switches, lead wires of 0-5000 volts may be less than 3 inches from the surface of crossarms (Table 1, Case 9, Column C, D, and E) but shall be not less than 1 inch from such surfaces.

D. Climbing and Working Space

Switches and cutouts shall be so located that when in either open or closed position they are not less than 15 or 18 inches from center line of pole as required by Table 1, Case 8, and no part of such equipment shall be in the climbing space. Such apparatus is permitted to be wholly or in part within working spaces.

E. Indicating Position

All enclosed switches shall indicate clearly whether they are in the open or closed position.

F. Grounding (see Rule 52.7-F)

G. Operating Mechanism

Grounded metal operating rods which pass through conductor levels shall be protected with a suitable insulating covering for a distance of 8 feet vertically or 6 feet horizontally from communication conductors (including cables) and from unprotected supply conductors. As an alternative to this provision, metal rods shall be ungrounded and shall have installed in them, at a point as near as possible to the switch, a suitable insulating link or section. All rods shall be securely held in position by staples or straps or other suitable means to afford clearances as specified in Table 2, Case 18 from conductors of circuits below the switch level.

All cables, ropes and other flexible means of operating switches shall have insulators installed in them at a point as close as possible to the switch and shall pass through guides to insure their separation from conductors through which they pass.

Where line switches are operated from the ground level by means of all-metal control mechanisms without suitable insulating links, an insulated platform shall be provided unless such operating mechanism is effectively grounded.

58.6 Time Switches, Meters, Metal Boxes and Other Apparatus

A. Location and Clearance From Transformer, Capacitor or Regulator Cases

Time switches, meters and other apparatus, including their enclosures, which extend more than 5 inches from the surface of a pole shall not be installed in the climbing space. Such apparatus, installed on the surface of a pole supporting a transformer (or other equipment of similar dimensions), shall be not less than 4 feet above or below the nearest part of transformer case (or other equipment), unless the time switch, meter, etc., is installed on the side of the pole occupied by the transformer (or other equipment).

B. Clearance From Unprotected Conductors

On wood poles or structures, all grounded metal boxes and grounded metal cases for time switches, meters, or other apparatus shall be not less than 3 feet above or 6 feet below the level of unprotected supply conductors. Where it is impracticable to obtain a clearance of at least 6 feet below unprotected supply conductors of 750 volts or less, a clearance of not less than 4 feet below such conductors will be permitted if a protective covering or guard is provided above the grounded surface.

C. Within 8 Feet of the Ground

Boxes or enclosures containing switches, meters, or other apparatus having accessible live parts, which are located 8 feet or less above the ground shall be effectively locked or sealed.

Metal boxes which contain supply or control equipment or conductors and are located 8 feet or less above the ground shall be effectively grounded.

59. COMMON PRIMARY AND SECONDARY GROUNDED NEUTRAL SYSTEMS

59.1 Definition (see Rule 20.7)

59.2 Applicability

The following rules cover certain special details for common neutral systems where the neutral conductor is common to primary circuits of less than 15,000 volts and secondary circuits of 0-750 volts supplied therefrom. These rules are supplemental to the rules given for supply lines in general and to other detailed construction requirements for supply lines.

59.3 Conductors

A. Material

Conductors of common neutral systems shall be of copper, copper-covered steel, bronze, stranded composites of any of the foregoing, aluminum, aluminum cable steel reinforced, or of other corrosion-resisting metal, but shall not be of galvanized iron or steel.

B. Size

In common neutral systems the common neutral line conductor shall have a cross-sectional area approximately 50 per cent or more of the area of the largest related primary phase conductor, as set forth in Table No. 14, and in no case shall have less conductivity or mechanical strength than No. 6 AWG medium-hard-drawn copper wire.

TABLE 14

Relative Sizes of Common Neutral System Line Conductors

Size of primary phase conductor (cir mils or AWG)	Minimum size of neutral conductor (AWG)
500,000	4/0
350,000	3/0
250,000	2/0
4/0	1/0
3/0	1
2/0	2
1/0	3
1	4
2	6
4	6
6	6

This table is based on the requirement that the common neutral line conductor shall have a minimum area of approximately 50 per cent of the area of the largest related primary phase conductor and that the phase and neutral conductors are of the same material. Where these are not of the same material, the copper conductance equivalents of the table will be considered as meeting the requirements.

C. Connections

All electrical connections shall be of suitable electrical and mechanical design.

D. Neutral Conductors

The arrangement and continuity of common neutral conductors shall conform to the following requirements:

Wherever existing plant permits, cross ties of the neutral conductor shall be made to form a continuous interconnected grid network. From each grid section there shall be one or more separate and continuous metallic return conductors to the source of supply.

If one return conductor is used, it shall have a minimum area of approximately 50 per cent of the area of the primary phase conductor of the largest overhead feeder serving the area. (See Table No. 14 of Rule 59.3-B for minimum sizes.)

If more than one return conductor is used, the current-carrying capacity of the return system shall be such that a break in one path shall leave one return path which shall have a minimum area of approximately 50 per cent of the area of the primary phase conductor of the largest overhead feeder serving the area. (See Table No. 14 of Rule 59.3-B for minimum sizes.)

Primary neutral conductors or secondary neutral conductors, where continuous, may be used as a return loop from a common neutral provided they are of sufficient current-carrying capacity as specified in Rule 59.3-B and provided that they are grounded throughout in accordance with the requirements for common neutral line conductors as specified in Rule 59.4-B. Primary or secondary neutral line conductors so used shall be carried in their normal primary or secondary positions respectively.

E. Common Neutral Line Conductor Location

(1) With Primary Circuits: On poles where all circuits are in excess of 750 volts, the common neutral line conductor may be located in a conductor position in the primary space.

(2) With Secondary Circuits: On poles where all circuits of a common neutral system are of less than 750 volts, the common neutral line conductor shall be located in a secondary conductor position.

(3) With Primary and Secondary Circuits: On poles where circuits of a common neutral system are of more and less than 750 volts, the common neutral line conductor shall be located in a related secondary conductor position; or common neutral line conductors may be located in both primary and secondary positions provided a metallic connection of a size not smaller than the largest neutral line conductor involved is installed between the neutral conductors in accordance with the construction

requirements for ground wires on poles at each location where a ground is required, and provided proper designation (see Rule 59.3-F) is made of the common neutral conductor in the primary position.

(4) In Conduits: Common neutral conductors may be installed in the same conduits with related phase conductors, provided that the insulation of the neutral conductor is not less than that required of the phase wires and, further, that it is treated as a phase wire for the entire run between terminals. Where the conduit installation is an effectively grounded metal riser pipe, the reference to insulation of the common neutral need not apply, provided the neutral conductor is connected to both ends of the riser pipe and effectively grounded.

The reference to insulation of the common neutral need not apply where the conduit installation is a plastic pipe having a dielectric strength of not less than 1000 volts per mil and a mechanical strength of not less than rigid, high impact, Type II, polyvinyl chloride pipe of a wall thickness not less than 0.2 inch.

(5) Under Crossarms: Incidental pole wiring connected to the common neutral conductor may be stapled to the underside of crossarms, provided the installation is such as to offer the least possibility of contact to workmen and such wiring under crossarms in the primary position is covered by a suitable protective covering.

59.4 Grounding

A. Material and Size

(1) Grounding Conductors: The grounding conductor from each ground electrode to the base of pole shall be not less than 1 foot below the surface of the ground and shall have not less conductivity and mechanical strength than No. 4 AWG medium-hard-drawn stranded copper. The grounding conductor shall be continuous without splices and shall be not less than No. 4 AWG copper.

(2) Ground Electrodes: Ground electrodes on common neutral systems shall conform to the following specifications as a minimum:

a) Not Part of a Water System: Ground electrodes which are not part of a water system shall be one-piece corrosion-resisting metal rods or pipes (or equivalent in physical and electrical qualities) 5/8 inch in diameter by 8 feet in length and driven to a minimum depth of 8 feet below the surface of the ground.

When two or more metal rods are installed, they shall be located at not less than 6-foot centers.

b) Part of a Water System: Where ground conductors are attached directly to a water pipe system, they shall be connected on the main line side of any water metering equipment.

B. Neutral Conductors

(1) Location: The common neutral grid system shall be grounded at intervals not greater than 1500 feet. On branch circuits extending from a grid, where return loop paths are not available, the common neutral line conductor shall be grounded at intervals not greater than 800 feet. Each transformer installation on a branch circuit without a loop return shall be so located that there will be one or more metallic water pipe system grounds, each of a resistance not greater than 3½ ohms, on each side of the transformer installation.

(2) Resistance: Where a common neutral system is used the resistance of the continuous metallic neutral grid to ground at any point shall not exceed 3½ ohms at any time.

If, after definite effort has been made, it is found not practicable to meet the above requirement, the following alternate requirement will be accepted:

The resistance between any point of said grid and the ground connection at the substation shall not exceed 1 ohm, and, furthermore, the resistance of the ground connection at the substation either shall not exceed 1 ohm or, if in excess of 1 ohm, shall be lower than that of any individual ground connection on the grid and in no case in excess of 2 ohms.

Measurement of resistance by any approved method is recognized. In lieu of measurements of resistance of the neutral conductor under the second alternative prescribed above, approved joints and demonstrable calculations will be accepted.

C. Transformers

Ground conductors of transformers on common neutral systems shall conform to the requirements of Rule 59.4-A1.

On common neutral systems, each transformer installation on a branch circuit without a loop return shall be so located that there will be one or more metallic water pipe system grounds of a resistance not greater than 3½ ohms on each side of the transformer installation.

A transformer installation located on a grid section of a common neutral system requires no independent ground provided that there is a ground connection, having a resistance not in excess of 3½ ohms, to the common neutral line conductor either at the transformer pole or at an adjacent pole.

SECTION CONTENTS

SECTION VI

ADDITIONAL CONSTRUCTION REQUIREMENTS FOR TOWER LINES

SECTION VI

ADDITIONAL CONSTRUCTION REQUIREMENTS FOR TOWER LINES

60. GENERAL

The following rules cover certain special details for the construction of tower lines. These rules are supplemental to the rules given for supply lines in general and to the detailed construction requirements for supply lines, which rules must be observed in tower line construction, except as modified herein, or where clearly inapplicable.

60.1 Definition (see Rule 21.7-C)

61. MAINTENANCE AND INSPECTION (see Rules 31.1 and 31.2)

62. STRENGTH REQUIREMENTS (see Section IV)

Where steel supports or towers are used which are not capable of withstanding practically as great a stress longitudinally as transversely, longitudinal guying shall be used (see Rule 47.2) or anchor towers shall be placed at intervals not greater than 10 spans. Such anchor towers shall be capable of withstanding the combined longitudinal tension under the loadings of Section IV of all conductors up to 10,000 pounds plus one half the excess above 10,000 pounds.

63. MATERIALS

63.1 Tower Members

Tower members shall have a thickness of metal not less than the following:

Galvanized steel: Main corner members, 3/16 inch; other members, 1/8 inch.

Painted steel: Main corner members, 1/4 inch; other members, 3/16 inch.

All iron or steel members of towers and all hardware subject to injurious corrosion under the prevailing conditions shall be protected by galvanizing, painting or other treatment which will effectively retard corrosion.

63.2 Overhead Ground Wires

Overhead ground wires or lightning protection wires shall be galvanized steel cable not less than 1/4 inch in diameter, or other corrosion resistant material of equal tensile strength. Where overhead ground wires are not used, effort shall be made to secure an effectively grounded structure.

63.3 Guys And Anchors

A. Guys

Guys shall be galvanized steel strand not less than 5/16 inch in diameter, or other corrosion resistant material of equal tensile strength, or they shall be rolled rods of galvanized steel or other corrosion resistant material, with a tensile strength at least equivalent to 5/16-inch steel cable.

B. Anchors

Anchor rods shall be galvanized steel not less than 5/8 inch in diameter or shall be of other material of equal strength and durability.

64. STEPPING

All metal towers shall be provided with steps or ladders, which shall start at not less than 7 feet 6 inches from the ground line and the spacing between steps on the same side of the tower legs shall not exceed 36 inches.

Where the members of the tower structure are so arranged that the tower may be climbed with safety no steps or ladder need be provided.

65. MARKING

All fabricated steel towers and similar structures which are of a design easily climbed and which are located in urban districts or in cultivated agricultural areas or near roads or trails which are frequently traveled, shall be equipped with a sign so worded as to warn the public of the danger of climbing same. Such sign shall be placed and arranged so that it may be read from the four corners of the structure. Such signs shall be neither less than 8 feet nor more than 20 feet above the ground except where the lowest horizontal member of the tower is more than 20 feet above the ground in which case the sign shall be not more than 30 feet above the ground.

66. CROSSINGS

Where lines supported by towers cross over major railroads (see Rule 22.3-B), or major communication lines (see Rule 20.5-A1), or other tower lines of voltages exceeding 30,000 volts, the towers supporting the crossing spans shall be designed to withstand, with safety factors as specified in Rule 44, the most severe conditions of temperature and loading specified in Rule 43 combined with the unbalanced pull which would be caused by any two conductors dead-ended or any two conductors broken in the span adjacent to the crossing.

SECTION CONTENTS

SECTION VII

DETAILED CONSTRUCTION REQUIREMENTS FOR TROLLEY CONTACT AND FEEDER CONDUCTORS AND THEIR SUPPORTING MESSENGERS, SPAN WIRES, ETC.

(Class T Circuits)

SECTION CONTENTS

SECTION VII

SECTION CONTENTS

SECTION VII

SECTION CONTENTS

SECTION VII

SECTION CONTENTS

SECTION VII

RULE | PAGE

SECTION VII

DETAILED CONSTRUCTION REQUIREMENTS FOR TROLLEY CONTACT AND FEEDER CONDUCTORS AND THEIR SUPPORTING MESSENGERS, SPAN WIRES, ETC.

(Class T Circuits)

70. GENERAL

The following rules cover certain special details for the construction of Class T circuits, together with their supporting messengers, span wires and appurtenances. These rules are in many cases supplemental to the rules for supply lines in general (Class T circuits being by definition supply lines), which general rules, including construction details of Section V, must be observed, except where clearly inapplicable or where specifically modified herein.

When the use of a special type of construction appears desirable or is necessary, and these rules are not clearly applicable thereto, the Commission will consider the application of a trolley system for such modification or amplification of these rules as shall be deemed necessary to apply to such case or special construction (see Rules 15 and 16).

71. POLES, TOWERS AND STRUCTURES

71.1 Definition (see Rules 21.7-C and 22.0)

71.2 Maintenance and Inspection (see Rules 31.1 and 31.2)

71.3 Material and Strength

The strength of poles shall be as prescribed in Section IV, except that in computing the strength of poles supporting Class T circuits, consideration shall be given the stresses set up by the dead weight of brackets, span wires, etc.

71.4 Clearances

A. From Railroad Tracks (see Rule 36)

71.5 Dimensions and Settings (see Rules 49.1-B and 49.1-C)

71.6 Marking and Guarding

A. Marking

Poles supporting only Class T conductors in excess of 750 volts not on crossarms need not be marked as supporting high voltage conductors as required by Rule 51.6.

B. Guarding Of Latticed Poles And Latticed Structures (see Rule 51.6-B)

71.7 Stepping (see Rule 51.7)

72. CROSSARMS

72.1 Definition (see Rule 20.9)

72.2 Maintenance and Inspection (see Rules 31.1 and 31.2)

72.3 Material and Strength (see Rule 49.2)

72.4 Marking

The provisions of Rule 52.4 apply to crossarms supporting Class T conductors except that any crossarm (either of wood or metal) or any appliance used in lieu thereof attached to poles or structures which support only Class T conductors of more than 750 volts, or such conductors and private communication conductors of the same ownership, need not be marked as supporting high voltage conductors.

72.5 Hardware

A. Protection Against Corrosion (see Rule 49.8)

B. Separation Between Different Hardware Elements (see Rules 52.7-C and 52.7-D)

73. PINS, DEAD ENDS AND CONDUCTOR FASTENINGS

73.1 Maintenance and Inspection (see Rules 31.1 and 31.2)

73.2 Material and Strength (see Rule 49.3)

73.3 Pin and Dead-End Spacing (Table 2, Case 15)

73.4 Bonding and Grounding (see Rules 52.7-F and 53.4)

74. CONDUCTORS

74.1 Definition (see Rule 20.8)

74.2 Maintenance and Inspection (see Rules 31.1 and 31.2)

74.3 Material and Strength

In determining strength requirements, Class T lines are classed as supply lines of equal voltage and will take grades of construction accordingly. This will generally mean Grade "C" construction for d-c trolley lines of 0-750 volts, Grade "A" or "B" being required at crossings over railways according to the importance of the railway crossed. (See Rule 22.3, Table 3, Rule 49.4 and Section XI.)

The minimum size which shall be used for trolley contact conductors on public streets or highways is No. 0 solid medium-hard-drawn copper, or other wire of equal strength.

The minimum size of wire to be used as a feeder span or feeder auxiliary span wire shall be No. 4/0 stranded medium-hard-drawn copper or other wire of equal strength.

74.4 Clearances

Except where specifically designated, Class T conductors take clearances specified for supply lines of like voltage.

A. Above Ground

The minimum vertical clearances above ground for Class T conductors shall be those specified in Rule 37, Table 1. References to rules modifying the tabulated values for supply conductors and Class T conductors of equal voltage are given in notes following Table 1.

B. Above Railways

(1) Tracks: The vertical clearance of 16 feet above rails for trolley contact, feeder and span wires of Table 1, Case 2, Column C, applies only to those railways which do not transport or propose to transport freight cars. This value shall be increased to 22½ feet where the railway involved does transport or proposes to transport freight cars.

(2) Crossings: Unless electric railroad systems are protected by interlocking plant at grade crossings with interurban or other heavy or high speed railway systems, the trolley contact conductors shall be at the same elevation above their own tracks throughout the crossing and next adjoining spans and, in addition thereto, catenary construction shall be provided when crossing spans exceed 100 feet. (See Appendix G, Figs. 62 and 63.) This rule is not intended to apply where pantagraph collector or similar device is used.

C. Between Conductors

The minimum clearances specified in Case 2, Column D; Case 4, Column B; Case 5, Column E and Case 15, Column D of Table 2 are not required between Class T conductors of the same potential and system.

The minimum clearance of 24 inches specified in Table 2, Case 9, Column D, is not required between trolley feeders of the same system provided, however, that the clearance shall be not less than 12 inches.

The minimum clearance of 48 inches specified in Table 2, Case 2, Column D, and Case 4, Column B, is not required in double trolley construction between feeder auxiliary span cables or equalizer cables and trolley contact conductors of opposite polarity provided, however, that the clearance shall be not less than 18 inches or, where the feeder or equalizer cables are attached to the span wires in accordance with Rule 74.4-G3, the clearance shall be not less than 3 inches at the point of crossing the trolley contact conductor.

Trolley contact conductors of the same system but of opposite polarity, (as in double trolley construction) or of different systems and of the same or opposite polarity, shall have a separation of not less than 11½ inches. Excepted from this provision are conductors at switches, frogs, crossings, etc., in which locations a vertical separation of not less than 3 inches shall be maintained between conductors of opposite polarity.

D. From Poles

Class T conductors of not more than 750 volts and of the same polarity, potential and system when carried on poles supporting no other conductors are not required to obtain the clearance of 15 inches from center line of pole (Table 1, Case 8), but shall comply with the clearance of 3 inches from surface of pole (Table 1, Case 9). The attachment of clearance arms for either supply or communication service drops does not affect the pole clearance of Class T conductors which are carried on one side or the top of a pole.

Where Class T conductors are carried on more than one side of jointly occupied poles the clearances of Table 1, Cases 8 and 9, shall apply and a climbing space conforming to Rule 54.7 shall be provided.

E. Under Bridges, Etc.

A reduction of the clearances given in Table 1 to a minimum of 14 feet for trolley contact conductors is permitted for subways, tunnels or bridges, provided the railway does not operate freight cars where the vertical distance from the top of car or load to trolley contact conductor is less than 6 feet. This will require the grading of the trolley contact conductor from the prescribed construction down to the reduced elevation. (See App. G, Fig. 64)

No clearance is specified between the trolley contact conductor and the structure. Where the structure is of material which will ground the trolley current in the event the collector leaves the contact conductor, a properly insulated trolley trough or equivalent protection shall be installed to prevent contact between the collector and the structure. Where pantagraph collectors are used, this protection is not required. See Rule 54.4-I for provisions applicable to conductors other than trolley contact conductors.

F. At Points of Failure

(1) Overhead Trolley Contact Conductors: All overhead trolley contact conductors shall be so supported and arranged that the breaking of a single "suspension" or fastening will not allow the trolley conductor, or live span wire, or current carrying connections to come within 10 feet from the ground or from any platform accessible to the general public. This does not apply to feeder taps to or from trolley contact conductors. (See App. G, Figs. 65 and 66.)

(2) Trolley Contact Conductors Of More Than 1500 Volts: Where in urban districts and not on fenced rights of way, trolley contact conductors of more than 1500 volts shall be so suspended that if the conductor is broken at a single point it cannot fall within 10 feet from the ground or from any platform accessible to the general public. This practically requires catenary construction.

G. From Span Wires, Guys and Messengers

The minimum clearances of conductors from span wires, guys and messengers are specified in Table 2 and are modified for Class T conductors by the following rules and by Rule 78.

(1) Span Wires and Contact Conductors: The minimum clearance of 48 inches specified in Table 2, Case 1, Column B, and Case 2, Column A, is not required between span wires and trolley contact conductors supported therefrom.

(2) Trolley Contact Conductors of 750-7500 Volts: The clearance specified in Table 2, Case 1, Column E, and Case 5, Column A, shall be increased to not less than 48 inches where trolley contact conductors of 750-7500 volts are involved. These clearances are not intended to apply to span wires and trolley contact conductors supported therefrom.

(3) Feeder and Equalizer Cables: Feeder auxiliary span cables or equalizer cables shall be installed at a distance not less than 18 inches above the span wire (see App. G, Fig. 67), or in lieu thereof, such cables, when protected by the equivalent of triple-braid weatherproof covering, may be supported not less than 2½ inches above the span wire by insulating supports attached to the span wire at intervals of not more than 5 feet.

74.5 Sags (see Rule 54.5)

74.6 Vertical and Lateral Conductors (see Rule 54.6)

74.7 Climbing and Working Space

The requirements of Rule 54.7 apply to poles supporting Class T conductors except where in accordance with the provisions of Rule 74.4-D conductors are permitted to have clearances from center line of pole less than are specified in Table 1, Case 8.

75. CONDUCTOR INSULATORS (see Rule 55)

76. GUYS AND ANCHORS

All of the provisions of Rule 56 are applicable to guys and anchors in trolley lines but are not intended to apply to trolley span wires, or other wires or cables used to support trolley contact conductors. Provisions applicable to trolley span wires are in Rule 77.

77. SPAN WIRES, BACKBONES, MESSENGERS, ETC.

77.1 Definitions (see Rules 20.1, 21.9, 22.9)

77.2 Inclusions

The provisions of Rule 77 apply to span wires, backbones, messengers, cross span wires, pull-offs, trolley strain guys and any other wires used to support trolley contact conductors and appurtenances.

77.3 Material and Strength

A. Material

Span wires, backbones, messengers, etc., shall be stranded and of galvanized steel or other corrosion-resisting material of equal durability.

B. Strength

The strength of span wires, backbones, messengers, etc., shall be such that the safety factors of Rule 44 are met:

77.4 Clearances

The basic minimum clearances for trolley span wires are specified in Table 1, Column C and in Table 2, Column A. Modifications of these basic clearances are specified in Rules 37 and 38 and by the following provisions:

A. Above Railways

The minimum vertical clearance of 16 feet above rails for trolley span wires (Table 1, Case 2, Column C) applies only to those railways which do not transport or propose to transport freight cars. This minimum clearance shall be not less than 22½ feet where the railway involved does transport or proposes to transport freight cars.

B. Under Bridges, Etc.

A reduction of the clearances given in Table 1 to a clearance of not less than 14 feet above the rails is permitted for trolley span wires under bridges, in tunnels, or in subways, provided the railway does not transport freight cars where the vertical distance from the top of car or load to trolley contact conductor is less than 6 feet. The grading of the level of trolley span wires from the basic clearance to this reduced clearance is permitted at approaches to bridges, tunnels, or subways.

C. From Conductors

The clearances of trolley span wires from conductors shall be as specified in Table 2, Column A, except as modified by the provisions of Rules 74.4-G and 78.

D. From Guys or Span Wires

The clearance specified in Table 2, Case 1, Column A (18 inches) is not required between trolley span wires, backbones, messengers, and similar wires or cables, used to support trolley contact conductors and appurtenances.

E. From Poles and Crossarms

The clearances specified in Table 1, Column C, Cases 8 and 9, are not intended to apply to insulated (unenergized) portions of span wires, backbones, messengers, pulloffs and similar equipment at the poles to which they are attached.

77.5 Fastenings

Hardware by which span wires, messengers, etc., are dead ended to poles or structures shall have a strength at least equal to that of the strand to which they are attached. Cedar and other soft-wood poles around which any span wire or messenger having an ultimate strength of 5000 pounds or more is wrapped, shall be protected by suitable shims. Hooks, lag bolts or other equivalent means to prevent the span wire or messenger from slipping along the pole shall be provided where necessary.

77.6 Requirements for Sectionalizing with Insulators

Span wires, backbones, messengers, etc., shall be sectionalized by means of insulators placed in them in accordance with the following rules.

Insulators used in the sectionalizing of span wires, backbones and messengers shall conform to the specifications for guy insulators as given in Rule 56.8 based on the voltage of the trolley contact conductor.

A. Span Wires

Span wires, not including bracket span wires, supporting or attached to wires which support contact conductors shall be sectionalized as follows:

(1) Supporting One Contact Conductor: One insulator (preferably of the interlocking strain type) shall be placed in the span wire between 4 feet and 5 feet (measured along the span wire) from each hanger or point of support of the trolley contact conductor and its appurtenances which have electrical contact therewith. Where the angle between the span wire and contact conductor is so small that the insulator will interfere with the movement of the current collecting device, such insulator may be installed more than 5 feet (measured along the span wire) from the contact conductor, but shall be not more than 4 feet in a perpendicular direction from the contact conductor. (See App. G, Figs. 68 and 69.)

A second insulator (preferably of the interlocking strain type) shall be placed in the span wire not less than 6 feet and not more than 9 feet from the pole or structure.

The separation between the first and second insulators shall be at least 4 feet wherever practicable but where the distance between the pole or structure and the trolley contact conductor is less than 14 feet the second insulator shall be not less than 15 inches from the surface of the pole or structure and outside of the climbing and working spaces.

Where the span wire is attached to a building, the second insulator shall be not less than 3 feet from the building.

Where the support is a wood pole and all facilities supported thereon are of one ownership and are operated and maintained by the same crews of workmen, the second insulator may be omitted.

(2) Supporting Two or More Contact Conductors of Same Polarity: Span wires supporting two or more contact conductors of the same polarity shall be sectionalized in accordance with Rule 77.6-A1, above. If the contact conductors are more than 18 feet apart an insulator shall be placed in the section of the span wire between the contact conductors at a point between 4 feet and 5 feet from each contact conductor hanger or support. Where the distance between contact conductors is less than 18 feet this provision does not apply.

(3) Supporting Contact Conductors of Opposite Polarity: Span wires supporting contact conductors of opposite polarity shall be sectionalized as follows: (insulator preferably of the interlocking strain type.)

(a) Where the support is a wood pole, one insulator placed between the nearest contact conductor of the pair and pole or structure shall be deemed sufficient. Location: Preferably four feet and not more than nine feet away from pole;

(b) Where the support is a steel pole, or is attached to a building, a second insulator in addition to the one mentioned above shall be placed between the nearest contact conductor of the pair and pole. Location: Preferably within the distance between four feet and nine feet;

(c) A span wire which supports trolley contact conductors of opposite polarity shall have an insulator placed in the span wire between the hangers of such opposite polarity conductors unless the hangers have a dry flash-over insulating value of 6,000 volts or more.

(4) Feeder Cables Used as Span Wires: One insulator (preferably of the interlocking strain type) shall be placed in such a span wire at a distance of not less than 15 inches from the surface of the pole supporting the feeder (except where only Class T circuits of the same polarity are installed on the pole as specified in Rule 74.4-D) and outside of the climbing and working spaces on such pole.

A second insulator (preferably of the interlocking strain type) shall be placed at the point where the feeder cable terminates, which point shall be not less than 1 foot nor more than 5 feet beyond the last trolley contact conductor to which it is electrically connected.

A third insulator (preferably of the interlocking strain type) shall be placed in the remaining section of the span wire at a distance of not less than 6 feet and not more than 9 feet (measured along the span wire) from the opposite pole or structure. (See App. G, Fig. 71.)

In catenary construction, the point at which the second insulator is placed shall be not less than 1 foot plus the distance between the messenger and contact conductor, nor more than 5 feet, beyond the last trolley contact conductor to which the feeder cable is electrically connected.

(5) Feeder Cables Used as Auxiliary Span Wires: Where the feeder cable is used as an auxiliary span wire, it shall be installed and maintained at a distance of not less than 18 inches above the span wire, or it may be attached to the span wire as provided in Rule 74.4-G3. Auxiliary feeder cable spans shall be sectionalized in accordance with the provisions of Rule 77.6-A4 above. (See App. G, Fig. 67.) In this type of construction the attachment of the feeder to the trolley contact conductor shall preferably be made on the side of the contact conductor opposite approaching traffic. (See App. G, Fig. 70.)

(6) Feeder Cables Crossing Poles: Where a feeder cable crosses the pole laterally, it shall not impair the climbing or working spaces and it is recommended that the cable be installed under a crossarm in fiber conduit or other suitable protective covering. (See Rule 54.6-C.)

B. Backbones And Pull-Offs

(1) Backbones Supported on Crossarms: A backbone which is supported by insulators on crossarms, pole brackets or trolley brackets, shall be treated as a Class T line conductor except in that section between the last such support and its dead-end attachment where it shall be sectionalized by means of an insulator placed not less than 6 feet and not more than 9 feet from each support. (See App. G, Fig. 72.)

(2) Backbone Attached to Poles: A backbone run between and attached directly to poles shall have insulators placed in it not less than 6 feet and not more than 9 feet (measured along the line of the backbone) from the points of attachment to the poles. (See App. G, Fig. 73.)

(3) Pull-Offs: Each pull-off from the contact conductor to that section of the backbone between the insulators specified in Rule 77.6-B2, above, shall have an insulator placed in it at a distance between 4 feet and 5 feet from the nearest contact conductor; or if this is not practicable, the insulator shall be installed as far as possible from the contact conductor. Any pull-off from the contact conductor to a point between the supporting pole and the backbone insulator shall have two insulators installed in it and the insulator nearest the pole or the backbone shall be not less than 15 inches from the center line of pole and shall be outside the climbing and working spaces. (See App. G, Fig. 73.)

C. Brackets or Bracket Arms

In bracket construction span wires which support, or are attached to other span wires which support, trolley contact conductors or appurtenances in electrical contact therewith shall be sectionalized as follows:

(1) General: An insulator shall be inserted in the span wire between the suspension of the trolley contact conductor and each point of support of the span wire, such insulators to be not less than 12 inches from the nearest trolley contact conductor. (See App. G, Figs. 74 and 75.)

Where the span wire supports contact conductors of opposite polarity an additional insulator shall be inserted between the hangers of such opposite polarity conductors unless the hangers have a dry flashover insulating value of 6000 volts or more.

(2) Exceptions: Where the brackets are supported on wood poles which support only conductors of one ownership, the insulators between the hangers and points of span wire support may be omitted. (See App. G, Figs. 76 and 77.)

Where brackets and their lift spans are suitably insulated along their length (perpendicular to the poles) and from the span wire, that part of Rule 77.6-C1 which prescribes an insulator between the contact conductor suspension and the point of bracket support need not apply. (See App. G, Fig. 78.)

Insulators placed in metal brackets and lift spans shall be not less than 12 inches radially from the trolley contact conductor. (See App. G, Fig. 79.)

(3) Feeder Conductors: Feeder wires used as bracket span wires shall be sectionalized as follows:

One insulator (preferably of the interlocking strain type) shall be placed in the span wire at a distance of not less than 15 inches from the surface of poles (except where only Class T circuits of the same polarity are installed on the pole as specified in Rule 74.4-D) and outside the climbing and working spaces. A second insulator shall be placed at the point where the feeder terminates. (See App. G, Fig. 80.)

On high speed lines it is recommended that in lieu of this type of construction the bracket span be installed as specified in Rule 77.6-C1 and the feeder span be installed as a bracket guy or lift span. In this case, one insulator shall be placed in the lift span so that the horizontal distance between the insulator and the surface of the supporting pole or structure shall be not less than 15 inches, and a second insulator shall be placed along the line of this lift span adjacent to the point of attachment to the bracket.

D. Messengers

Where an extended messenger is treated as a guy, the requirements specified for guys shall be met.

78. ATTACHMENTS OF FEEDER, COMMUNICATION OR FOREIGN CONDUCTORS

78.1 Feeder Conductors

Trolley feeders not exceeding 750 volts may, when suitably insulted, be attached to span wires supporting trolley contact conductors of the same system.

78.2 Private Communication Conductors

The general requirements for private communication conductors of trolley line systems are specified in Rules 20.5-B, 32.4-C and 89 of Section VIII. In addition to the treatment therein provided, private communication wires (Class C) owned by and used solely in the operation of trolley systems may, where suitably insulated, be attached to span wires supporting trolley contact conductors of such systems when installed and maintained in accordance with the following provisions.

A. Attached to Unenergized Span Wires

Private communication conductors (Class C) may be supported by unenergized portions of span wires provided they are attached between the first span wire insulator specified in Rules 77.6-A1 and 77.6-A2 or the second span wire insulator specified in Rule 77.6-A4 and the pole or structure. They shall not be attached to the section of span wire between contact conductor hangers except within such section of span wire sectionalized by means of insulators placed between 4 feet and 5 feet from each contact conductor hanger.

B. Attached to Energized Span Wires

Private communication conductors (Class C) may, where necessary, be supported by feeder cables of 0-750 volts used as span wires when such communication conductor attachments to feeder spans are insulated for not less than the trolley voltage.

78.3 Foreign Conductors

The following rules shall apply to decorative lighting fixtures, decorative lighting circuits, decorative garlands, and all other apparatus used for decorative purposes, where supported by and attached to the lines of trolley systems and when special permission for such supports and attachments has been secured from the trolley systems concerned.

Nothing herein contained shall be construed as requiring utilities to grant permission for such use of their overhead facilities; or permitting any use of joint poles or facilities for such temporary construction without the consent of all parties having any ownership whatever in the poles to which attachments may be made; or granting authority for the use of any poles or facilities without the owner's or owners' consent.

A. Attachment to Span Wires

(1) Decorative Lighting Fixtures and Circuits: Decorative lighting fixtures and decorative lighting circuits of not more than 300 volts may be attached temporarily to trolley span wires provided that such equipment and appurtenances meet all of the following requirements:

Circuit wires shall be rubber covered,
Wires shall be suitably insulated from (and in no case shall contact) the span wire,
Such equipment shall be placed only between the pole (or other support in lieu thereof) and the span wire insulator nearest the suspension of the trolley contact conductor, and
No energized part of such equipment shall be less than 18 feet above the street surface.

It is recommended that no attachment be made to energized portions of feeder span wires. However, if such attachment is permitted by the utility the insulators and rubber covered wire used shall be capable of withstanding the trolley voltage.

(2) Decorative Garlands and Other Unenergized Decorations: Decorative garlands and other decorations which are not energized may be supported by trolley span wires provided that no span wire insulator is made ineffective (shorted out) by such attachment.

B. Attachment to Poles

Where temporary lighting circuits of not more than 300 volts are attached to poles and used independent of span wire attachments or used to serve those span wire attachments, they shall comply with all of the requirements for supply conductors of 0-750 volts.

No decorative equipment shall be attached in any manner to longitudinal feeder cables (along or across thoroughfares).

C. Attachment of Auxiliary Span Wires to Poles Supporting Trolley Contact Conductors

Auxiliary span wires for the support of decorative lighting fixtures, decorative lighting circuits, decorative garlands, and any other apparatus used for temporary decorative purposes are strictly prohibited except when special permission is secured from this Commission. Under such permission the auxiliary span wire shall comply with all of the following requirements:

It shall be sectionalized, by means of insulators, in accordance with the rules applicable to overhead guys,

The span wire and conductors and any apparatus attached thereto shall be installed and maintained not less than 4 feet above the level of the trolley contact conductors and not less than 4 feet below any conductor in excess of 750 volts,

The span wire shall provide an ultimate strength of not less than that afforded by 3/8-inch common galvanized-steel strand, and

The additional mechanical loads on poles resulting from such installation shall not be such that the requirements of Section IV are not maintained.

No permits issued by Municipal or County Inspection Departments, or any trolley line system or other utility, shall be construed to permit the use of auxiliary span wires attached to poles supporting span wires of electric trolley systems, other than those auxiliary span wires which shall comply with all conditions set forth above.

79. THIRD RAILS

79.1 Territory

A. Cities, Towns, Etc.

Third rail construction or reconstruction shall not be permitted in or through cities, towns or urban territory, except for local rapid transit lines principally located in subways or on elevated structures.

B. Along Fenced Rights-of-Way

Third rail construction or reconstrction shall not be permitted unless the rights of way, easement or other property upon which same is located is entirely fenced. At every opening in such fence cattle guards or suitable fence gates must be used and a sign installed near such opening as provided in Rule 79.4.

79.2 Protection

Third rail construction or reconstruction shall not be permitted unless the third rail is protected by suitable guards made of wood or other suitable material. In lieu of such protection on spurs and loading tracks, disconnecting switches may be used, which shall be locked open when cars are not being switched.

79.3 Grade Crossings

A. Highways

Third rail railroads shall not cross a public highway at grade unless suitable wing fences are constructed dividing said highway from the private rights-of-way or fenced portion of highway or other property upon which said third rail railroad is located and unless all portions of said third rail are excluded from the portions of the highway between said wing fences, suitable signs being installed on either side of the highway as provided in Rule 79.4.

B. Fenced Railroad Rights-Of-Way

Where third rail railroads cross railroads located on fenced rights-of-way, wing fences and cattle guards need not be installed. No portion of the third rail shall be constructed or reconstructed within 10 feet of the nearest rail of the railroad crossed.

C. Railroad Rights-Of-Way Not Fenced

Where third rail railroads cross railroads not located on fenced rights-of-way, wing fences and cattle guards must be installed on both sides of the crossing at least 10 feet from the nearest rail of the railroad crossed. No portion of the third rail shall extend beyond the wing fences.

79.4 Warning Signs

At every cattle guard, gate or other opening in the fence surrounding the third rail, a sign bearing the words, "Danger," "Electric Third Rail" and "Keep Away," in letters at least three inches in height, shall be installed. The sign may carry other information relative to the hazard present, but these three items shall be in type of larger size than the type of the additional items.

SECTION CONTENTS

SECTION VIII

DETAILED CONSTRUCTION REQUIREMENTS FOR COMMUNICATION LINES

(Class C Circuits)

SECTION CONTENTS

SECTION VIII

SECTION CONTENTS

SECTION VIII

SECTION CONTENTS

SECTION VIII

SECTION CONTENTS

SECTION VIII

SECTION CONTENTS

SECTION VIII

SECTION CONTENTS

SECTION VIII

SECTION CONTENTS

SECTION VIII

SECTION VIII

DETAILED CONSTRUCTION REQUIREMENTS FOR COMMUNICATION LINES

(Class C Circuits)

80. GENERAL

The following rules cover detailed construction requirements for communication lines. These rules are supplemented, in certain cases, by rules in other sections. See Section IX for additional rules applicable to communication lines on poles jointly used with supply lines; see Section X for additional rules applicable to line crossings or conflicts; see Section XI for additional rules applicable to lines crossing railroads.

81. POLES, TOWERS AND STRUCTURES

81.1 Definition (see Rules 21.7-C and 22.0)

81.2 Maintenance and Inspection (see Rules 31.1 and 31.2)

81.3 Material and Strength

Communication poles shall meet the material and strength requirements specified in Section IV.

A. Replacement in Grade F Construction

Wood poles in Grade F construction shall be replaced or reinforced before the safety factor has been reduced to less than one-half, except that the circumference of sound solid wood within 18 inches above the below the ground line on such poles before replacement or reinforcement shall in no case be less than as follows:

Poles supporting 10 wires or less of open-wire local exchange conductors ------------------ 9 inches

Poles supporting cable, interexchange conductors or more than 10 wires of open-wire local exchange conductors ------------------------12 inches

Examples of replacement circumferences which meet these requirements are given in Tables 26 and 27 of Appendix D.

81.4 Clearances

A. From Railroad Tracks (see Rule 36; also Appendix E)

81.5 Dimensions and Settings (see Rules 49.1-B and 49.1-C)

81.6 Stepping

The lowest step on any stepped pole shall be not less than 7 feet 6 inches from the ground line where supply conductors are supported on the same pole with communication conductors. On poles supporting communication conductors only, the lowest metal step may be placed not less than 6 feet 6 inches above the ground and one wood step may be placed 3 feet 6 inches above the ground.

82. CROSSARMS

82.1 Definition (see Rule 20.9)

82.2 Maintenance and Inspection (see Rules 31.1 and 31.2)

82.3 Material and Strength (see Rule 49.2)

82.4 Hardware

A. Protection Against Corrosion (see Rule 49.8)

B. Metal Back Braces

Metal back braces shall be considered as one of the arms of double arm construction.

83. PINS, DEAD ENDS AND CONDUCTOR FASTENINGS

83.1 Maintenance and Inspection (see Rules 31.1 and 31.2)

83.2 Material and Strength (see Rule 49.3)

83.3 Pin and Dead-End Spacing (see Table 1, Case 8 and Table 2, Case 15)

84. CONDUCTORS

84.1 Definition (see Rule 20.8)

84.2 Maintenance and Inspection (see Rules 31.1 and 31.2)

84.3 Material and Strength (see Rule 49.4)

84.4 Clearances

Allowable variations in clearances due to temperature, loading, dead ending, etc., are given in Rules 37 and 38.

A. Above Ground

The minimum vertical clearances shall be those specified in Rule 37 and Table 1, with the following modifications:

(1) Across Arid or Mountainous Areas: The clearance of 15 feet specified in Table 1, Case 4, Column B may be reduced to not less than 13 feet over arid or mountainous areas which are not under cultivation and over which there is no likelihood of vehicular travel.

(2) In Rural Districts: The clearance of Table 1, Case 4, Column B may be reduced to not less than 13 feet above ground along thoroughfares in rural districts where no part of the line overhangs any part of the thoroughfare which is ordinarily traveled and where it is unlikely that vehicles will be required to cross under the communication conductors.

(3) Accessible to Pedestrians Only: Communication conductors of not more than 160 volts which transmit not more than 50 watts and communication cables having grounded metal sheaths may have a clearance of 8 feet above ground accessible to pedestrians only.

(4) Fenced Railway Rights-of-Way: Railway signal cables between line poles and signaling devices, which are entirely on fenced railway rights-of-way, and which are exposed to vehicular traffic but do not cross thoroughfares, may have clearances above ground less than as specified in Table 1, Column B, Case 4 (15 feet) but not less than 10 feet. Such cables which are entirely on fenced railway rights-of-way and which are in areas accessible to pedestrians only may have clearances above ground less than as specified in Table 1, Column B, Case 5 (10 feet) but not less than 7 feet.

(5) Above Swimming Pools: Crossings of communication line conductors above swimming pools shall be avoided where practicable. Line conductors shall have radial clearances from the top edge of the pool wall and vertical clearances above the highest water level of the pool of not less than 18 feet. Grounded metallic sheathed cables, plastic-jacketed cables with an inner grounded metallic sheath, and grounded messengers and grounded span wires which support cable may have minimum radial and vertical clearances as hereinabove stated of not less than 16 feet.

Service drops having coverings of materials specially approved by the Commission for installation above swimming pools and used in line cable construction may have minimum radial and vertical clearances as hereinabove stated of not less than 14 feet.

B. Above Railways and Trolley Lines

(1) Which Transport Freight Cars: The clearance specified in Table 1, Case 1, Column B (25 feet) is based upon the maximum height of standard freight cars, 15 feet 1 inch between top of rail and top of running board. This clearance shall in no case be reduced more than 5% because of temperature and loading as specified in Rule 43.

(2) Operated by Overhead Trolleys: The clearance specified in Table 1, Case 2, Column B (26 feet) is based upon a trolley pole throw of 26 feet, the usual maximum height of a free trolley pole above the rails or other traveled surfaces used by trolley cars or coaches. Where trolley lines have a maximum trolley throw at variance with 26 feet the specified clearance shall be increased or may be reduced accordingly except that in no case shall the clearance be reduced such that there is less than 4 feet vertical separation from trolley contact wires. Where the trolley system consists of buses with retractable trolley poles, trolley span wires will be considered adequate guarding for telephone drop wires which are attached to the same poles as the span wires if the drop wires are essentially in the same vertical plane with the span wires. In such cases the drop wires will be placed such that there is a minimum separation of 4 feet between the drop wires and the trolley contact wire.

See Rule 87.4-B2 for the clearance of grounded cables and messengers.

Where railways operated by overhead trolleys transport freight cars, the clearance requirements of Rule 84.4-B1 also apply.

C. Between Conductors

The minimum clearances shall be those specified in Rule 38, Table 2, (see also Rule 32.2-D) with the following modifications:

(1) Open Wire

a) On Related Line and Buck Arms: The clearance of 6 inches specified in Table 2, Case 14, Column C is not required between conductors on line arm and related buck arm where the conductors supported by such arms do not cross.

b) On Brackets Attached to Crossarms: Line conductors supported on brackets or extensions attached to crossarms shall be maintained at, or outside of, the outer pin or dead-end positions on the crossarm with a radial separation not less than the minimum pin spacing specified in Table 2, Case 15 (3 inches) from any other line conductors supported by the same crossarm, except that not more than two conductors on the same side of pole on any crossarm may be supported on brackets within the outer pin position and below conductors normally supported on pins on the crossarm provided that all conductors concerned do not carry more than 160 volts and the power transmitted does not exceed 50 watts and the vertical separation between conductors so supported on brackets and those attached on pins or dead ends on crossarms not supporting the bracket shall be not less than 12 inches. The vertical clearances specified in Table 2, Cases 1 to 14 shall be provided between the conductor on the bracket and the conductor level of any other conductors not supported on the crossarm to which the bracket is attached.

This rule shall not be held to apply to clearances between conductors of the same or similar circuits at points of transposition.

c) Attached Directly to Poles: On poles which carry no crossarms, open wire conductors which are attached to the sides of poles by means of hooks, knobs or brackets may be placed in any position within the 3 feet next below the topmost conductor on the pole. The vertical separation between conductor supports on the same side of pole in this space of 3 feet shall be not less than 6 inches. Below this point (3 feet below the topmost conductor) conductors shall be attached to one side of pole only, not more than 6 conductors shall be so attached, and the vertical separation between these conductors shall be not less than 12 inches.

On poles which carry communication crossarms only, one pair of open wire conductors may be attached to opposite sides of the pole by means of hooks, knobs, or brackets, at a point not less than 2 feet below the lowest level of conductors supported on crossarms. Below this point (2 feet below conductors on crossarm) other conductors which are attached to surface of pole shall be attached to one side of pole only, not more than six conductors shall be so attached, and their vertical separation shall be not less than 12 inches.

Branch or tap lines and service drops from conductors attached to poles may be similarly attached to the face or back of a pole, but not both.

(2) Duplex, Triplex, and Cables: Insulated single conductors (rubber insulated), duplex, triplex, and paired conductors are considered as cables (see definition, Rule 20.3) and the clearances for such conductors are specified in Rule 87.4.

D. From Poles and Crossarms

Table 1, Case 8, Column B specifies a minimum clearance of 15 inches from center line of pole which is applicable to communication conductors including cables and service drops. Modifications of this basic 15-inch clearance are specified in Rule 37 and by the following provisions where conductors are not on poles jointly used for supporting supply conductors excepting supply service drop clearance attachments (see Rules 54.8-C2 and 54.8-C3). On poles jointly used for supporting supply conductors the basic 15-inch clearance may be reduced to 9 inches on one side of the pole provided that it is increased to not less than 21 inches on the other side of the pole.

The clearance of 3 inches specified in Table 1, Case 9, Column B is not intended to apply to communication conductors.

(1) Conductors Supported on Crossarms: The 15-inch minimum clearance from center line of pole specified for communication conductors supported on crossarms may be reduced under the following conditions:

For open wire toll and other open wire line conductors not used for exchange or local distribution, a clearance of not less than 9 inches from center line of pole may be used;

For open wire exchange or local distribution conductors which were originally installed as toll line conductors, a clearance of not less than 9 inches may be used provided such exchange conductors do not carry more than 160 volts and 50 watts;

For open wire local exchange and local distribution conductors in rural districts, the conductor clearance from center line of pole may be not less than 9 inches provided the voltage of such conductors is not more than 160 volts, power transmitted does not exceed 50 watts;

Cables or messengers may be attached to opposite sides of pole and have clearances less than 15 inches from center line of pole where placed 2 feet or more below the level of the lowest communication conductors supported on crossarms;

Cables or messengers may have clearances less than 15 inches from center line of pole where placed between crossarms or less than 2 feet below the level of the lowest communication conductor supported on crossarms.

(2) Conductors Not Supported on Crossarms: Communication conductors which are not supported on crossarms may be attached to poles by means of hooks, knobs, or brackets and thus are not required to be any specified distance from center line of poles provided the clearance between conductors complies with the requirements of Rule 84.4-C1c. The minimum clearance of such conductors from the surface of poles shall be such that suitable insulation is maintained.

(3) Colinear, Conflicting or Crossing Lines (See Rule 32.3): Where two communication lines are colinear or otherwise in conflict or where a pole of one line is interset in another line at crossings, the clearances of Rule 32.3 and Table 1, Case 8, Column B may be modified as follows:

In applying any of the provisions of this Rule 84.4-D3 an unobstructed climbing space on each pole concerned shall be maintained with horizontal dimensions of not less than 30 inches square for conductors carrying more than 160 volts and 50 watts, and not less than 18 inches in width and 30 inches in depth for conductors carrying lower voltage and power.

a) Where Clearance Arms are Used: Where clearance arms are used, on poles which support only communication conductors, to support the conductors of a colinear or conflicting communication line the clearance of such conductors from the center line of pole shall be not less than 15 inches for conductors carrying more than 160 volts and 50 watts and shall be not less than 9 inches for conductors carrying lower voltage and power.

b) Where Clearance Arms are Not Used: Communication conductors which in passing another communication pole unattached would be less than 15 inches from the center line of pole or less than 5 inches from the surface of pole shall be attached to the pole in accordance with the provisions of Rules 84.4-C1c and 84.4-D2.

(4) Conductors Passing Supply Poles and Unattached Thereto: The center line clearance between poles supporting supply conductors and any communication conductors which pass such poles unattached shall be not less than 22½ inches (1½ times the clearance specified in Table 1, Case 8), except where the supply pole

is within 10 feet of the pole on which the communication conductors are supported. Where poles of the two lines are less than 10 feet apart, clearances not less than as specified in Table 1, Case 8, shall be maintained.

a. Cable sheath and messenger are suitably insulated for the street lighting and other voltages involved. For metallic poles, insulation to extend 3 feet horizontally from pole center line.

b. Cable and messenger to be mechanically protected from abrasion where necessary.

E. Above or Beside Buildings, Bridges and Other Similar Structures

Conductors (including cables) shall be so arranged as to hamper and endanger firemen and workmen as little as possible in the performance of their duties. The basic clearances of conductors from buildings are specified in Table 1, Cases 6 and 7. The requirements of Table 1, Case 7, also apply at fire escapes, exits, windows, etc., at which human contact may be expected.

Communication cables are not required to be any specified distance from the sides of buildings, but they shall be installed so that they do not interfere with the free use of fire escapes, exits, etc.

The vertical clearance of communication conductors (including cables) above buildings as specified in Table 1, Case 6, may be reduced to not less than 2 feet under the following conditions:

Over roofs of 3/8 pitch (37 degrees from the horizontal) or greater,

Over roofs where the conductor does not overhang the building by more than 6 feet

See Rule 84.8-C4 for service drop clearance requirements.

F. Under or Through Bridges, Viaducts or Similar Structures

Open wire communication conductors which cross under or through bridges, viaducts, or similar structures shall be maintained at clearances above ground and walkways as specified in Table 1, Cases 1 to 6; at a radial clearance from unprotected conductors of other classifications of not less than as specified in Table 2, Case 3; at clearances from walls and the underside of such structures as specified in Table 1, Case 7 except where it is not practicable to obtain the 3-foot clearance therein specified this clearance may be reduced to not less than 6 inches where the voltage does not exceed 160 volts; or where supported on the walls or underside of such structures, at clearances as specified in Table 1, Case 9 with supports at least every 50 feet.

In lieu of the above requirements, conductors which cross under or through bridges, viaducts, or similar structures shall be enclosed in metal sheaths, run in metal conduits, or be placed in ring construction on a messenger.

G. From Guys and Messengers (see Table 2, Cases 18 and 19, Column C; also Rules 86.4-C and 87.4).

84.5 Sags

The minimum conductor sags shall be such that under the specified loading conditions, the safety factor specified in Table 4, Rule 44 shall be met. See Table 25 in Appendix C for suggested minimum sags.

84.6 Vertical and Lateral Conductors

A. Open Wire

Open wire conductors from one level to another level on a pole or structure shall not pass within the climbing space (see Rule 84.7), and shall not pass between conductors of any other circuit except between pole-in conductor positions.

B. Ground Wires

Ground wires, other than lightning protection wires not attached to equipment or ground wires on grounded structures, shall be covered by metal pipe or suitable covering of wood or metal or of plastic pipe material designated as Type II in the standard specified in Rule 22.2, for a distance above ground sufficient to protect against mechanical injury, but in no case shall such distance be less than 7 feet. Such covering may be omitted providing the ground wire in this 7-foot section has a mechanical strength at least equal to the strength of No. 6 AWG medium-hard-drawn copper.

Portions of ground wires which are on the surface of wood poles and within 6 feet vertically of unprotected supply conductors supported on the same pole, shall be covered with a suitable protective covering (see Rule 22.2).

C. Risers

Risers of wires or underground cables shall be encased in securely grounded iron or steel pipe (or other covering of equal strength) from the ground line to a level not less than 8 feet above the ground line. Risers from underground cables of Class C circuits may be encased in plastic pipes in lieu of the grounded iron or steel pipe required by this rule. Such plastic pipe shall be of material as specified in Rule 22.2-D:

"A cable U-guard made of No. 14 gauge steel shall be considered adequate to meet the requirements of this rule."

Risers shall be covered by a suitable protective covering as defined in Rule 22.2, where within a vertical distance of 3 feet above or 6 feet below the level of unprotected supply conductors supported on the same pole or structure.

Vertical risers of wires or cables shall be encased in grounded iron or steel pipe, or protected by other suitable grounded metal covering of equal strength, from the ground line to a level not less than 8 feet above the ground line.

Risers where within both a 6-foot radius of another pole supporting supply conductors and within a vertical distance of 3 feet above or 6 feet below the level of any unprotected supply conductor shall be covered.

Exception: The dimension of 6 feet below the level of unprotected supply conductors as specified in the preceding two paragraphs may be changed to 40 inches provided that the electric and communications utilities involved agree that the basic minimum clearances specified by this general order, and its revisions, are adequate for their requirements.

D. Protective Covering

Protective covering shall be attached to poles, crossarms, and structures by means of corrosion-resistant metal straps or staples which are adequate to maintain such covering in a fixed position.

Where such covering consists of hardwood moulding the distance between straps or staples shall not exceed 3 feet.

Where such covering consists of a wood trough, due care shall be exercised to avoid the possibility of nails protruding through any inner surface.

84.7 Climbing Space

Climbing space shall be provided on one side or quadrant of all poles or structures supporting communication conductors excepting at the level of the one pair of conductors attached to the pole below the lowest crossarm (Rules 84.4-C1c, 84.4-D1 and 87.4-C3) and the top 3 feet of poles carrying communication conductors only which are attached directly to pole in accordance with the provisions of Rule 84.4-C1c.

The climbing space shall be maintained in the same position on the pole for a minimum vertical distance of 4 feet above and below each conductor level through which it passes excepting that where a cable is attached to a crossarm or a pole with the cable less than 9 or 15 inches from the center line of the pole supporting conductors on line arms (no buck arm construction involved) in accordance with the provisions of Rules 84.4-D1 or 87.4-C3, the 4 foot vertical distance may be reduced to not less than 3 feet.

The position of the climbing space shall not be shifted more than 90 degrees around the pole within a vertical distance of less than 8 feet.

The climbing space shall be kept free from obstructions excepting those obstructions permitted by Rule 84.7-E.

A. Where Line Arms Only are Involved (see App. G, Fig. 34)

The climbing space through the levels of conductors supported on line arms only should be so located that the center line of pole is approximately <u>midway</u> on the side of the climbing space parallel to the crossarms. The horizontal dimensions of such climbing spaces, with widths measured perpendicularly to the conductors, and with depths measured from center line of pole and parallel to the conductors, shall be not less than those specified in Rules 84.7-A1 and 84.7-A2, except at angles in lines in which cases the widths of 18 and 30 <u>inches</u> may be reduced provided the horizontal separation or pole pin conductors measured parallel to the crossarm shall be not less than 16 and 30 respectively.

(1) On Poles Which Support Communication Conductors Only: The climbing space for toll, trunk and for exchange or local distribution conductors shall be not less than 18 inches in width and not less than 30 inches in depth.

(2) On Poles Jointly Used With Supply Conductors: The climbing space through the levels of communication conductors on line arms on poles jointly used with supply conductors, shall be not less than 30 inches in width and not less than 30 inches in depth, except that climbing spaces of the dimensions specified in Rule 84.7-A1 may be used where the only supply conductors supported by the pole are on service drop clearance attachments as permitted by Rules 54.8-C2 and 54.8-C3.

B. Where Buck Arms are Involved

The horizontal dimensions of the climbing space on jointly used poles shall be fixed according to the following crossarm combinations of line arms and related buck arms. For this purpose a metal back brace shall be considered as one of the arms of double arm construction and where used the requirements for double arm construction shall be met.

(1) Double Line Arm and Double Buck Arm: Where the combination is double line arm and double buck arm the climbing space shall be not less than 26½ inches square measured horizontally from the center line of pole (see App. G, Fig. 37).

(2) Double Buck Arm and Single Line Arm, or Vice Versa: Where the combination is double buck arm and single line arm, or vice versa, and the climbing space is left open on the opposite side of pole from the single arm, the climbing space (measured horizontally from center line of pole) shall be not less than 20 inches perpendicular to the single arm, and not less than 26½ inches perpendicular to the double arms (see App. G, Fig. 36).

(3) Single Line Arm and Single Buck Arm: Where the combination is single line arm and single buck arm and the climbing space is left open on the sides of pole opposite the crossarms, the climbing space shall be not less than 20 inches square measured horizontally from center line of pole (see App. G, Fig. 35).

(4) Alternative: Where a combination of a single line arm and a single buck arm or a double line arm and single buck arm (or vice versa) is involved and it is impracticable to locate the climbing space on the side of the pole opposite the single arm or arms, it may be located in another quadrant provided that any arm within such climbing space is treated as one of the arms of a double arm installation and that where a change of quadrant is involved the provisions of Rule 84.7 are observed.

C. Through Conductors Not on Crossarms

Where communication conductors are not supported on crossarms, an unobstructed climbing space not less than 30 inches square shall be maintained on jointly used poles through all conductor levels of such conductors (see App. G, Fig. 38).

D. Through Service Drops Not on Crossarms

Where hooks, knobs, or brackets are used for the support of service drops and other conductors are supported at a higher level on the pole, an unobstructed climbing space 30 inches square shall be maintained on jointly used poles through such attachments, and for not less than 4 feet above and below such attachments, using any one of the service drops as one side of the climbing space and having one other side perpendicular to it and tangent to the surface of the pole (see App. G, Fig. 39).

For clearance of service drop attachments above or below supply conductors see Rule 84.8-D1.

E. Allowable Climbing Space Obstructions

Vertical conductors, when in a suitable protective covering attached directly to the surface of the pole, terminal boxes or similar equipment which do not extend more than 5 inches from the surface of the pole, and guys, will not be held to obstruct the climbing space provided not more than one guy and one other of the above named obstructions are installed in any 4-foot vertical section of climbing space.

Crossarms and their supporting members are allowed in climbing spaces provided that, where buck arms are involved, any arms within climbing spaces are treated as double arms.

A guard arm, a longitudinal run of messenger, cable or insulated wire will not be held to obstruct the climbing space where they are placed in the climbing space because the presence of a building wall or similar obstacle will not permit the cable to be placed on the side of pole opposite the climbing space. Pole steps shall be suitably placed for the purpose of facilitating climbing past the level of terminal box, cable, drop wires and guard arm.

Unnecessary impairment of the climbing space is not permitted by the application of this Rule 84.7-E.

F. Colinear, Conflicting or Crossing Lines

(see Rule 84.4-D3)

84.8 Service Drops

A. Material and Size

Communication service drops shall be of material and size as specified in Table 8 and Rule 49.4-C7b with a covering at least equivalent to standard double-braid weatherproofing.

The following conductor covering materials are authorized for communications drop installations above swimming pools at the reduced clearances permitted in Rule 84.8C(5) (Page 242) provided the voltage of such conductors is not more than 160 volts and the power transmitted does not exceed 50 watts.

a. Neoprene-jacketed, reinforced, rubber-insulated parallel conductor drop wire conforming to Rural Electrification Administration Specification PE-7, dated May, 1956, or to American Telephone and Telegraph Company Specification AT-7412, Issue 3, dated Jan. 12, 1960.

b. Conductors which are protected by weather-resistant, abrasion-resistant suitably insulated tubing throughout that portion of their length which is over the pool and within a 20-foot radius of the top edge of the pool wall.

B. Attached to Surface of Pole

(1) Service Drops From Open Wire Lines: Where open wire communication line conductors are supported on crossarms, service drop attachments (by means of hooks, knobs or brackets) on the surface of pole shall be not less than 6 feet below or 4 feet above the level of the nearest unprotected supply conductor supported on the same pole.

(2) Service Drops From Cabled Lines:

a) Cable Supported on Crossarm: Service drops attached to crossarms supporting cables shall be not less than 15 inches from center line of pole as required by Table 1, Case 8, Column B.

b) Cable Without Guard Arm, Supported on Surface of Pole: Where the cable is supported on the surface of pole with messenger and cable 6 feet or more below the level of the nearest unprotected supply conductor, service drops may be attached to opposite sides of poles but not more than two sides (there being four sides). Such service drop attachments shall be not less than 6 feet below the level of any supply conductor of more than 750 volts and shall be not less than 5 feet vertically below the level of any unprotected supply conductor of 0-750 volts. Where drive hooks are used, they shall occupy pole surface areas not more than 8 inches in vertical extent and 1 inch in width, and not more than four hooks shall be placed in each of these areas.

c) Cable With Guard Arm, Supported on Surface of Pole: Where the cable is supported on the surface of pole at a minimum of 4 feet below the nearest unprotected supply conductor supported on the same pole, and is below a guard arm, service drop attachments may be attached to the face, back and bottom of the guard arm, provided such attachments are not less than 15 inches from center line of pole, the drop wires are below the top surface of the guard arm and the lateral run of the drop wires is installed in accordance with the provisions of Rule 84.6-C.

(3) With the agreement of the communications and electric utilities concerned with any joint use situation, a basic minimum clearance of 40 inches may be maintained between any supply conductor of 0-7500 volts and any communication service drop.

C. Clearances Above Ground and Buildings

The vertical clearances of communication service drops shall be not less than the minimum clearances specified in Rule 37, Table 1, Column B, with the following modifications.

(1) Above Public Thoroughfares: Service drop conductors shall have a vertical clearance of not less than 18 feet above public thoroughfares, except that this clearance may grade from 18 feet at a position not more than 12 feet horizontally from the curb line to a clearance of not less than 16 feet at the curb line, provided the clearance at the center line of any public thoroughfare shall in no case be less than 18 feet. Where there are no curbs the foregoing provisions shall apply using the outer limits of possible vehicular movement in lieu of a curb line.

(2) Above Private Thoroughfares or Private Property:

a) Industrial and Commercial Premises: Over private driveways or lanes, or over private property accessible to vehicles, service drops shall have a vertical clearance of not less than 16 feet.

b) Residential Premises: Over residential driveways or lanes, or over residential property accessible to vehicles, service drops shall have a vertical clearance of not less than 12 feet. If the building served does not permit an attachment which will provide this 12-foot clearance without the installation of a structure on the building the clearance shall be as great as possible but in no case less than 10 feet.

(3) Above Ground in Areas Accessible to Pedestrians Only:

a) Industrial and Commercial Premises: Over areas accessible to pedestrians only, service drops shall have a vertical clearance of not less than 12 feet.

b) Residential Premises: Over areas accessible to pedestrians only, service drops shall be maintained at a vertical clearance of not less than 8 feet.

c) Above Ground on Fenced Railway Rights-of-Way: Service drops to railway signal devices shall be maintained at clearances as specified in Rule 84.4-A4. Service drops which are entirely on fenced railway rights-of-way in areas accessible to pedestrians only may have clearances above ground less than as specified in Table 1, Column B, Case 5 (10 feet), but not less than 7 feet.

(4) From Buildings and Structures: Service drops shall be so arranged as to hamper and endanger firemen and workmen as little as possible in the performance of their duties.

Service drops are not required to clear buildings any specified horizontal distance but shall be so installed that they do not interfere with the free use of fire escapes, exits, windows, doors and other points at which ingress or egress might be expected.

Service drops of less than 160 volts and 50 watts are not required to clear the roofs of buildings on the premises served any specified vertical distance. The vertical clearance above buildings on premises other than the one being served shall be not less than 8 feet, except that a reduction to not less than 2 feet is permitted for service drops of less than 160 volts and 50 watts under the following conditions:

Over roofs of 3/8 pitch (37 degrees from the horizontal) or greater;

Over roofs where the conductor does not overhang the building by more than 6 feet.

Service drops of other communication lines (greater than 160 volts and 50 watts) shall have vertical clearances above buildings as specified for supply service drops in Table 10 (Rule 54.8-B4b).

(5) Above Swimming Pools: Service drop installations above swimming pools shall be avoided where practicable. Where service drop conductors are installed above a swimming pool, the conductors shall have radial clearances from the top edge of the pool walls of not less than 18 feet and shall have the vertical clearances of not less than 18 feet above the highest water level of the pool. Service drops having coverings of materials specially approved by the Commission for installation above swimming pools may have vertical clearances above the pool and radial clearances from the top edge of the pool wall of not less than 14 feet for public and commercially operated pools and not less than 10 feet for residential pools. (see Rule 84.8A)

No service drop may be installed less than 14 feet vertically above the horizontal plane through a diving board or platform, the area of such plane being within 8 feet radially of the diving board or platform and over the water surface of the pool.

No service drop may be installed less than 10 feet vertically above the horizontal plane through a diving board or platform, the area of such plane being the area within 3 feet radially of the diving board or platform and not over the water surface of the pool.

D. Clearances Between Conductors

The clearances of communication service drop conductors from other conductors shall be not less than the minimum clearances specified in Rule 38, Table 2, Column C, with the following modifications:

(1) Above or Below Supply Line Conductors: (See Rule 32.2-F).

a) Crossings in Spans: Service drops which cross below supply line conductors of 0-750 volts, or above supply line cables where treated as in Rule 57.8, may have a vertical clearance less than as specified in Table 2, Case 4, Column C (48 inches), from such supply conductors, but not less than 24 inches; provided the crossing is 6 feet or more from any pole which supports any conductor involved in the crossing but which does not support both conductors involved in the crossing.

b) Supported on the Same Pole: Service drops which are supported on a pole which also support supply conductors and which are not on a pole-top clearance attachment may have a vertical clearance less than as specified in Table 2, Case 9, Column C (48 inches), above or below supply line conductors provided not less than the clearance shown in Table 15 are maintained:

TABLE 15

MINIMUM RADIAL CLEARANCE BETWEEN COMMUNICATIONS SERVICE DROPS AND LINE CONDUCTORS

Radial Distance of Crossing from Supporting Pole (Feet)	Minimum radial clearance (inches): From police and fire alarm line conductors	Minimum radial clearance (inches): From supply line conductors
5 or less	6	12
10 or less, but more than 5	9	18
15 or less, but more than 10	15	24
20 or less, but more than 15	21	24
More than 20	24	24

(2) On Clearance Crossarms: Communication service drops may be supported on a clearance crossarm at a vertical distance less than as specified in Table 2, Case 9, Column C (48 inches), but not less than 24 inches above or below supply circuits of 0-750 volts, or above supply cables when treated as in Rule 57.8, provided the communication service drop

conductors are at least 25 inches horizontally from the center line of pole or are attached to suitable brackets on each end of the clearance arm and carried on the underside of the clearance arm from end to end in fiber or plastic conduit or under wood protective covering as specified in Rule 54.6-C. Service drops installed in accordance with this rule will not entail any change in the supply conductors supported on the pole.

(3) On Pole-Top Extensions: Communication service drops may be carried in a clearance crossing on pole-top extensions or brackets above supply conductors of 0-750 volts with a minimum vertical conductor separation of 24 inches, provided the service drop conductors clear the center line of pole (projected) not less than 25 inches horizontally, and further provided the service drop conductors clear the outside pin position conductors of the other circuit not less than 24 inches. Where, in addition to the pole-top extension or bracket, the communication service drops are supported on a bracket on the end of the 0-750 volt supply line crossarm, a minimum radial clearance of 12 inches will be permitted at the point of crossing of the outside pin position conductor. In such construction the crossarm of the extension shall be of wood.

Service drops installed in accordance with this rule will not entail any change in the supply conductors supported on the pole.

(4) Above or Below Supply Service Drops: The radial clearance between communication service drop conductors and supply service drop conductors may be less than 48 inches as specified in Table 2, Column C, Cases 4 and 9; Column D, Cases 3 and 8, but shall be not less than 24 inches. Where within 15 feet of the point of attachment of either service drop on a building, this clearance may be further reduced but shall be not less than 12 inches.

(5) Above Trolley Contact Conductors: Service drops may cross above trolley contact conductors, including messenger in catenary construction, at a vertical distance of not less than 4 feet. See also Rule 32.2-F.

E. Clearance From Other Poles

Service drops shall clear the center line of any pole by which they are not supported by not less than 22½ inches, except where such pole is less than 10 feet from the pole which supports the service drops. Where these two poles are less than 10 feet apart this clearance may be less than 22½ inches but shall be not less than 15 inches.

85. CONDUCTOR INSULATORS

85.1 Material

Insulators used on lines shall be porcelain, glass, or other equally suitable material.

85.2 Strength (see Rule 49.5)

86. GUYS AND ANCHORS

86.1 Definition (see Rule 21.3)

86.2 Use

Where mechanical loads imposed on poles, towers or structures are greater than can be supported with the safety factors as specified in Rule 44, additional strength shall be provided by the use of guys or other suitable construction.

Where guys are used with poles or similar structures capable of considerable deflection before failure, the guys shall be able to support the entire stress, the pole below the point of guy attachment acting merely as a strut.

Guys shall be attached to structures as nearly as practicable at the center of load. They shall be maintained taut and of such strength as to meet the safety factors of Rule 44.

86.3 Material and Strength (see Rule 49.6)

86.4 Clearances

The basic minimum clearances of guys above the ground and from other wires or cables are specified in Tables 1 and 2. Modifications of these basic clearances are specified in Rules 37 and 38 and by the following provisions:

A. Above Ground

(1) Across or Along Public Thoroughfares: Guys over or across public thoroughfares in urban districts shall have a clearance of not less than 18 feet above ground (Table 1, Case 3, Column A) except that a clearance of not less than 16 feet is permitted for the portions of guys over that part of the public thoroughfare which is an entrance to or exit from industrial or commercial premises; and not less than 14 feet in cases where an entrance to or exit from private residential premises is involved.

Overhead guys along public thoroughfares may have clearances, above ground which is not normally accessible to vehicles, less than as specified in Table 1, Column A, Cases 3 and 4 (18 feet and 15 feet respectively) but sections of such guys between insulators shall have a clearance of not less than 8 feet above the ground, and sections of guys between insulators and poles shall have a clearance of not less than 7 feet above ground, and such guys without insulators shall be not less than 7 feet above ground.

(2) Over Private Property: Those portions of guys over private roadways or areas normally accessible to vehicles may have a clearance above ground less than 18 feet (Table 1, Case 3, Column A) but not less than 16 feet in rural districts and not less than 14 feet in urban districts.

(3) Above Swimming Pools: Guys shall have vertical clearances above the highest water level of the pool of not less than 16 feet.

No communications guy may be installed less than 16 feet vertically above the horizontal plane through a diving board or platform, the area of such plane being within 8 feet radially of the diving board or platform and over the water surface of the pool.

No communications guy may be installed less than 8 feet vertically above the horizontal plane through a diving board or platform, the area of such plane being the area within 3 feet radially of the diving board or platform and not over the water surface of the pool.

B. Above Railways and Trolley Lines

(1) Which Transport Freight Cars: The clearance specified in Table 1, Case 1, Column A (25 feet) is based upon the maximum height of standard freight cars, 15 feet 1 inch from top of rail to top of running board. This clearance shall in no case be reduced more than 5% because of temperature, wind or mechanical loading.

(2) Operated by Overhead Trolley: The clearance of 26 feet specified in Table 1, Case 2, Column A is based upon a trolley pole throw of 26 feet. Guys and span wires may have clearances of less than the trolley throw distance (26 feet) above the running surfaces, top of rail or surface of street, used by trolley cars or coaches provided the guys and span wires are not less than 4 feet above the trolley contact conductors and are encased in wood boxing or moulding 7/8-inch or more in thickness for distances of at least 2 feet horizontally from the vertical plane through each trolley contact conductor.

C. From Conductors

(1) Crossing in Spans: Vertical clearances at points of crossing not less than as specified in Table 2, Case 1, and radial clearances not less than as specified in Table 2, Case 18, shall be maintained between guys or span wires and conductors supported on other poles.

(2) On Colinear Lines: The radial clearances between guys on a line and conductors on a colinear line shall be not less than as specified in Table 2, Case 18. Vertical clearances not less than as specified in Table 2, Case 1, shall also be maintained at points of crossing between guys on a line and conductors supported on other poles of a colinear line.

(3) Parallel on Same Poles: The radial clearances between guys and communication conductors which are approximately parallel and supported by the same poles may be less than as specified in Table 2, Case 18, but shall be not less than 3 inches.

(4) Passing on Same Poles: The radial clearances between guys and conductors supported by or attached to the same poles or crossarms shall be not less than as specified in Table 2, Case 19.

a) Overhead Guys: Overhead guys of communication lines passing through the level of supply conductors shall do so only between pole pin positions or outside of the outer pin position of such conductors on the crossarm.

b) Anchor Guys: Anchor guys which pass supply conductors shall clear such conductors by not less than the clearances shown in Table 2, Case 19. Anchor guys which pass through the level of supply conductors at positions other than between pole pin positions or outside of the outer pin positions, shall be sectionalized by means of an insulator placed below the supply conductors in accordance with the provisions of Rule 86.7-B, and in addition thereto an insulator shall be placed not less than 2 feet above the supply conductor level.

D. From Span Wires or Other Guys

(1) Crossing in Spans: At points of crossing, vertical clearances not less than 18 inches as specified in Table 2, Case 1, Column A, and radial clearances of not less than 12 inches, shall be maintained between guys or span wires and other guys or span wires which are not attached to the same poles.

(2) Passing and Attached to Same Pole: Where a guy of a communication system and a guy of a supply system pass each other and are attached to the same pole, a separation of not less than 3 inches shall be maintained between such guys. No separation is required between such guys of communication systems, provided neither is an exposed guy (see Rule 21.3-C).

(3) Approximately Parallel and Attached to Same Poles: Where two or more overhead guys are approximately parallel and attached to the same poles, either or both of which poles support supply conductors, such guys shall have a vertical separation of at least

one foot between the points of attachment on the pole, or poles, which support supply conductors. In cases where this 1-foot minimum separation is not practicable other means may be employed to insure the effectiveness of guy insulators, but in no case shall the distance between any guy wire and the surface of the insulator in any other guy be less than 3 inches. This rule shall not prohibit the contact of such guys to the same shim and shall not apply to guys acting in different directions, nor to guys in which insulators are not required by any provision of Rule 86.6.

Where two or more anchor guys are attached to the same pole carrying supply conductors and the same grounded anchorage, either directly or through the medium of a stub, they shall be separated at the pole by a vertical distance of at least one foot, provided any guy wire shall be not less than 3 inches from the surface of the insulator in any other guy. In lieu of securing this 3-inch minimum separation by means of the 1-foot minimum separation of guy attachments at the pole, it shall be afforded by separation of the grounded anchorages or by other practicable means which shall insure the minimum clearance of 3 inches. The provisions of this rule do not apply to guys which act in different directions from the pole or to guys attached to grounded metal structures or to guys which do not require insulators.

The provisions of this rule requiring separation of guys shall not be held to apply to guys attached to poles supporting only communication conductors.

E. From Poles

Where guys passing poles supporting supply conductors are less than 15 inches from surface of pole and less than 8 feet below supply conductors of less than 20,000 volts supported on such pole, the guys shall be sectionalized, in addition to the normal sectionalization required by Rule 86.6, by means of insulators in accordance with Rule 86.6-B2 as though attached to the pole or structure.

F. Above Buildings

The minimum vertical clearance of 8 feet specified for guys above buildings (Table 1, Case 6, Column A) may be reduced over roofs of 3/8 pitch (37 degrees from the horizontal) or greater to a clearance of not less than 2 feet.

86.5 Fastenings

Guy wires shall be protected by the use of guy thimbles or their equivalent where attached to anchor rods or through bolts.

Cedar and other soft-wood poles, around which any guy having an ultimate strength of 5000 pounds or more is wrapped, shall be protected by suitable guy shims. Hooks, lag screws or other equivalent means shall be used where necessary to prevent the guy from slipping along the pole.

86.6 Sectionalizing and Grounding Requirements

The general requirements governing the sectionalizing of guys by means of insulators are based upon the exposure or proximity of the guys to supply conductors. For definitions of guys exposed and guys in proximity to supply conductors see Rules 21.3-C and D respectively (see also App. G, Figs. 44 and 45). The following requirements shall apply to the treatment and sectionalizing of guys.

A. Where Not Exposed to Supply Conductors

Guys attached to or passing poles or structures supporting only communication conductors need not be sectionalized or grounded provided such guys are not exposed to supply conductors of 250-20,000 volts and are not in proximity to supply conductors of 0-20,000 volts.

B. Sectionalized Because of Exposure or Proximity to Supply Conductors

(1) Overhead Guys Exposed to Supply Conductors of 250-20,000 Volts: Ungrounded overhead guys which are exposed to supply conductors of 250-20,000 volts, and which are not in proximity to supply conductors of 0-20,000 volts shall be sectionalized by means of insulators located as specified in Rule 86.7-A1 (see App. G, Fig. 44).

(2) Guys in Proximity: Every overhead or anchor guy, any portion of which is in proximity to a wood pole and supply conductors of 0-20,000 volts (see App. G, Figs. 45, 48 and 49) shall be sectionalized by means of insulators as specified in Rule 86.7-A2 or Rule 86.7-B and no portion in proximity to such supply conductors shall be grounded. Excepted from this requirement are effectively grounded anchor guys, and grounded overhead guys, which are attached to poles at a level less than 8 feet but not less than 6 feet below the level of supply conductors provided the level of the guy attachment is at or below the level of communication cable messenger attached to the same pole (see App. G, Figs. 48a and 49f). Also excepted from this requirement are anchor guys, and grounded overhead guys, which are attached to poles at a level less than 6 feet but not less than 4 feet below the level of supply conductors of 0-750 volts provided such guys are extensions of or attached to a cable messenger, are in the same vertical plane (or extension thereof) as the messenger, and are below the guard arms required by Rule 87.7-B for such a messenger (see App. G, Fig. 48a).

With the agreement of the supply and communication utilities concerned, a basic minimum clearance of 40 inches may be maintained between unsectionalized guys and any supply conductor of 0-7500 volts.

C. Exposed to Supply Conductors of More Than 20,000 Volts

Portions of guys exposed to supply conductors of more than 20,000 volts shall be securely grounded and such guys need not be sectionalized, unless sectionalization is required by Rule 86.6-B2 because of proximity to supply conductors of 0-20,000 volts. (See App. G, Fig. 52c).

D. Guys Attached to Grounded Poles or Structures

Guys attached to securely grounded metal poles or structures are not required to be sectionalized except as required by Rule 86.6-B2 because of proximity to supply conductors of less than 20,000 volts supported on wood poles.

E. Anchor Guys Through Supply Conductor Levels

An anchor guy which passes through the level of supply conductors at positions other than between pole pin positions or outside of the outer pin positions shall have insulators above and below the level of supply conductors at locations as specified in Rule 86.7-B. (See App. G, Fig. 49d.)

86.7 Location of Sectionalizing Insulators

A. Overhead Guys

All insulators in overhead guys shall be not less than 8 feet above the ground.

(1) Exposed: Ungrounded overhead guys which are required by Rule 86.6-B1 to be sectionalized because of exposure to supply conductors of 250-20,000 volts shall have an insulator not less than 6 feet and not more than 9 feet (measured along the guy) from each point of attachment to wood poles or structures which support conductors. One insulator will suffice where such an overhead guy is less than 17 feet in length between wood poles or structures.

(2) In Proximity: Overhead guys which are required to be sectionalized by Rule 86.6-B2 shall have an insulator not less than 6 feet and not more than 9 feet (measured along the guy) from each point of attachment to poles, crossarms or structures (see App. G, Figs. 47 and 48)

Excepted from this requirement are guys to poles which support no conductors provided such guys are not in proximity to supply conductors of 0-20,000 volts on any poles other than the poles to which they are attached. Such guys, if required to be sectionalized by Rule 86.6-B2, shall have an insulator 6 to 9 feet from the point of attachment to the pole which supports conductors (see App. G, Figs. 44b and 44e).

B. Anchor Guys

An insulator shall be installed in each anchor guy which is required to be sectionalized by Rule 86.6-B2, so that such insulator is located not less than 8 feet above the ground and either 8 feet below the level of the lowest supply conductor or not less than 6 feet from surface of pole and not less than one foot below the level of the lowest supply conductor. These sectionalizing requirements for anchor guys can normally be met by insulation at one location; however, short guys or other conditions may require insulation at two locations, one location being not less than 8 feet above the ground and the other location either not less than 8 feet below the lowest supply conductors, or not less than 6 feet horizontally from pole and not less than one foot below the level of the lowest supply conductor. In order to prevent trees, buildings, messengers, metal-sheathed cables or other similar objects from grounding portions of guys above guy insulators, it is suggested that anchor guys be sectionalized, where practicable, near the highest level permitted by this Rule 86.7-B.

Anchor guys which pass through the level of supply conductors at positions other than between pole pin positions or outside of the outer pin positions, shall be sectionalized by means of an insulator placed below the supply conductors in accordance with the foregoing provisions of this rule, and in addition thereto an insulator shall be placed not less than 2 feet above the supply conductor level.

An insulator or insulators shall be located in "sidewalk" guys so that no grounded horizontal brace is less than 8 feet below the lowest supply conductor.

C. Truss Guys

An insulator shall be installed in each truss guy which is required to be sectionalized by Rule 86.6-B, so that such insulator is located not less than 8 feet above the ground and not less than 8 feet below the level of the lowest supply conductor passing within 6 feet of the guy. These requirements can normally be met by insulation at one position; however, in certain unusual conditions the distances above ground and below conductors may overlap, in which case insulation will be necessary at two positions.

86.8 Guy Insulators

Insulators which sectionalize guys shall conform to the following specifications based on the highest voltage of supply conductors carried at the level on the pole, tower, structure or crossarm nearest which the guy is attached and adequate for the voltage of supply circuits through which the guy passes.

A. Material

Insulators used in guys on communication lines shall be porcelain, glass or other equally suitable material.

B. Strength

(see Rule 44, Table 4 and Rule 49.5-B)

C. Voltage Requirements

Insulators used in guys on communication lines shall be so designed that their dry flashover voltage is not more than 75% of their puncture voltage at the operating frequencies of supply lines to which guys are exposed.

Insulation used in guys on communication lines shall have a dry flashover voltage not less than as specified in Table 16 when tested in accordance with the Standards (No. 41, March, 1930) of the American Institute of Electrical Engineers under the maximum mechanical loadings specified by this Order for the guy construction involved.

TABLE 16

GUY INSULATOR FLASHOVER VOLTAGE

Nominal voltage of circuits nearest point of attachment	Dry Flashover voltage of insulation
0-7500 volts	15,000 volts
7500-17,500 volts	Double the circuit voltage
Over 17,500 volts	35,000 volts

86.9 Protection

A substantial wood guard (preferably painted white), or metal guard, or a plastic guard of suitable materials, not less than 8 feet in length, shall be securely attached to each anchor guy which is exposed to traffic. Such a guard will not be required where the anchor rod is 1¼ inches or greater in diameter, has an overall length above ground of not less than 8 feet and extends to a height of not less than 6 feet vertically above ground.

87. CABLES AND MESSENGERS

87.1 Definition

The term cable includes rubber-insulated single conductors, duplex, triplex, paired conductors whether single or grouped, and multiple-conductor cables and is defined in Rule 20.3. The term messenger is defined in Rule 21.9.

87.2 Use of Messenger

Where a cable is of such weight that it would not meet the safety factors of Table 4 when self-supported, said weight shall be supported by attachment to a stranded messenger.

87.3 Material and Strength (see Rule 49.7)

87.4 Clearances

The clearances for conductors as specified in Rule 84.4 shall apply to cables and their messengers except where modified herein and shall be measured to the nearest surfaces of the cable and messenger assembly, including cable rings and messenger supports.

A. Above Ground (see Rule 84.4-A)

B. Above Railways and Trolley Lines

(1) Which Transport Freight Cars: See Rule 84.4-B1.

(2) Operated by Overhead Trolley: The clearances specified in Table 1,Case 2,Columns A and B are based upon a maximum trolley pole throw of 26 feet.

Messengers and cables may have clearances above the rails or running surfaces used by trolley cars or coaches less than the distance specified in Table 1, Case 2, Columns A and B (26 feet) for trolley-throw clearance, provided the messengers and cables are not less than 4 feet above the trolley contact conductor and are encased in wood boxing or moulding 7/8-inch or more in thickness for distances of at least 2 feet horizontally from the vertical plane of each trolley contact conductor.

Where railways operated by overhead trolleys transport freight cars, the provisions of Rule 84.4-B1 also apply.

C. Between Conductors and Cables

The minimum horizontal and vertical clearances shall be those specified in Rule 38, Table 2, (see also, Rule 32.2-D) with the following modifications.

(1) Cable Conductors: Insulated cables (including rubber-insulated single conductors, duplex, triplex, and paired conductors, whether single or grouped and whether with or without supporting messengers) are treated as single conductors and therefore no specified clearance is required between the individual conductors which comprise them. The clearance of 3 inches required by Table 2, Case 15, Column C, likewise does not apply between different cables.

(2) Between Separate Cables: The horizontal separation of 3 inches specified in Table 2, Case 15, Column C, is not intended to apply between separate cables on crossarms.

(3) Attached to Poles: On poles which carry no supply conductors and no crossarms, communication cables or messengers attached to the sides of poles may be placed in any position within 3 feet of the top of the pole provided metal-sheathed cables or messengers are separated from open wire conductors in this section of the pole by a vertical distance of not less than 12 inches.

On poles which carry no supply conductors (except supply service drop clearance attachments) and which support communication conductors on crossarms, messengers and cables may be attached to surface of pole between crossarms or less than 2 feet below the conductors on the lowest crossarms.

On poles which carry no supply conductors (except supply service drop clearance attachments) and which support communication conductors on crossarms, messengers and cables may be attached directly to opposite sides of pole.

Cables or messengers where attached to the surface of poles which support supply conductors, shall be not less than 6 feet vertically below the level of supply conductors, except that this minimum clearance of 6 feet may be reduced to not less than 4 feet below supply conductors of 0-750 volts provided a guard arm is placed above the messenger and cable (or self-supporting cable) in accordance with the provision of Rule 87.7-B (see Rule 20.9-D for guard arm definition). No cable or messenger, where attached to surface of such a pole, shall be less than 2 feet below the lowest level of communication conductors on crossarms unless a horizontal separation of not less than 30 inches is maintained between the messenger or cable and the communication conductors on the opposite side of pole.

With the agreement of the communication and electric utilities concerned with any joint use situation, a basic minimum clearance of 40 inches may be maintained between any supply conductor of 0-7500 volts and any communication cable or messenger and guard arms will not be required above the messenger and cable.

D. From Poles

(1) Cables or Messengers Supported on Crossarms: Cables or messengers supported on crossarms shall have a clearance of not less than 15 inches from the center line of poles which support supply conductors.

Cables or messengers supported on crossarms shall have a clearance of not less than 9 inches from the center line of poles which support only communication conductors.

(2) Cables or Messengers Not Supported on Crossarms: Cables or messengers may be attached directly to the surface of poles and the clearance specified in Table 1, Cases 8 and 9, shall not be held to apply provided all vertical clearances between conductors are maintained as specified throughout these rules.

(3) Colinear Lines: See Rule 84.4-D3.

(4) Cables or Messengers Passing Supply Poles and Unattached Thereto: See Rule 84.4-D4.

E. Above or Beside Buildings, Bridges and Other Structures: See Rule 84.4-E.

F. Between Cables and Messengers

Cables supported by messengers are not required to be any specified distance from their supporting messengers.

G. Between Messengers

No clearance between messengers is required where messengers of the same system branch or cross and the clearance specified in Table 2, Case 1, Column A, does not apply in such instances.

87.5 Fastenings

Messenger fastenings shall meet the safety factors of Rule 44. The fastenings or attachments by which messengers are dead ended shall have a strength at least equal to that of the strand to which they are attached.

87.6 Sectionalizing of Messengers

Where an extended messenger is treated as a guy, the sectionalizing requirements specified for guys shall be met. (See Rule 86.)

87.7 Covering or Guarding

A. Vertical and Lateral Cables

See Rules 84.6-C, D, and E for covering or protection of vertical and lateral cables attached to the surface of poles, crossarms or structures.

B. Longitudinal Aerial Cables or Messengers

A guard arm, at least 4 feet in length, shall be placed directly above and as nearly parallel as practicable to longitudinal aerial cables or messengers over which a guard arm is required by the provisions of Rule 87.4-C3.

In lieu of the guard arm a suitable wood covering of the length specified for guard arms may be placed around the cable and messenger.

Double guard arms shall be installed above cables and messengers which are dead ended on poles where the installation of guard arms is required by the provisions of Rule 87.4-C3.

No communication conductor, cable or messenger shall be supported on or attached to the top or side surface of any guard arm except as permitted for service drops and their (vertical and lateral) runs by the provisions of Rules 84.6-C and 84.8-B2c.

C. Crossing Trolley Lines: See Rule 87.4-B2

87.8 Sags

The sags of cables and their supporting messengers shall be such that the messengers conform to the requirements of Rule 49.7-B.

88. MISCELLANEOUS EQUIPMENT

88.1 Cable Terminals or Boxes

Cable terminals or boxes on poles supporting communication conductors may be placed upon any surface of the pole provided such terminals or boxes where placed in the climbing space shall not extend more than 5 inches from the surface of pole, and provisions of Rule 84.7-E for climbing space obstructions are met. This rule is not intended to apply to equipment placed within the top 3 feet of a pole supporting only communication conductors and no crossarms.

89. PRIVATE COMMUNICATION CIRCUITS

89.1 Definition (see Rule 20.5-B)

89.2 Construction and Operation

Private communication circuits shall be constructed and maintained throughout (by suitable coordination with supply circuits or by the use of arresters, drainage coils, insulating transformers, or other suitable devices) so as to prevent, under normal (neither transient nor fault) conditions, an induced potential in excess of 400 volts to ground or 750 volts between any two points on the circuit.

Private communication circuits or sections thereof shall be constructed and operated as Minor Class C circuits, and shall be consistently so treated with regard to voltages, clearances and strengths of construction except as provided in Rule 89.2-A where supported on the same crossarms with supply conductors.

See Rule 78.2 for provisions applicable to private communication circuits supported on trolley span wires.

A. Private Communication Circuits and Supply Circuits on the Same Crossarms (see Rule 32.4-C)

(1) Supply Conductors of 7500-20,000 Volts, Same Ownership: Where private communication conductors are supported on the same crossarms with supply conductors of 7500-20,000 volts, the private communication circuits shall have the strengths and clearances required for Class L circuits of 750-5000 volts. The private communication conductors shall be on opposite ends of the arms from the supply conductors and shall be separated a horizontal distance of not less than 36 inches from the nearest supply conductor. Where buck arms are used in connection with such circuit arrangement, the minimum vertical separation between related line and buck arms shall be 4 feet and the horizontal separation between the nearest conductors of the two classes of circuits on the same arm shall be not less than 36 inches plus any horizontal space provided by vacant pin positions which are required by climbing space rules.

(2) Supply Conductors of 750-7500 Volts, Same Ownership: Where private communication conductors are supported on the same crossarms with supply conductors of 750-7500 volts, the private communication circuits shall have the strengths and clearances required for Class L circuits of 0-750 volts. The private communication conductors shall be on opposite ends of the arms from the supply conductors with conductor clearances and the spacing between related line and buck arms in conformity with the requirements for combination arm construction. (See Rules 32.4-A3, 54.4-C2b, and 54.7-A.)

(3) Supply Conductors of 0-750 Volts, Same Ownership: Where private communication conductors are supported on the same crossarms with supply conductors of

0-750 volts, the private communication circuits shall have strengths and clearances as required for Class C conductors except that the clearances from supply conductors of the same ownership shall conform to the requirements for Class L circuits of 0-750 volts. The communication conductors shall preferably be located in the outer pin positions.

(4) Supply Conductors of 0-750 Volts, Different Ownership: Supply circuits of 0-750 volts and private communication circuits of different ownership may be supported on the same crossarm, provided the two classifications of circuits are installed on opposite ends of the arm and the nearest conductor of the two classifications are separated a horizontal distance of not less than 36 inches. Services direct from such a crossarm are not permitted to cross conductors of other classification supported on the same crossarm.

(5) Change in Location With Respect to Supply Conductors: At both ends of any section of private communication circuits supported on the same crossarms with supply conductors in accordance with Rules 89.2-A1 or 89.2-A2, suitable equipment shall be provided to prevent effectively the transmission, from one section of the line to another, of voltages exceeding 400 volts to ground or 750 volts between any two points of the circuit, including voltages caused under transient or fault conditions, by induction from or contact with the supply conductors supported on the same arms with the private communication conductors.

B. Private Communication Circuits and Supply Circuits on the Same Pole

Where private communication circuits are supported on the same poles with supply conductors but not on crossarms which also support supply conductors, the clearance requirements for 0-750 volt supply conductors may be applied in lieu of the clearance requirements for Class C conductors, to the clearance between the private communication conductors and supply conductors of the same ownership.

89.3 Telephone Instruments on Poles or Structures

Where a telephone instrument is attached to the surface of a pole or structure at less than 8 feet vertically above the ground (or at any elevation on a grounded metal pole or structure) and is connected to a private communication circuit constructed on the same pole line with, or colinear with, a Class H supply circuit, or is connected to a private communication circuit carried on crossarms with supply conductors of 750-20,000 volts, such instrument shall be enclosed in a suitable box of wood or equivalent insulating material, which shall be locked to prevent access by unauthorized persons. Where such a telephone instrument is so attached, connected, and enclosed, unless isolated from the communication circuit by an adequate insulating transformer, a suitably insulated stool or platform, on which a person can stand while using the instrument, shall be provided.

89.4 Cables and Messengers

Where private communication circuits are carried in cables the provisions of Rule 87 shall apply, except that such circuits may be carried in cables on crossarms which support supply conductors, under the provisions of Rule 89.2-A, in which case the requirements of Rule 57 shall apply to such private communication cables.

SECTION CONTENTS

SECTION IX

JOINT POLES OR POLES JOINTLY USED

SECTION IX

JOINT POLES OR POLES JOINTLY USED

90. GENERAL

The following rules cover certain details of construction on jointly used poles (see Rule 21.4 for definition of joint use of poles). These rules are additional to those contained in other sections, and the requirements of such other sections shall be followed in all respects except as modified herein.

No attempt is made in these rules to deal with the prevention or mitigation of inductive interference in communication lines resulting from supply lines.

91. POLES, TOWERS AND STRUCTURES

91.1 Joint Use

Joint use of poles shall be given consideration by all interested parties where construction or reconstruction is involved and where used it shall be subject to the appropriate grade of construction as specified in Section IV.

Nothing herein shall be construed as requiring utilities to use poles jointly, or as granting authority for the use of any poles without the owner's consent.

Each utility should definitely designate its space requirements on joint poles, which space shall not be occupied without consent, by equipment of any other utility.

Non-climbable metal poles in partial underground construction (see Rules 22.0-D and 21.10) shall not be jointly used.

91.2 Strength

Poles used to support circuits of different classification shall have a strength determined by using the total loading due to all circuits supported by the pole computed according to Section IV. The grade of construction for such poles shall be the highest required for any circuit present or condition existing.

91.3 Stepping

A. Location of Steps

The lowest step shall be not less than 7 feet 6 inches from the ground line and above this point steps shall be placed, with spacing between steps on the same side of the pole not exceeding 36 inches, at least to that conductor level above which only circuits operated and maintained by one party remain. Steps shall be so placed that runs or risers do not interfere with their free use.

91.4 Hardware

On jointly used wood poles or structures, hardware which is less than 3 feet above or 6 feet below unprotected supply conductors of 0-7500 volts shall be ungrounded. Excepted from the requirements of this rule are the following:

Hardware of risers treated as specified in Rules 54.6-E or 84.6-E;
Hardware of riser terminals treated as specified in Rule 54.6-F;
Hardware associated with grounded cables and messengers supported on crossarms provided such hardware has vertical clearances and pole clearances as specified in Tables 1 and 2 for such cables and messengers;
Hardware associated with guarded cables and messengers which are treated as specified in Rules 57.4-F or 87.4-C3; and
Hardware associated with guys or extended messengers when installed as specified in Rule 86.6-B2.
Hardware which is required to be ungrounded by any provision of this Rule 91.4 shall be not less than $1\frac{1}{2}$ inches from any grounded cable, messenger or hardware. . .

92. CONDUCTORS, CABLES AND MESSENGERS

The following provisions shall apply to conductors and cables on jointly used poles which support supply conductors.

92.1 Vertical Clearances

On jointly used poles the vertical clearances specified in Table 2, Case 8, Columns D and E; Case 9, Columns C, D, E, and F; Case 10, Columns C and D; and Case 11, Column D, are modified by the following requirements. These requirements are applicable to the clearances between communication and supply conductors and to clearances between supply conductors of different ownerships.

A. Between Low-Voltage Rack Conductors and Other Conductors

On jointly used poles, the following minimum vertical clearances shall apply between 0-750 volt supply conductors in rack construction and other conductors (see App. G, Fig. 9):

Racks Above
- Conductors or cables 15" or more from center line of pole ---------------------------------- 4 feet
- Unguarded cables, messengers or racks attached to poles ---------------------------------- 6 feet
- Guarded cables, messengers, or racks attached to poles ---------------------------------- 4 feet

Unguarded Racks Below
- All circuits ---------------------------------- 6 feet

Guarded Racks Below
- Circuits of 0-20,000 volts or communication circuits ---------------------------------- 4 feet

Exception: In situation where 0-750 volt supply conductors are in rack construction above communication conductors, cables, or messengers, a basic minimum clearance of 40 inches may be maintained between the bottom of the rack and the highest communication attachment provided that such is agreed upon by the supply and communication utilities concerned. Guard arms will not be required in such situations.

B. Between Cables and Messengers and Other Conductors

Where any cable or messenger (supply or communication) is less than 15 inches from center line of pole or is attached directly to the surface of jointly used poles, the following minimum vertical clearances shall apply between such cable and other conductors or cables (see App. G, Fig. 9):

Cables or Messengers Above
- Conductors, cables or messengers 15 inches or more from center line of pole ----------------- 4 feet
- Unguarded racks attached to pole -------------- 6 feet
- Unguarded cables or messengers attached to pole 4 feet
- Guarded cables, messengers or racks attached to poles ---------------------------------- 4 feet

Unguarded Cables or Messengers Below

All unprotected supply conductors (a) --------- 6 feet
All grounded cables (c) ---------------------- 4 feet

Guarded Cables or Messengers Below

Unprotected supply conductors of more than 750 volts (b) ---------------------------------- 6 feet
Unprotected supply conductors of 0-750 volts or communication circuits (c) ----------------- 4 feet

(a) See Rule 84.6-C for exception applicable to suitably insulated lateral runs.

(b) This is not intended to prohibit the attachment of an unguarded cable or messenger 6 feet or more below supply circuits of more than 750 volts.

(c) This is not intended to apply between communication cables or messengers and other communication conductors.

In situations where communication cables or messengers are installed below supply conductors or cables, a basic minimum clearance of 40 inches may be maintained between supply and communications cables or conductors provided that such is agreed upon by the supply and communications utilities concerned. Guard arms will not be required in such situations.

C. Communication Open Wire Conductors

Open wire Class C communication conductors may be attached by means of hooks, knobs or brackets to one side of poles jointly used with supply conductors provided all of the clearances in Rule 92.1-B are applied, and any guard arm required is installed above the top communication conductor in accordance with the provisions of Rule 87.7-B. Excepted from the provisions of this Rule 92.1-C is the single communication circuit treated in Rule 92.1-D.

D. Circuits Serving Same Party

Supply conductors of 0-750 volts and the conductors of one paired (parallel, duplex or twisted) or open-wire communication circuit may be supported on jointly used poles on private property with a clearance of not less than 5 feet between the conductors of the two classifications and without guard arm, provided such circuits are used for service to one (the same) party only and where openwire communication conductors are used they shall be placed on one side of pole only.

With the agreement of the communication and electric utilities concerned, a basic minimum clearance of 40 inches may be maintained between any supply conductor of 0-750 volts and any communication paired or open wire conductor.

E. Communication Service Drop Attachments

Guard arms are not required above communication service drops from cabled lines where such drops are installed in accordance with the provisions of Rule 84.8-B2b.

F. Between Conductors, Cables, Messengers and Miscellaneous Equipment

(1) Unenergized and Ungrounded Equipment: Communication conductors or 0-750 volt supply conductors, which are on crossarms with not less than 15-inch clearance from center line of pole or which are attached to pole surface and provided with guard arm, shall be not less than 40 inches below unenergized and ungrounded cases or enclosures of apparatus of the other classification.

This rule will not prohibit the placing of communication conductors on crossarms within 9 inches of the center of the pole on one side provided that the clearance is increased to not less than 21 inches on the other side of the pole. The 40-inch clearance shall also apply in situations where with the agreement of the supply and communication utilities concerned the use of guard arms is not required.

(2) Cable Terminals or Metal Boxes: On jointly used poles metal communication cable terminals, metal boxes or similar equipment which are less than 8 inches from center line of pole or are attached to surface of pole shall be placed not less than 6 feet vertically below or 3 feet above the level of the nearest unprotected supply conductor.

All parts of such metal terminals, boxes or similar equipment which are 8 inches or more from center line of pole shall have vertical clearances from conductors not less than the clearance specified in Table 2, Col. C, Cases 8 to 13 inclusive.

For clearance between street light drop wires and cables, other conductors, and metal boxes see Rules 58.2-B3 and 92.1-F5.

(3) Drip Loops: The lowest point of the drip loop of the terminal or end of a vertical run or riser of supply conductors of more than 750 volts shall be not less than 48 inches above the nearest communication conductor level below the drip loop. Where the supply conductors are of more than 7500 volts, this clearance shall be not less than 60 inches.

The lowest point of the drip loop of supply conductors of 750 volts or less shall be not less than 36 inches above the nearest communication conductor level below the drip loop except that the drip loop of such supply conductors may be less than 36 inches but not less than 12 inches above the level of police or fire alarm conductors carried as specified in Rule 92.2.

(4) Transformers or Regulators: Transformers or regulators of supply systems shall normally be located above communication equipment. Where it is necessary to locate transformers or regulators below communication equipment they shall be placed at least 6 feet vertically below and all energized parts shall be protected and guarded so as to afford the least possibility of contact.

Where transformers or regulators are installed on platforms having continuous flooring which extends not less than 1 foot horizontally outside of the vertical plane of all transformer or regulator lead and bus wires on the same pole or structure, cables or other conductors may be installed at a minimum vertical distance of 12 inches below the transformer or regulator cases provided such cables or conductors do not extend laterally beyond the platform.

(5) Street Lighting Equipment: All parts of street light drop wires, street lamps, and their supporting fixtures (including rods, braces and guys) shall be not less than 1 foot above or 2 feet below the level of messengers or conductors supported by messengers. These vertical clearance requirements

shall not apply to those parts of such street lighting equipment which are 2 feet or more horizontally from the vertical plane of messengers, conductors supported by messengers, and metal boxes.

All parts of street light drop wires, street lamps, and their supporting fixtures (including rods, braces and guys) shall be not less than 1 foot radially from all communication conductors not supported on messengers.

92.2 Police and Fire Alarm Circuits

Police and fire alarm circuits which are carried on crossarms are permitted to occupy a position between supply circuits of 0-750 volts and other Class C communication circuits provided the police or fire alarm circuits have a vertical clearance of not less than 2 feet from each of such circuits and the conductors of such police or fire alarm circuits have a clearance of not less than 25 inches from center line of pole and have a weather-resistant covering at least equal to double-braid weatherproofing. In lieu of conductors with weather-resistant covering, non-metallic sheathed cable may be used. Where such cable is supported on a messenger, the messenger shall be ungrounded throughout its length and shall be sectionalized by means of insulators placed 6 feet to 9 feet from each attachment to crossarms. Where a 4-foot neutral space is reserved between supply and communication circuit levels on joint poles, it is recommended that police and fire alarm circuits which are installed in accordance with the foregoing provisions be at a level at the center of such a neutral space.

Police and fire alarm circuits which are less than 25 inches from center line of pole, or are attached to the surface of pole, shall have vertical clearances from supply conductors not less than those specified throughout this Order for Class C communication conductors.

92.3 Vertical Runs, Risers, Ground Wires and Hardware

Vertical runs, risers, ground wires and hardware of supply lines shall have a clearance of not less than 1½ inches from similar equipment of communication lines and from similar equipment of supply lines of different ownership.

Vertical runs, risers, ground wires and hardware shall be so located that they do not interfere with the free use of pole steps.

93. CLIMBING SPACE

Climbing space shall be provided on all jointly used poles which support conductors and the provisions of Rules 54.7 and 84.7 are directly applicable to such poles. Climbing space on jointly used poles shall be so correlated between conductor levels that its position in relation to the pole is not changed by more than 90 degrees in a vertical distance of less than 8 feet.

SECTION CONTENTS

SECTION X

SUPPLY AND COMMUNICATION LINES IN LINE CROSSINGS OR CONFLICTS

SECTION X

SUPPLY AND COMMUNICATION LINES IN LINE CROSSINGS OR CONFLICTS

100. GENERAL

The following rules cover certain details for the construction of supply and communication lines in line crossings or conflicts and apply to the line which is at the higher elevation. These rules are supplemental to the rules for lines of these classifications in general and to the construction details for such lines where alone, which general rules shall be followed in all respects except as modified herein.

101. POLES, TOWERS AND STRUCTURES

101.1 Height Adjacent to Crossing

The vertical difference of the conductor level between the crossing and adjacent poles, towers or structures, shall, at all times, be less than that which would produce an uplift strain on the pin, insulator or tie, on the poles, towers or structures, adjacent to the crossing spans, unless due precaution is taken to prevent the conductor from becoming detached from the crossarm.

101.2 Spliced or Stub-reinforced Poles

Spliced poles, stub-reinforced poles and pole top extensions shall not be used in crossings or conflicts where Grade "A" construction is required.

102. PINS AND CONDUCTOR FASTENINGS

102.1 Duplex Pin Construction

Duplex pin construction is not permitted in crossings or colinear lines.

103. CONDUCTORS

103.1-A. Prevention of Conductor Breakage and Burning of Supports

A. Splices and Taps

(1) Splices shall not be made or permitted in crossing spans where Grade "A" construction is required unless the mutual consent of all parties involved in such spans is obtained. Nothing contained in this Rule 103.1-A(1) shall be construed as requiring that splices be made, or as granting authority for or permitting the making of splices in such crossing spans without the consent of all parties owning or operating overhead lines involved in such crossing spans.

(2) Splices and taps shall, as far as practicable, be avoided in crossing spans where Grade "A" construction is required. If it is impracticable to avoid such splices, they shall be of such type and be so made as to have a strength practically equal to the conductor in which the splice is made. Splices and taps should not be made in spans adjacent to such crossing spans if the crossing span is not dead-ended. Splices or taps in spans adjacent to a Grade "A" crossing span shall, if practicable, be placed nearer to the crossing support than the nearest conductor crossed over. This rule is not intended to prohibit splices or taps on the free ends of conductors which are dead-ended in the crossing span.

B. Supply Conductor Supports

In installing insulators and conductors precautions shall be taken to guard against the possibility of arcs or leakage current injuring conductors or burning any wood parts of the supporting structure which would render the conductors liable to fall. In cases where two or more circuits are carried on the same poles and steel pins with wood crossarms are used, the insulator pins of different circuits, if bonded, shall be bonded independently of each other in conformity with Rule 53.4-A3. The conductor used for bonding shall have a conductivity not less than No. 10 AWG copper wire.

103.2 Overhead Lightning Protection Wires

Overhead lightning protection wires or cables, if used, shall conform to the requirements of this Order as to grades of construction, material, size and strength, for conductors of the voltage of the circuit protected. See Rule 63.2 for the requirements for lightning protection wires where supported by towers.

103.3 Limitation of Span Lengths

The crossing span shall be made as short as is practicable. In no case shall the length of the crossing span be greater than the normal span of the line, and the length of the next adjoining span shall be no greater than one and one-half times the normal span.

Spans of extraordinary length, made necessary by unusual conditions of topography, shall be considered as exceptions to the above rule.

103.4 Communication Wires

No paired wire line conductors or single conductor smaller than that specified in Table 8 for the grade of construction involved shall be used without supporting messengers, except where the circuits crossed over are of less than 750 volts. For communication service drops crossing over supply conductors see Rule 32.2-F and 32.2-G.

103.5 Crossing or Colinear Clearances

Where supply conductors of 750-7500 volts cross over, or are above and in conflict, or above and colinear with communication conductors within 6 feet radially of a pole or structure which supports the communication conductors, the vertical clearance specified in Table 2, Case 3, Column E and Case 5, Column C (48 inches) shall be increased to not less than 60 inches.

104. INSULATORS FOR SUPPLY CONDUCTORS

Where grounded pins are used at crossings with ungrounded construction being used at other parts of the line, the insulators used on such grounded supports shall have a rating of 25% greater than the flashover voltage values of the line insulators used on ungrounded pins, except where these values exceed those specified in Table 12, Rule 55.3, by 50%. As an alternative, the conductors at their points of attachment, where suspension insulators are used, may be protected by arcing shields.

105. SCREENS AND CRADLES

The use of screens or cradles for crossing protection is not approved under these rules.

SECTION CONTENTS

SECTION XI

SUPPLY LINES OR COMMUNICATION LINES CROSSING OVER RAILWAYS

SECTION XI

SUPPLY LINES OR COMMUNICATION LINES CROSSING OVER RAILWAYS

110. GENERAL

The following rules cover certain details for the construction of supply lines or communication lines crossing over railroads, excluding crossings over street railways. These rules are supplemental to the rules for lines in general, and to construction details of various classes of lines where alone, which general rules shall be followed in all respects except where clearly inapplicable to railroad crossing construction or where specifically modified herein.

Wherever a utility wishes to cross railroad tracks with any of its wires at a location other than a public thoroughfare, or a railroad wishes to cross beneath the wires of any utility at such a location, the consent of the utility whose facilities are being crossed must be obtained.

111. POLES, TOWERS AND STRUCTURES

111.1 Location

Poles or towers supporting crossing spans shall be located outside the railroad company's rights-of-way wherever practicable; shall be located as far as practicable from inflammable material or structures and shall be as nearly as practicable in line with the adjoining span on each side. The crossing span and the next adjoining spans shall be kept free from trees which might fall into the line.

In all cases the clearances from tracks to the nearest surface of poles, towers or structures shall conform to those specified in General Order No. 26-D. (See Appendix E)

111.2 Height Adjacent to Crossing

The vertical difference of the conductor level between the crossing and adjacent poles, towers or structures shall, at all times, be less than that which would produce an uplift strain on the pin, insulator or tie, on the poles, towers, or structures adjacent to the crossing span, unless due precaution is taken to prevent the conductor from becoming detached from the crossarm.

111.3 Spliced or Stub-reinforced Poles

Spliced or stub-reinforced poles and pole top extensions shall not be used in crossings or conflicts where Grade "A" construction is required or where Grade "B" construction is required for Class C lines crossing railroads.

112. PINS AND CONDUCTOR FASTENINGS

112.1 Duplex Pin Construction

Duplex pin construction is not permitted at crossings over railroads.

113. CONDUCTORS

113.1 Prevention of Conductor Breakage and Burning of Supports

A. Splices and Taps

Splices shall not and taps should not be made in crossing spans where Grade "A" construction is required or where Grade "B" construction is required for Class C lines crossing railroads. Splices and taps should not be made in spans adjacent to such crossing spans if the crossing span is not dead ended. This rule is not intended to prohibit splices or taps on the free ends of conductors which are dead ended at the crossing span.

The provisions of this rule shall not apply to conductor splices which are made by any accepted standard method which has been proved by test before this Commission to develop practically the full strength of the conductor in which the splice is made.

B. Supply Conductor Supports

In installing insulators and conductors, precautions shall be taken to guard against the possibility of arcs or leakage current injuring conductors or burning any wood parts of the supporting structure which would render the conductors liable to fall. In cases where two or more circuits are carried on the same poles and steel pins with wood crossarms are used, the insulator pins of different circuits, if bonded, shall be bonded independently of each other in conformity with Rule 53.4-A3. The conductor used for bonding shall have a conductivity not less than No. 10 AWG copper wire.

113.2 Overhead Lightning Protection Wires

Overhead lightning protection wires or cables, if used, shall conform to the requirements of this Order as to grades of construction, material, size and strength, for conductors of the voltage of the circuit protected. See Rule 63.2 for the requirements for lightning protection wires where supported by towers.

113.3 Limitation of Span Length

The crossing span shall be made as short as is practicable. In no case shall the length of the crossing span be greater than the normal span of the line, and the length of the next adjoining span shall be no greater than one and one-half times the normal span. Spans of extraordinary length, made necessary by unusual conditions of topography, shall be considered as exceptions to the above rule.

113.4 Communication

For crossing spans, the size of conductors not supported on messengers shall be not less than No. 12 BWG galvanized steel or No. 10 AWG hard-drawn copper or copper covered steel, except that paired wire, of which each wire has an ultimate strength of not less than 170 pounds, may be used without supporting messenger in spans which do not exceed 100 feet in Heavy Loading Districts or 150 feet in Light Loading Districts.

113.5 Trolley Contact Wires

Unless electric railroad systems are protected by interlocking plant at grade crossings with interurban or other heavy or high speed railway systems, the trolley contact conductors shall be at the same elevation above their own tracks throughout the crossing and next adjoining spans and, in addition thereto, catenary construction shall be provided where crossing spans exceed 100 feet. (See Appendix G, Figs. 62 and 63.) This rule is not intended to apply where pantagraph collector or similar device is used.

114. INSULATORS FOR SUPPLY CONDUCTORS

Where grounded pins are used at crossings with ungrounded construction being used at other parts of the line, the insulators used on such grounded support shall have a rating of 25% greater than the flashover voltage values of the line insulators used on ungrounded pins, except where these values exceed those specified in Table 12, Rule 55.3, by 50%. As an alternative, the conductors at their points of attachment, where suspension insulators are used, may be protected by arcing shields.

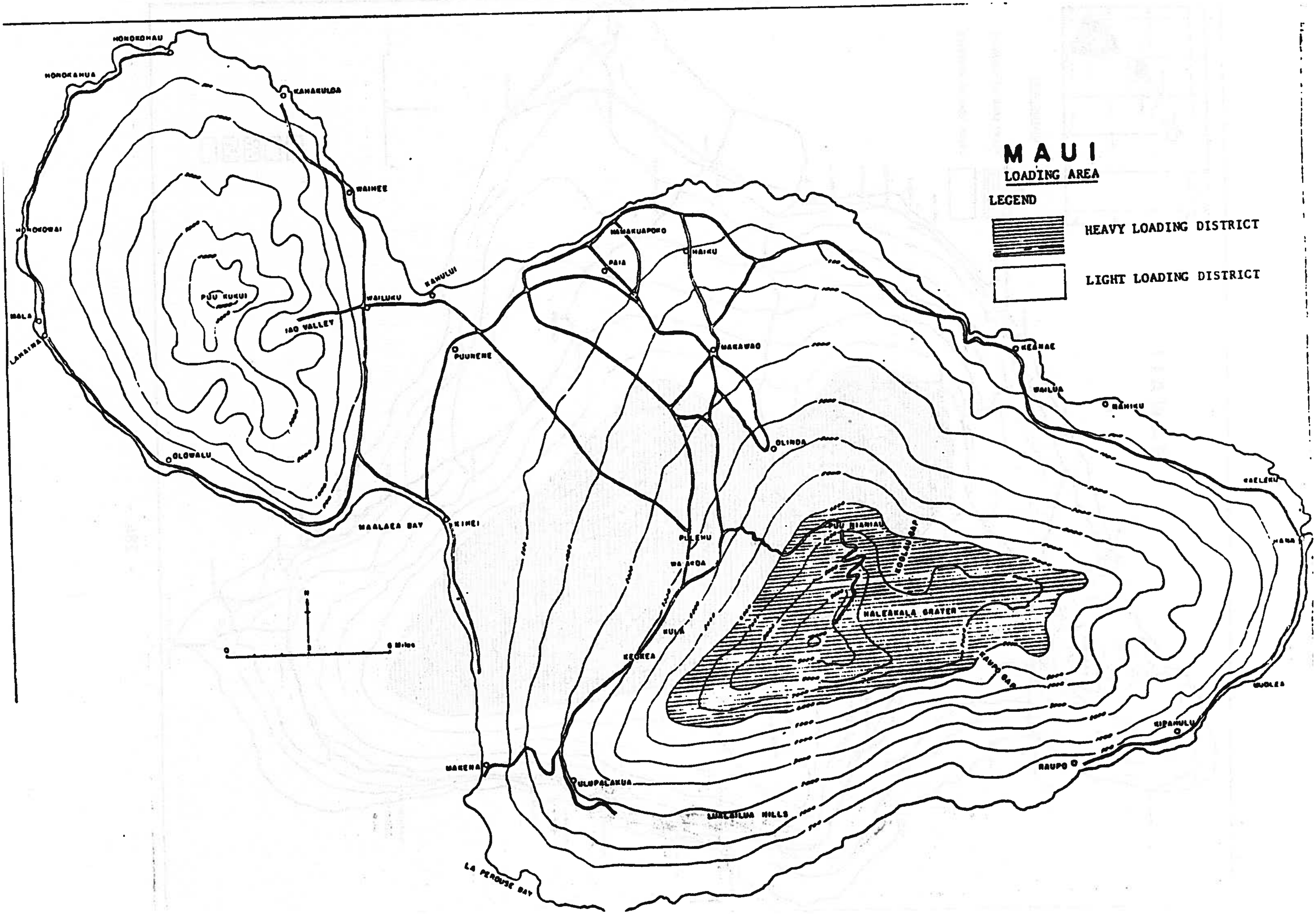
115. SCREENS AND CRADLES

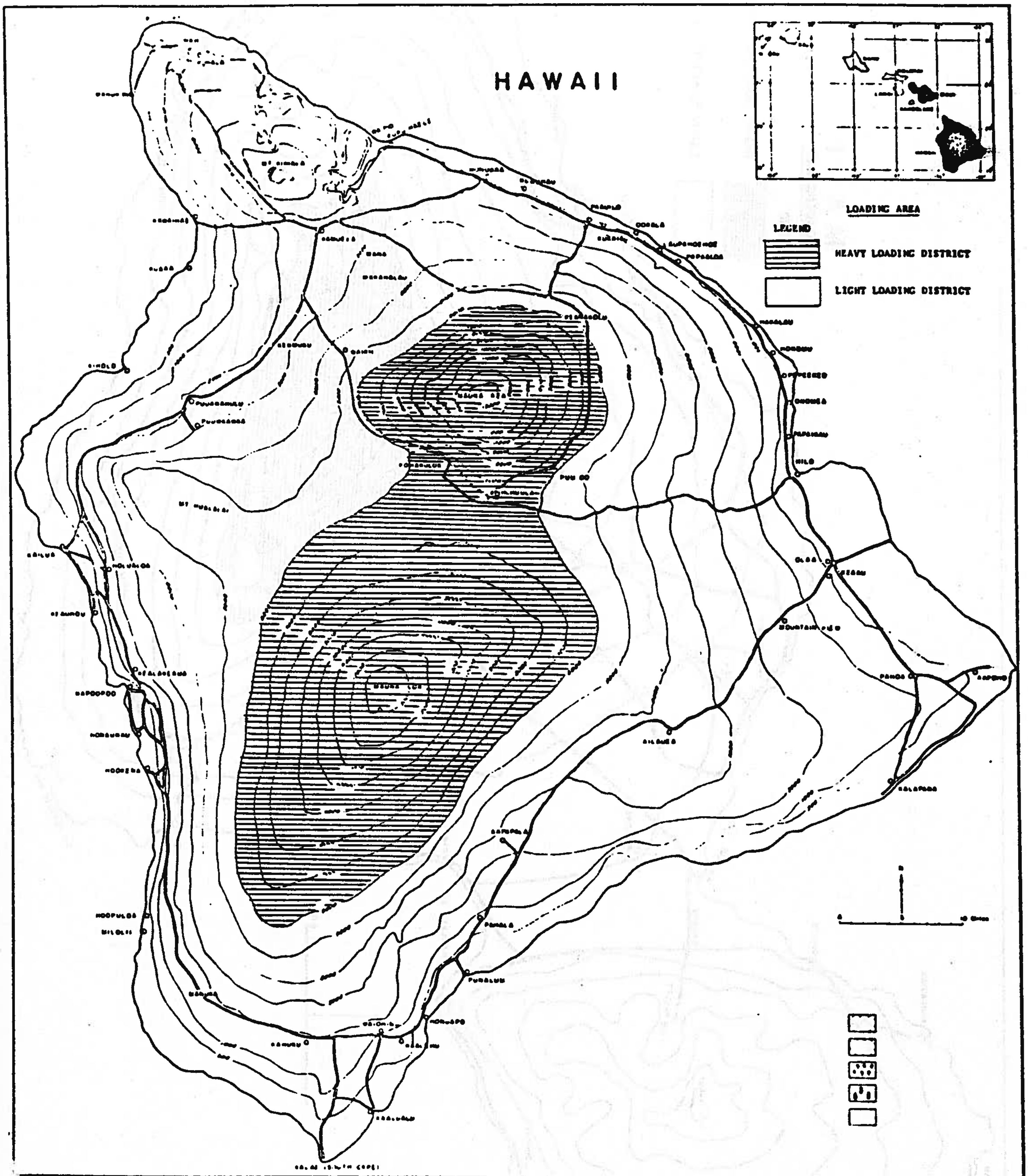
The use of screens or cradles for crossing protection is not approved under these rules.

APPENDICES

A P P E N D I C E S

CONTENTS


MAUI
LOADING AREA
LEGEND
HEAVY LOADING DISTRICT
LIGHT LOADING DISTRICT
HONOKOHAU
HONOKAHUA
KAHAKULOA
WAIHEE
HONOKOWAI
PUU KUKUI
WAILUKU
KAHULUI
IAO VALLEY
LAHAINA
OLOWALU
PUUNENE
MAALAEA BAY
KIHEI
HAMAKUAPOKO
PAIA
HAIKU
MAKAWAO
OLINDA
KEANAE
WAILUA
NAHIKU
PULEHU
WAIAKOA
KULA
KEOKEA
PUU NIANIAU
KOOLAU GAP
HALEAKALA CRATER
KAUPO GAP
HANA
HAELEKU
MUOLEA
KIPAHULU
KAUPO
MAKENA
ULUPALAKUA
LUALAILUA HILLS
LA PEROUSE BAY
N
0
6 Miles


HAWAII
LOADING AREA
LEGEND
HEAVY LOADING DISTRICT
LIGHT LOADING DISTRICT
HILO
PUU OO
MAUNA LOA

APPENDIX B

MECHANICAL AND LOADING DATA FOR CONDUCTORS

The tables included in Appendix B contain mechanical data for conductors commonly used in supply and communication lines. The ultimate strengths and other data for copper, steel and iron wires are those contained in specifications of the American Society for Testing Materials or are ultimate strengths based upon such specifications. For other types and kinds of conductors the ultimate strengths and other data used have been taken from manufacturers' specifications.

The requirements of Rule 43 were used to calculate the loaded conductor conditions.

Table No.

17 Copper Wire—Bare—Solid

18 Copper Wire—Bare—Stranded and Solid

19 Copper Wire—Double-Braid-Weatherproof—Stranded and Solid

20 Copper Wire—Triple-Braid-Weatherproof—Stranded and Solid

21. Galvanized Steel and Iron Wire—Bare—Solid

22 Copper-covered Steel—Strand, Solid and Composite

23 Aluminum Cable Steel Reinforced—Bare

24 Galvanized Steel Strand

TABLE 17

COPPER WIRE—BARE—SOLID—CHARACTERISTICS AND LOADING

Characteristics of conductor						Loading per linear foot of conductor, pounds					
Gage number		Diameter, inch	Area, square inch	Ultimate tensile strength, pounds		Light loading district			Heavy loading district		
AWG	NBS			Hard drawn*	Medium hard drawn**	Vertical load, conductor only	Horizontal load, wind of 8 lbs. per sq. ft. on conductor	Resultant load	Vertical load, conductor with ½ inch of ice	Horizontal load, wind of 6 lbs. per sq. ft. on conductor with ½ inch of ice	Resultant load
--------	--------	0.165	0.02138	1,326	1,078	0.0825	0.1100	0.137	0.4960	0.5825	0.765
--------	9	.144	.01629	1,026	832	.0628	.0960	.115	.4632	.5720	.736
--------	--------	.134	.01410	894	720	.0544	.0893	.105	.4486	.5670	.723
--------	10	.128	.01287	820	662	.0496	.0853	.099	.4401	.5640	.715
9	--------	.1144	.01028	661	532	.0396	.0763	.086	.4216	.5572	.699
--------	--------	.114	.01021	656	528	.0394	.0760	.086	.4212	.5570	.698
--------	12	.104	.00850	551	440	.0327	.0693	.077	.4083	.5520	.687
12	--------	.0808	.00513	337	271	.0198	.0539	.057	.3809	.5404	.661
--------	14	.080	.00503	330	265	.0194	.0533	.057	.3800	.5400	.660

* Minimum ultimate strengths of ASTM Specification, B 1-39.
** Minimum ultimate strengths of ASTM Specification, B 2-39, plus ¼ the difference between minimum and maximum.

TABLE 18

COPPER WIRE—BARE—STRANDED AND SOLID—CHARACTERISTICS AND LOADING

Size of cable or wire, cir mils or AWG	Characteristics of conductor: Component wires (strands): Number	Characteristics of conductor: Component wires (strands): Diameter, inch	Characteristics of conductor: Diameter, inch	Characteristics of conductor: Area, square inch	Ultimate tensile strength, pounds: Hard drawn*	Ultimate tensile strength, pounds: Medium hard drawn**	Loading per linear foot of conductor, pounds: Light loading district: Vertical load, conductor only	Light loading district: Horizontal load, wind of 8 lbs. per sq. ft. on conductor	Light loading district: Resultant load	Heavy loading district: Vertical load, conductor with ½ inch of ice	Heavy loading district: Horizontal load, wind of 8 lbs. per sq. ft. on conductor with ½ inch of ice	Heavy loading district: Resultant load
500,000	37	0.1162	0.813	0.3927	22,510	18,726	1.544	0.5420	1.636	2.3604	0.9065	2.528
350,000	19	.1357	.679	.2749	15,590	13,024	1.081	.4523	1.172	1.8141	.8395	1.998
250,000	19	.1147	.574	.1964	11,365	9,366	0.7719	.3827	0.862	1.4397	.7870	1.641
0000	7	.1739	.527	.1662	9,154	7,772	.6533	.3514	.742	1.2919	.7635	1.500
000	7	.1548	.464	.1318	7,366	6,204	.5181	.3093	.604	1.1175	.7320	1.334
00	7	.1379	.414	.1045	5,925	4,952	.4109	.2760	.495	0.9792	.7070	1.208
0	7	.1228	.368	.0829	4,753	3,953	.3258	.2453	.408	.8655	.6840	1.103
1	7	.1093	.328	.0657	3,802	3,154	.2584	.2187	.338	.7733	.6640	1.019
2	7	.0974	.292	.0521	3,042	2,517	.2049	.1947	.283	.6974	.6460	0.950
2	3	.1487	.320	.0521	2,913	2,453	.2029	.2133	.294	.7128	.6600	.971
4	7	.0772	.232	.0328	1,940	1,604	.1289	.1547	.201	.5841	.6160	.849
4	3	.1180	.254	.0328	1,879	1,564	.1276	.1693	.212	.5964	.6270	.865
4	1		.2043	.03278	1,970	1,642	.1264	.1360	.185	.5641	.6020	.825
6	3	.0935	.201	.0206	1,204	995	.0825	.1340	.157	.5184	.6005	.793
6	1		.1620	.02062	1,280	1,046	.0795	.1080	.134	.4911	.5810	.759
8	1		.1285	.01297	826	667	.0500	.0853	.099	.4406	.5640	.716

* Minimum ultimate strengths of ASTM Specifications, B 1-39.

** For stranded conductors, 90% minimum ultimate strengths of ASTM Specifications, B 2-39, plus ½ of the difference between maximum and 90% of minimum ASTM values; for solid conductors, minimum ultimate strengths of ASTM Specifications, B 2-39, plus ½ of the difference between minimum and maximum.

TABLE 19

COPPER WIRE—STRANDED AND SOLID—DOUBLE BRAID WEATHERPROOF—CHARACTERISTICS AND LOADING

Characteristics of conductor							Loading per linear foot of conductor, pounds					
	Component wires (strands)				Ultimate tensile strength, pounds		Light loading district			Heavy loading district		
Size of cable or wire, cir mils or AWG	Number	Diameter, inch	Diameter with covering, inches***	Area without covering, square inch	Hard drawn*	Medium hard drawn**	Vertical load, conductor only	Horizontal load, wind of 8 lbs. per sq. ft. on conductor	Resultant load	Vertical load, conductor with ½ inch of ice	Horizontal load, wind of 6 lbs. per sq. ft. on conductor with ½ inch of ice	Resultant load
1,000,000	61	0.1280	1.430	0.7854	45,030	37,210	3.456	0.9534	3.585	4.6561	1.2150	4.812
750,000	61	.1109	1.195	.5890	34,090	28,272	2.635	.7967	2.753	3.6890	1.0975	3.849
500,000	37	.1162	1.081	.3927	22,510	18,726	1.765	.7207	1.906	2.7481	1.0405	2.938
350,000	19	.1357	0.867	.2749	15,590	13,024	1.248	.5780	1.375	2.0980	0.9335	2.296
250,000	19	.1147	.740	.1964	11,365	9,366	0.9070	.4934	1.032	1.6780	.8700	1.890
0000	7	.1739	.685	.1662	9,154	7,772	.7450	.4567	0.874	1.4818	.8425	1.704
000	7	.1548	.640	.1318	7,366	6,204	.6040	.4267	.740	1.3128	.8200	1.548
00	7	.1379	.560	.1045	5,925	4,952	.4820	.3734	.610	1.1411	.7800	1.382
0	7	.1228	.546	.0829	4,753	3,953	.3880	.3640	.532	1.0384	.7730	1.294
1	7	.1093	.445	.1657	3,802	3,154	.3030	.2967	.424	0.8906	.7225	1.147
2	7	.0974	.415	.0521	3,042	2,517	.2460	.2767	.370	.8149	.7075	1.079
4	7	.0772	.344	.0328	1,940	1,604	.1550	.2293	.277	.6798	.6720	0.956
4	1		.337	.03278	1,970	1,642	.1535	.2247	.272	.6739	.6685	.949
6	1		.290	.0206	1,280	1,046	.1030	.1933	.219	.5942	.6450	.877
8	1		.246	.01297	826	667	.0680	.1640	.178	.5319	.6230	.819

* Minimum ultimate strengths of ASTM Specifications, B 1-39.

** For stranded conductors, 90% minimum ultimate strengths of ASTM Specifications, B 2-39, plus ¼ of the difference between maximum and 90% of minimum ASTM values; for solid conductors, minimum ultimate strengths of ASTM Specifications, B 2-39, plus ¼ of the difference between minimum and maximum.

*** Average outside diameter [illegible] commercially.

TABLE 20

COPPER WIRE—STRANDED AND SOLID—TRIPLE BRAID WEATHERPROOF—CHARACTERISTICS AND LOADING

Size of cable or wire, cir mils or AWG	Characteristics of conductor: Component wires (strands): No.	Characteristics of conductor: Component wires (strands): Diameter, inch	Characteristics of conductor: Diameter with covering, inches***	Characteristics of conductor: Area without covering, square inch	Characteristics of conductor: Ultimate tensile strength, pounds: Hard drawn*	Characteristics of conductor: Ultimate tensile strength, pounds: Medium hard drawn**	Loading per linear foot of conductor, pounds: Light loading district: Vertical load, conductor only	Loading per linear foot of conductor, pounds: Light loading district: Horizontal load, wind of 8 lbs. per sq. ft. on conductor	Loading per linear foot of conductor, pounds: Light loading district: Resultant load	Loading per linear foot of conductor, pounds: Heavy loading district: Vertical load, conductor with ½ inch of ice	Loading per linear foot of conductor, pounds: Heavy loading district: Horizontal load, wind of 6 lbs. per sq. ft. on conductor with ½ inch of ice	Loading per linear foot of conductor, pounds: Heavy loading district: Resultant load
1,000,000	61	0.1280	1.656	0.7854	45,030	37,210	3.764	1.1041	3.836	5.0146	1.3280	5.188
750,000	61	.1109	1.380	.5890	34,090	28,272	2.822	0.9200	2.968	3.9910	1.1900	4.165
500,000	37	.1162	1.250	.3927	22,510	18,726	1.894	.8334	2.069	2.9822	1.1250	3.187
350,000	19	.1357	1.000	.2749	15,590	13,024	1.345	.6667	1.501	2.2777	1.0000	2.488
250,000	19	.1147	0.850	.1964	11,365	9,366	0.9850	.5667	1.136	1.8244	0.9250	2.045
0000	7	.1739	.805	.1662	9,154	7,772	.8000	.5367	0.963	1.6114	.9025	1.847
000	7	.1548	.710	.1318	7,366	6,204	.6530	.4734	.807	1.4054	.8550	1.645
00	7	.1379	.660	.1045	5,925	4,952	.5220	.4400	.683	1.2433	.8300	1.495
0	7	.1228	.610	.0829	4,753	3,953	.4240	.4067	.588	1.1142	.8050	1.375
1	7	.1093	.509	.0657	3,802	3,154	.3280	.3394	.472	0.9554	.7545	1.217
2	7	.0974	.488	.0521	3,042	2,517	.2700	.3253	.423	.8843	.7440	1.156
4	7	.0772	.390	.0328	1,940	1,604	.1700	.2600	.311	.7234	.6950	1.003
4	1		.387	.03278	1,970	1,642	.1665	.2580	.307	.7180	.6935	0.998
6	1		.347	.0206	1,280	1,046	.1136	.2313	.258	.6403	.6735	.929
8	1		.294	.01297	826	667	.0760	.1960	.210	.5697	.6470	.862

* Minimum ultimate strengths of ASTM Specifications, B 1-39.
** For stranded conductors, 90% minimum ultimate strengths of ASTM Specifications, B 2-39, plus ¼ of the difference between maximum and 90% of minimum ASTM values; for solid conductors, minimum ultimate strengths of ASTM Specifications, B 2-39, plus ¼ of the difference between minimum and maximum.
*** Average outside diameter obtained commercially.

TABLE 21

GALVANIZED STEEL AND IRON WIRE—BARE—SOLID—CHARACTERISTICS AND LOADING

Size of wire, BWG	Characteristics of conductor					Loading per linear foot of conductor, pounds					
	Diameter, inch	Area, square inch	Ultimate tensile strength, pounds*			Light loading district			Heavy loading district		
			EBB grade	BB grade	Steel grade	Vertical load, conductor only	Horizontal load, wind of 8 lbs. per sq. ft. on conductor	Resultant load	Vertical load, conductor with ½ inch of ice	Horizontal load, wind of 6 lbs. per sq. ft. on conductor with ½ inch of ice	Resultant load
4	0.238	0.0445	2,028	2,270	2,433	.1530	0.1587	0.220	0.6119	0.6190	0.870
6	.203	.0324	1,475	1,650	1,770	.1120	.1353	.176	.5491	.6015	.814
8	.165	.0214	975	1,090	1,170	.0740	.1100	.133	.4875	.5825	.760
9	.148	.0172	785	880	942	.0600	.09867	.116	.4629	.5740	.737
10	.134	.0141	645	720	774	.0490	.08934	.102	.4432	.5670	.720
11	.120	.0113	515	575	618	.0390	.08000	.089	.4245	.5600	.703
12	.109	.0093	425	475	510	.0320	.07267	.079	.4107	.5545	.690
14	.083	.0054	247	275	297	.0190	.05533	.058	.3815	.5415	.662

* All ultimate tensile strengths are from ASTM Specification A 111-33.

TABLE 22

COPPER COVERED STEEL—STRAND, SOLID AND COMPOSITE—CHARACTERISTICS AND LOADING

Characteristics of conductor									Loading per linear foot of conductor, pounds					
	Strands				Ultimate tensile strength, pounds				Light loading district			Heavy loading district		
					High strength									
Nominal diameter, inch	No.	Size AWG	Actual diameter, inch	Area of conductor, square inch	40% Cond.	30% Cond.	Extra high strength 30% Cond.		Vertical load, conductor only	Horizontal load, wind of 8 lbs. per sq. ft. on conductor	Resultant load	Vertical load, conductor with ½ inch of ice	Horizontal load, wind of 6 lbs. per sq. ft. on conductor with ½ inch of ice	Resultant load
1/2	7	6	0.486	0.1443	15,330	16,890	20,460		0.5150	0.3240	0.608	1.1281	0.7430	1.351
7/16	7	7	.433	.1145	12,670	13,910	16,890		.4084	.2887	.500	0.9885	.7165	1.221
3/8	7	8	.385	.0908	10,460	11,440	13,890		.3239	.2567	.413	.8742	.6925	1.115
5/16	7	10	.306	.0571	7,121	7,758	9,196		.2037	.2040	.288	.7049	.6530	0.961
	3	6	.349	.0618	6,204	6,835	8,281		.2203	.2327	.320	.7482	.6745	1.007
	3	8	.277	.0389	4,232	4,629	5,621		.1385	.1847	.231	.6216	.6385	0.891
	3	9	.247	.0308	3,488	3,802	4,565		.1099	.1647	.198	.5744	.6235	.848
	3	10	.220	.0245	2,882	3,140	3,722		.08713	.1467	.171	.5348	.6100	.811
	1	6	.1620	.0206	2,433	2,680	3,247		.07285	.1080	.130	.4844	.5810	.756
	1	8	.1285	.0130	1,660	1,815	2,204		.04581	.08567	.097	.4366	.5642	.713
	1	9	.1144	.0103	1,368	1,491			.03633	.07627	.084	.4183	.5572	.697
	1	10	.1019	.00816	1,130	1,231			.02881	.06794	.074	.4031	.5510	.683
	1	12	.08081	.00513	711	800			.01812	.05388	.057	.3792	.5404	.660
	3	*	.366	.0680			5,876		.2568	.2440	.354	.7953	.6830	1.048
	3	**	.290	.0428			3,938		.1615	.1933	.252	.6527	.6450	0.918
	3	***	.230	.0269			2,585		.1016	.1533	.184	.5555	.6150	.829

NOTES—Items marked with asterisks are composite conductors of 1 copper covered steel and 2 hard drawn copper wires.
Copper conductance equivalents: * = No. 2 AWG, ** = No. 4 AWG, *** = No. 6 AWG.

TABLE 23

ALUMINUM CABLE STEEL REINFORCED—BARE—CHARACTERISTICS AND LOADING

Characteristics of Conductor							Loading per linear foot of conductor, pounds					
		Number of strands					Light loading district			Heavy loading district		
A.C.S.R. size, cir mils or AWG	Copper equivalent conductivity size, cir mils or AWG	Aluminum	Steel	Diameter, inches	Area, square inch	Ultimate tensile strength, pounds	Vertical load, conductor only	Horizontal load, wind of 8 lbs. per sq. ft. on conductor	Resultant load	Vertical load, conductor with ½ inch of ice	Horizontal load, wind of 6 lbs. per sq. ft. on conductor with ½ inch of ice	Resultant load
795,000	500,000	30	19	1.140	0.7668	38,400	1.234	0.7600	1.449	2.2538	1.0700	2.495
795,000	500,000	26	7	1.108	.7261	31,200	1.093	.7387	1.319	2.0928	1.0540	2.343
795,000	500,000	54	7	1.093	.7053	28,500	1.023	.7287	1.256	2.0135	1.0465	2.269
397,500	250,000	30	7	0.806	.3850	19,980	0.6206	.5374	.821	1.4327	0.9030	1.694
397,500	250,000	26	7	.783	.3630	16,190	.5464	.5220	.756	1.3442	.8915	1.613
266,800	000	26	7	.642	.2436	11,250	.3668	.4280	.564	1.0769	.8210	1.354
0000	00	6	1	.563	.1939	8,420	.2921	.3754	.476	0.9531	.7815	1.232
000	0	6	1	.502	.1538	6,675	.2316	.3347	.407	.8546	.7510	1.138
00	1	6	1	.447	.1219	5,345	.1837	.2980	.350	.7725	.7235	1.058
0	2	6	1	.398	.0967	4,280	.1456	.2653	.303	.7040	.6990	0.992
2	4	7	1	.325	.0653	3,525	.1072	.2167	.242	.6202	.6625	.907
2	4	6	1	.316	.0608	2,790	.0916	.2107	.230	.5990	.6580	.890
4	6	7	1	.257	.0411	2,288	.0674	.1713	.184	.5381	.6285	.827
4	6	6	1	.250	.0383	1,830	.0576	.1667	.176	.5240	.6250	.816
6	8	6	1	.198	.0240	1,170	.0362	.1320	.137	.4702	.5990	.762

All data "Characteristics of Conductor" from manufacturer specifications.

TABLE 24

MECHANICAL CHARACTERISTICS OF GALVANIZED STEEL STRAND

Diameter, inch (nominal)	Weight per 1,000 ft. in pounds (approx.)	Ultimate tensile strength, pounds			
		Common	Siemens-Martin	High strength	Extra high strength
5/8	813	11,600	19,100	29,600	42,400
9/16	671	9,600	15,700	24,500	35,000
1/2	517	7,400	12,100	18,800	26,900
7/16	399	5,700	9,350	14,500	20,800
3/8	273	4,250	6,950	10,800	15,400
5/16	205	3,200	5,350	8,000	11,200
9/32	164	2,570	4,250	6,400	8,950
1/4	121	1,900	3,150	4,750	6,650
3/16	73	1,150	1,900	2,850	3,990

Note—All data from ASTM Specification A 122-33 for 7 strand cable.

APPENDIX C

CONDUCTOR SAGS

(a) Basis of Sag Curves for Supply Conductors

Data are presented in Appendix C in the form of curves in Charts numbers 1 to 9 inclusive, showing conductor sags which produce tensions that do not exceed either 35% of ultimate strength of the conductor at 60°F and no wind, or 50% of ultimate strength (safety factor of 2) of the conductor under the maximum loading conditions specified for Light or Heavy Loadings in Rule 43. These sags are considered particularly applicable to the stringing of new wire (i.e. they should be considered initial sags for conductors which have not been prestressed) and are not recommended in the case of used or so-called prestressed wire.

The curves of the sag charts were drawn from computations made under the following conditions:

1. Sag curves in the Light Loading charts are based on 35% of conductor ultimate tensions at 60°F and no wind.
2. Sag curves in the Heavy Loading charts show sags which will obtain at 60°F and no wind, in conductors which are so strung that under heavy loading conditions the conductor tension will be one-half of the ultimate tension.
3. The sag curves for weatherproof wire are for conductors having a triple-braid-weatherproof covering.
4. Conductor dimensions, weights and loadings were taken from the tables in Appendix B.
5. Modulus of Elasticity—lbs. per sq. in.

Copper	17,000,000
Steel and iron, solid	29,000,000
Steel, stranded	21,000,000
Copper-covered steel, solid	24,000,000
Copper-covered steel, stranded	23,000,000

6. Coefficient of Linear Thermal Expansion—per degree F.

Copper	.0000094
Steel and iron	.0000065
Copper-covered steel	.0000072

(b) Communication Conductor Sags

The safety factors of Rule 44 and the conductor sizes of Rule 49.4 are the minimum requirements applicable to communication conductors. Conductors having sags not less than those specified in Table 25 will meet the minimum requirements of these rules for Grade "F" construction. The sag values given in Table 25 are greater than are required by the minimum requirements, but are considered to be in accordance with good practice.

(c) Sags for Unequal Spans, Level Supports and Normal Conditions

When a crossing span and its adjoining spans are of different lengths it is not possible to string the conductors so as to make both the normal tension and the loaded tension balance in the several spans. This condition should be met by selecting a sag for the longest span not less than that shown in the accompanying curves, pages 299 to 304, inclusive.

The sags for the other spans should then be determined as follows: For each span multiply the sag for the longest span by the square of the ratio of the length of the span under consideration to that of the longest span. The total normal tension in each of the spans will then balance and the total tension under loaded conditions will be slightly less in the short spans than in the longest span.

Example

Assume—A crossing span length of 250 feet—Heavy Loading District.
Adjoining spans of 300 feet and 200 feet, respectively.
Conductors No. 0, AWG copper, medium-hard-drawn, stranded, bare.
Sag from curve on page 302, for a 300-foot span is 5.30 feet.

Making the sags in the other spans proportional to the squares of their length, the sag in the 250-foot span will be,

$$\frac{(250)^2}{(300)^2} \times 5.30 = 3.68 \text{ feet}$$

The sag in the 200-foot span will be,

$$\frac{(200)^2}{(300)^2} \times 5.30 = 2.36 \text{ feet}$$

(d) Sag Correction for Temperature

The curves, on page 305, cover the correction of sags for stringing temperatures other than that for which the sag curves were calculated. These figures cover the normal range of stringing conditions for temperatures at time of stringing, varying between 0°F and 130°F, and for spans of from 100 feet to 1000 feet, inclusive, in 100-foot steps, with the exception that the 150-foot span has also been included. They represent average values for each degree F. difference between actual stringing temperature and the temperature for which the curves were calculated, that is 60°F. The corrections for temperatures greater than 60°F are to be added to the normal sags while the corrections for temperatures less than 60°F are to be subtracted. The correction for a given difference of temperature from the base value is considered the same whether the stringing temperature is greater or less than the base value.

The use of these corrections may be illustrated by assuming a specific case:

Example

Assume—A span of 300 feet—Heavy Loading District.

Conductors No. 0, AWG copper, medium-hard-drawn, stranded, bare.
Stringing temperature 80°F.
Minimum normal sag, page 302, is 5.30 feet.
Difference between stringing temperature and normal temperature is 20°F.

The ratio for sag divided by span is 0.0177. From the curve on page 305, the correction per degree F for this ratio for a span of 300 feet is 0.024 feet.

The total correction for 20°F difference is,

20 x 0.024=0.48 feet

Then the corrected sag is 5.30+0.48 equals 5.78 feet.

If some other span than those covered by specific curves is used the correction may be obtained by interpolation between curves.

(e) Sags for Supports at Different Elevations

The sag curves have been based on the supports being at the same elevation. The curve on page 306 covers the correction of the sag to care for the difference of elevation of supports.

The use of this correction may best be illustrated by taking a concrete case:

Example

Assume—A span of 300 feet—Heavy Loading District.

A difference in level of supports of 5 feet.
Conductors No. 0, AWG copper, medium-hard-drawn, stranded, bare.
The curve, page 302, requires a sag of 5.30 feet.

The ratio of difference in level of supports divided by the sag is 5.0 divided by 5.30 which equals 0.94 and is the ratio marked h/S on curve, page 306. The multiplier C for this ratio is 0.58. Therefore the sag below the lower point of support is,

0.58 x 5.30=3.07 feet

If the sag is to be measured from the higher support, the sag below the lower support may be obtained as above and the difference in elevation of supports added thereto, which gives the sag below the higher support as 3.07+5.00 which equals 8.07 feet. The difference of levels may be such that the resultant pull is upward at the lower support; that is, the lowest point in the span is at the support. To cover this condition, and also as an alternative method of solving cases like that just considered, use may be made of the following approximate rule which is sufficiently accurate for all ordinary situations,—"The apparent sag, or the vertical distance between a straight line joining supports and the tangent to the span, parallel thereto, equals the sag for a normal span of the same length."

(f) Determination of Amount of Sag for Various Points in a Span

The sag curves on pages 299 to 304, inclusive, show for wires of different sizes and materials the value of the center sag at which these wires should be strung under normal conditions to have the assumed factors of safety under the designated load conditions. At times it is desirable to know, not only the amount of sag at the center of the span, but also the amount of sag at some other point in the span.

This is necessary, for example, in obtaining the clearance over other wires where the point of crossing between the crossing span and the wires crossed, occurs, not at the center of the crossing span, but at some other point.

On page 307 a curve is given by means of which, given the amount of center sag, the amount of the sag at any other point in the span can be determined. This curve gives the value of the sag at all points on the catenary curve expressed in per cent of the center sag. The use of this curve is shown by the following example:

Example

Assume—A span of 300 feet—Heavy Loading District.

A center sag, determined from the sag curves, of 5.30 feet.

The crossing span crosses over a Class C line, on which the top wire at the point of this crossing has an elevation of 25 feet.

This point of crossing to be 105 feet from the nearest support of the crossing conductor, and a minimum vertical clearance of 6 feet is required at the point of crossing.

Required—At what height must the crossing conductor be supported in order that this required vertical clearance shall be obtained?

As the span length is 300 feet, and the distance from the nearest support to the point of crossing is 105 feet, this distance is 35 per cent of the span length. From the curve, page 307, the value of the sag at this point is 91 per cent of the center sag. The sag at this point, therefore, equals 5.30x0.91=4.82 feet.

Therefore, the required elevation of the crossing conductor at its point of support is equal to the height of the Class C wires crossed (25 feet), plus the minimum vertical clearance required (6 feet), plus the sag of the conductor at the point of crossing (4.82 feet).

25 feet+6 feet+4.82 feet=35.82 feet

(g) Charts of Conductor Sag Curves

The following list includes charts of sags of various sizes and kinds of copper conductors, adjustment curves for temperature changes, sag adjustment curve for supports at different elevations, and a table of sags for communication conductors in Grade "F" construction:

CHART NO. 1. LIGHT LOADING

Sags at 60° F and No Wind

Bare Copper—Hard Drawn and Medium Hard Drawn

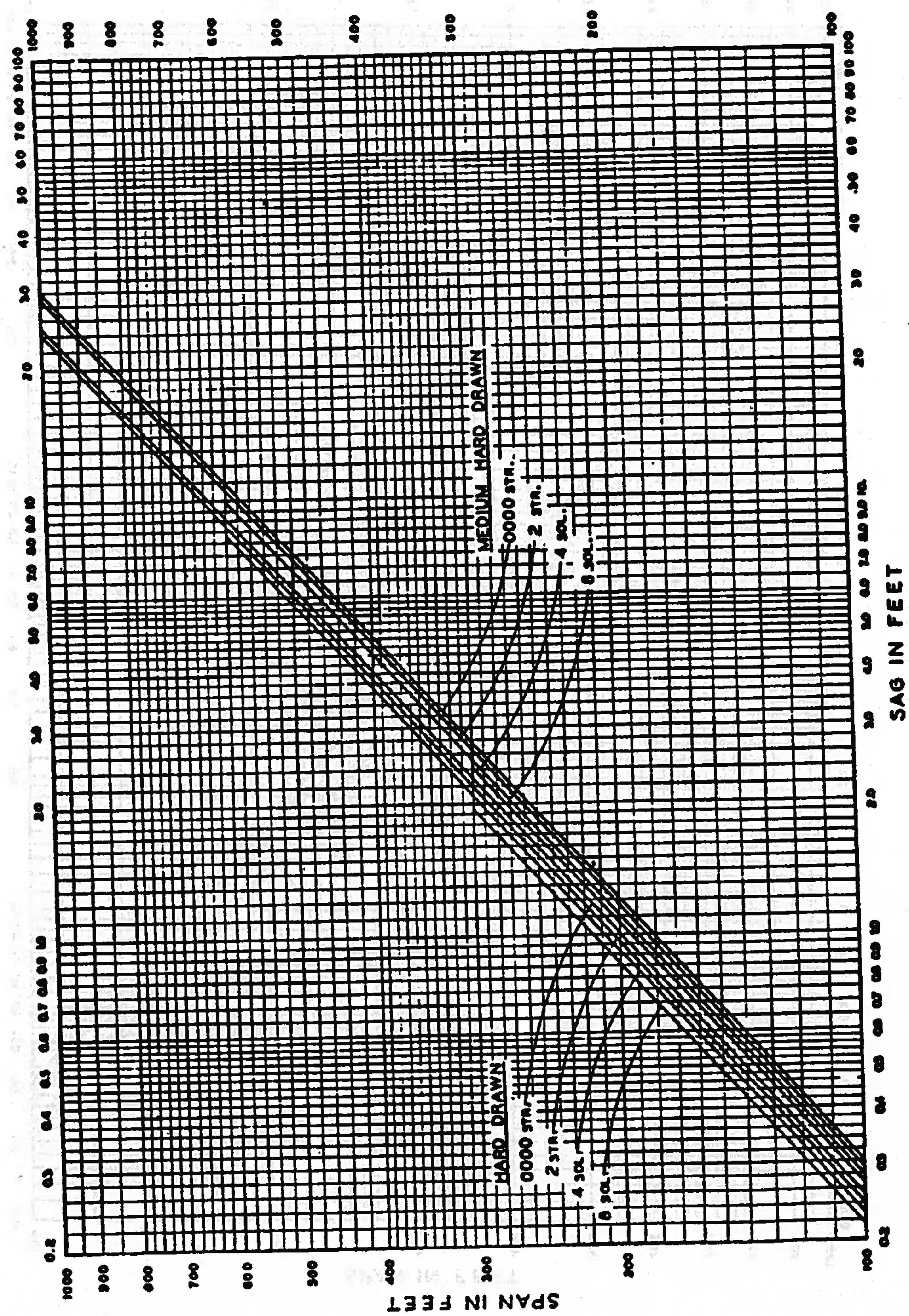


CHART NO. 2. LIGHT LOADING

Sags at 60° F and No Wind

Weatherproof Copper—Hard Drawn and Medium Hard Drawn

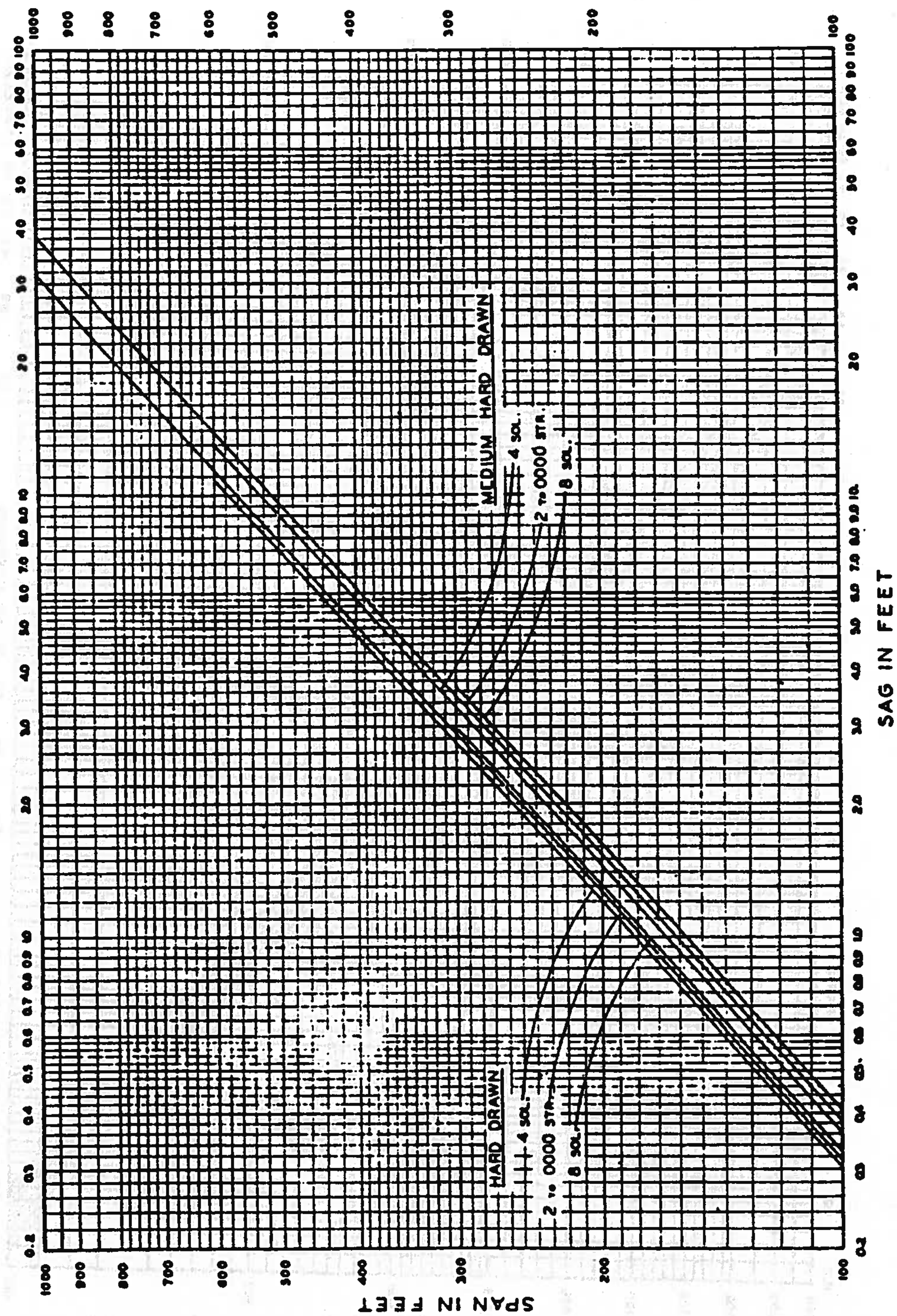


CHART NO. 3. HEAVY LOADING

Sags at 60° F and No Wind

Bare Copper—Hard Drawn

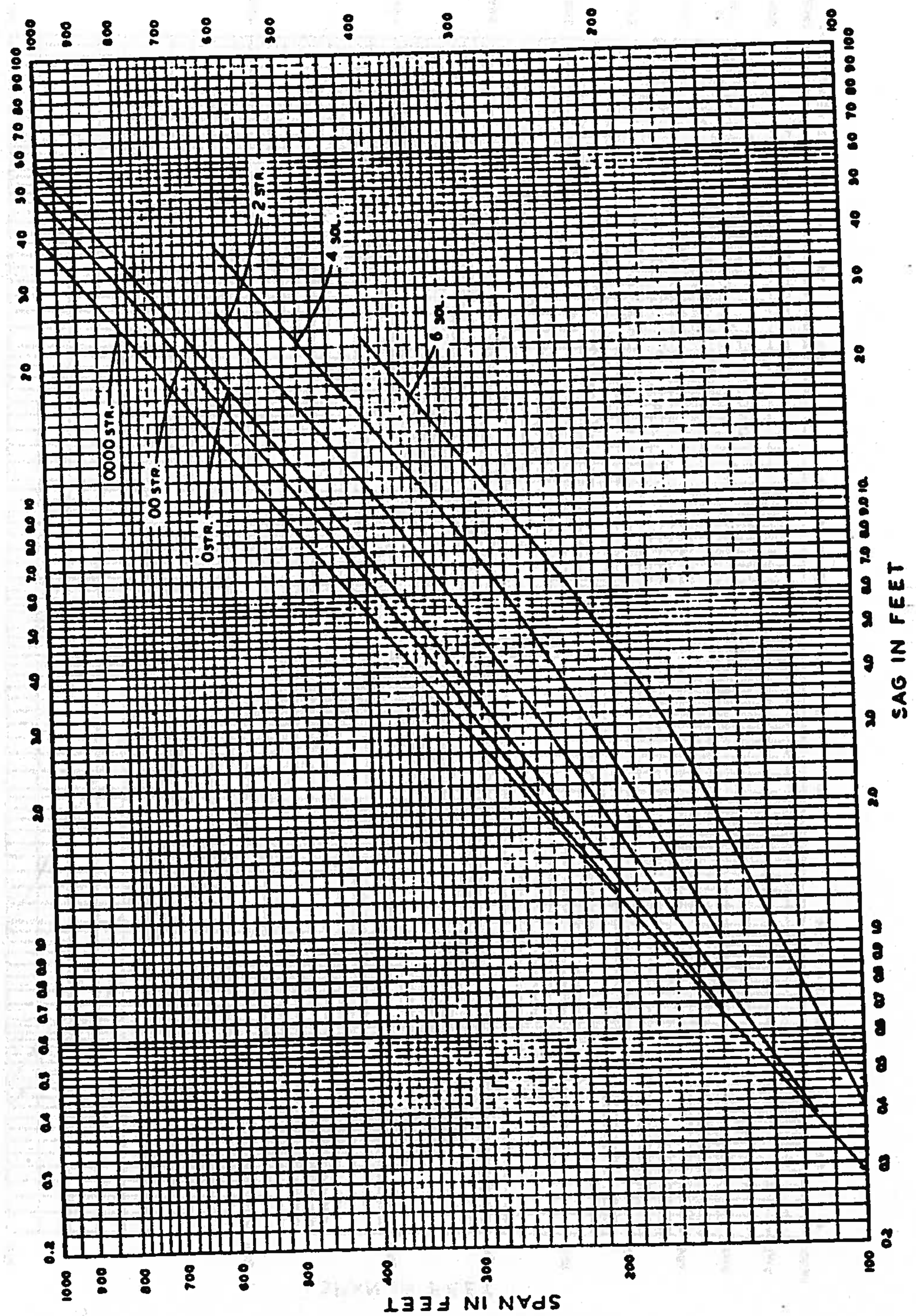


CHART NO. 4. HEAVY LOADING

Sags at 60° F and No Wind

Bare Copper—Medium Hard Drawn

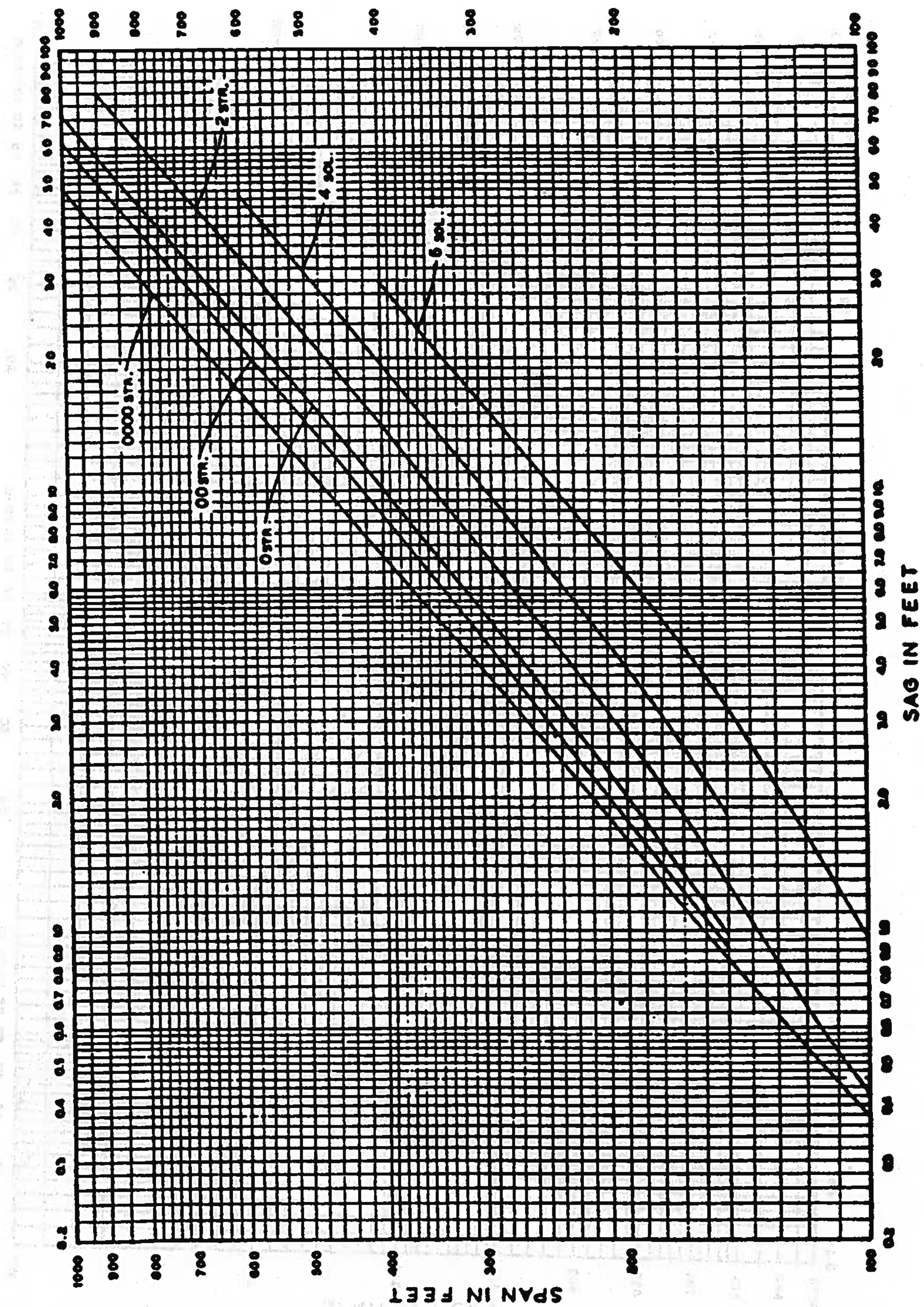


CHART NO. 5. HEAVY LOADING

Sags at 60° F and No Wind

Weatherproof Copper—Hard Drawn

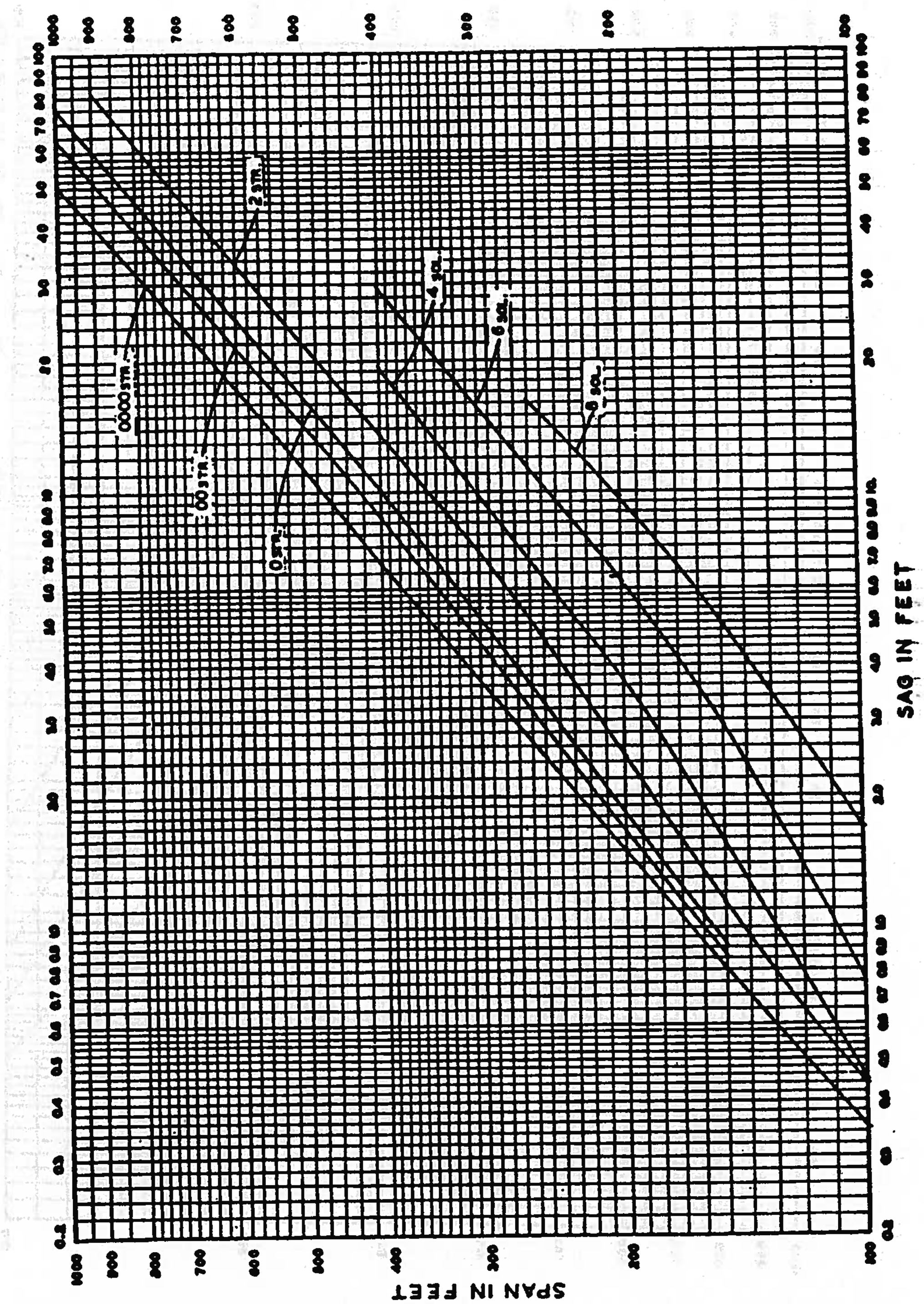


CHART NO. 6. HEAVY LOADING

Sags at 60° F and No Wind

Weatherproof Copper—Medium Hard Drawn

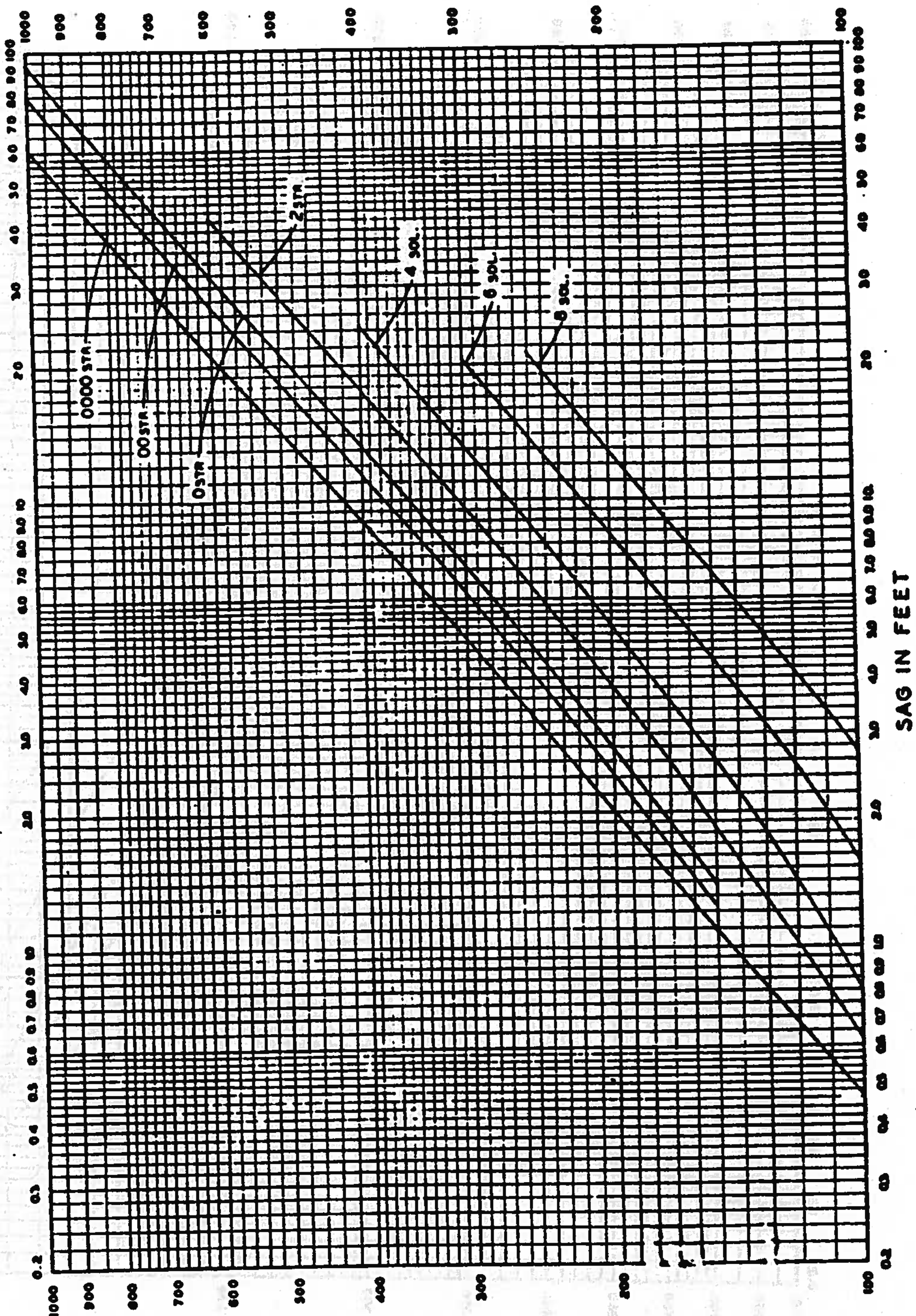


CHART NO. 7

SAG CORRECTION FOR TEMPERATURE – COPPER

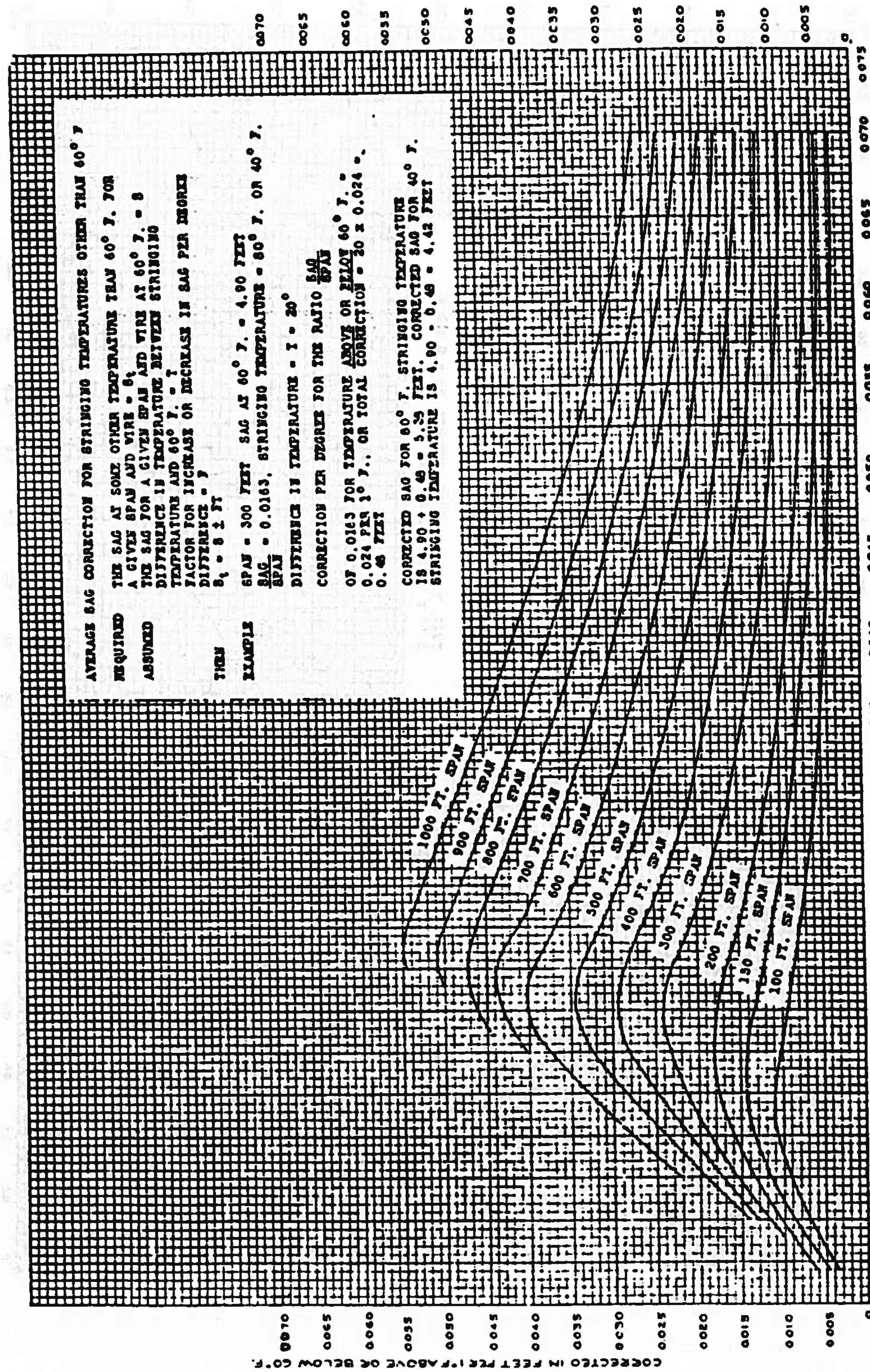


CHART NO. 8

SAG CORRECTION FACTOR – SUPPORTS AT DIFFERENT ELEVATIONS

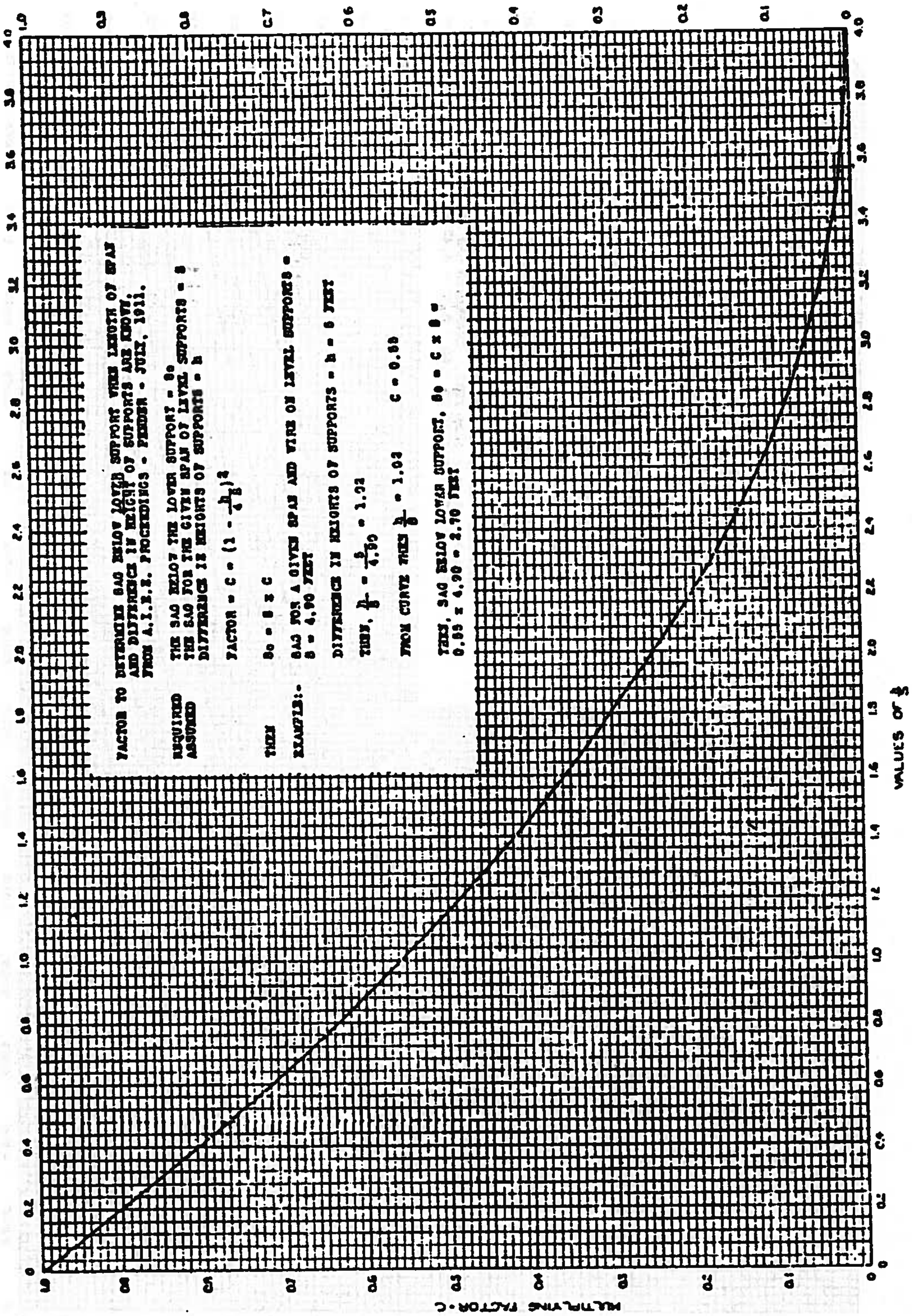


CHART NO. 9

CATENARY CURVE ORDINATES.

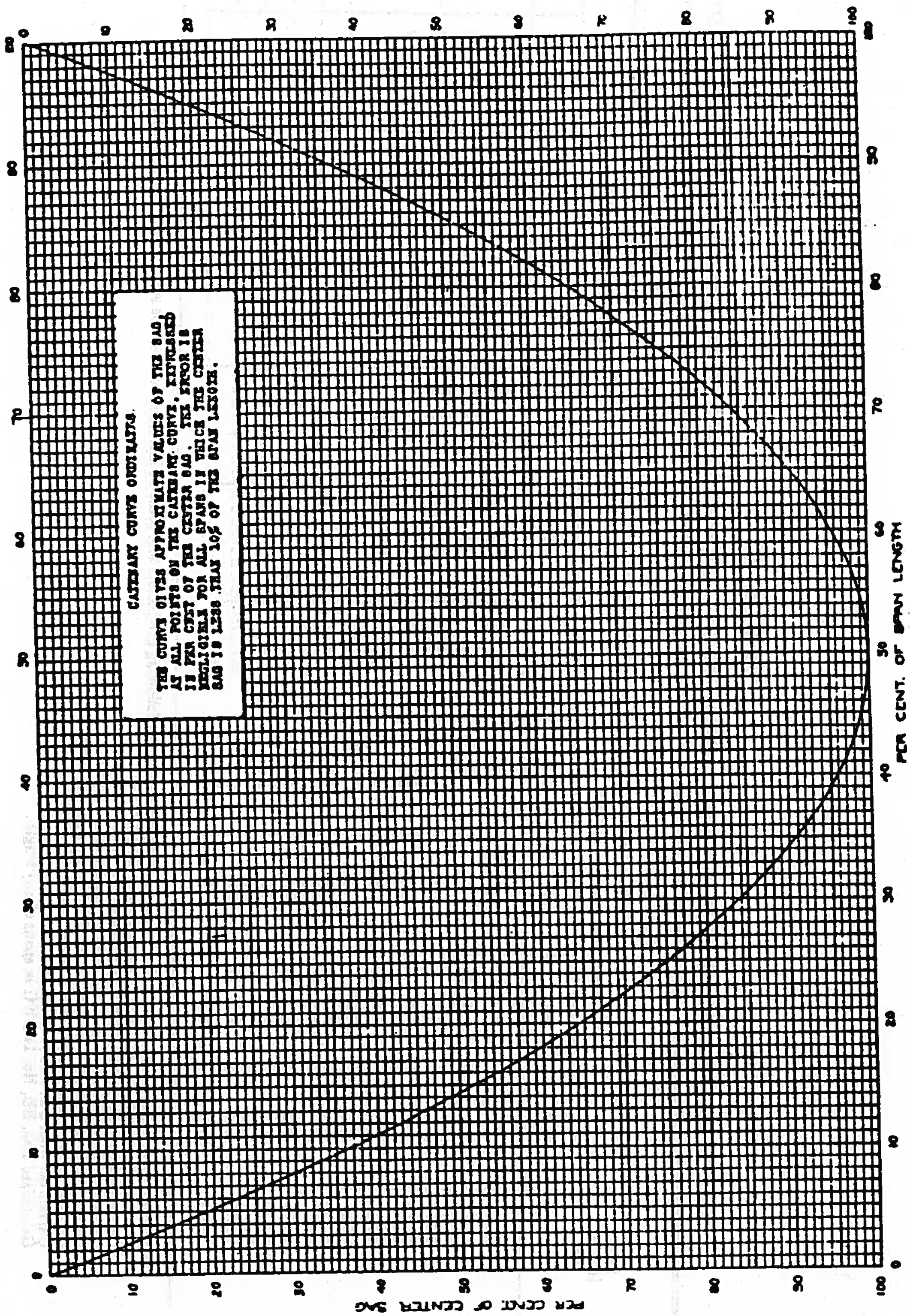


TABLE 25

STRINGING SAGS IN INCHES FOR COMMUNICATION CONDUCTORS IN GRADE F CONSTRUCTION

Span length, feet	Light loading					Heavy loading*					
	Temperature, degrees Fahrenheit					Temperature, degrees Fahrenheit					
	100	80	60	40	20	100	80	60	40	20	0
100	7	6	4.5	4	3.5	9.5	7.5	6	5	4	3.5
120	10.5	8.5	7	5.5	5	13.5	10.5	8.5	7	5.5	4.5
140	14	11	9	7.5	6.5	18.5	14.5	11.5	9.5	7.5	6.5
160	18	15	12	10	8.5	21	18	15	12.5	10.5	9
180	22	18.5	15.5	13	11	26.5	23	19	15.5	13	11
200	27	23	19	16.5	13.5	----	----	----	----	----	----
220	32.5	27.5	23	20	16.5	----	----	----	----	----	----
240	36	31.5	27	23.5	20.5	----	----	----	----	----	----
260	42	37	32	27.5	24	----	----	----	----	----	----
280	49	42.5	37	32	27.5	----	----	----	----	----	----
300	56	49	42.5	36.5	32	----	----	----	----	----	----

* In heavy loading districts, sags of the given values are inadequate for the following conductors and must be increased to meet the safety factor requirements:
Hard-drawn copper, No. 12 AWG in spans greater than 130 feet.
Galvanized iron, EBB, No. 9 BWG in spans greater than 170 feet.
Galvanized iron, EBB, No. 10 BWG in spans greater than 140 feet.
Galvanized iron, EBB, No. 12 and No. 14 BWG in spans of any length.
Galvanized iron, BB, No. 10 BWG in spans greater than 170 feet.
Galvanized iron, BB, No. 12 BWG in spans greater than 115 feet.
Galvanized iron, BB, No. 14 BWG in spans of any length.

APPENDIX D

TYPICAL COMMUNICATION LINE CONSTRUCTION

For a communication line carrying from approximately 6 to 20 conductors in a Light Loading area, the following specifications adequately meet all intents and requirements of this order:

POLES

Round, wood, butt-treated, 25 feet in length, minimum top circumference of 15 inches, and set to a minimum depth of 4.5 feet in firm soil.

CROSSARMS

3¼″x4¼″x10′. Attached by means of through bolts and washers, with a 15 inch center line of pole clearance to nearest conductors. Standard 30 inch quarter braces installed on the face of the crossarm with ⅜-inch bolts and ½-inch drive screw at the pole.

PINS

1¼″x8″ wood pins.

INSULATORS

Pin type insulators to be of design that will engage the thread of the pin for not less than two and one-half turns.

CONDUCTORS

Size and material dependent upon the class of circuit involved. Sags as specified in Appendix C, Table 25. The average span length is 150 feet.

GUYS

For guying at angles or dead ends, it is recommended that a "Lead over Height" (ratio of the horizontal distance from the face of the pole to the point of entrance of anchor rod in the ground to the vertical height above the ground of the attachment of said guy wire to the pole) of 1 be used. At angles in the line where the pull of the line exceeds 4 feet, i.e., the angle of departure exceeds 5 degrees, a guy strand having a strength of 1900 lbs. (¼″) or greater shall be used with the necessary pole shims, hook bolts, etc. (See App. G, Fig. 85)

HARDWARE

All line hardware to be galvanized or of other corrosion resisting material.

TABLE 26

REPLACEMENT GROUND LINE CIRCUMFERENCES IN INCHES OF SOUND SOLID WOOD FOR COMMUNICATION POLES IN GRADE "F" CONSTRUCTION

This table is suitable for poles supporting cables; interexchange lines (toll trunk and telegraph way wire); and exchange or local distribution lines of more than 10 wires. The circumferences given in this table are based on a safety factor of one-half, a modulus of rupture in bending of 5600 pounds per square inch, and the maximum number of wires (.104 inches in diameter) shown in the headings of the respective columns.

Length of pole (feet)	Span length (feet)	Load in number of wires											
		1-4		5-10		11-20		21-30		31-40		41-50	
		L. L.	H. L.	L. L.	H. L.	L. L.	H. L.	L. L.	H. L.	L. L.	H. L.	L. L.	H. L.
20	100	12	12	12	15	------	------	------	------	------	------	------	------
	125	12	12	12	16	------	------	------	------	------	------	------	------
	150	12	12	12	17	------	------	------	------	------	------	------	------
	175	12	13	12	18	------	------	------	------	------	------	------	------
25	100	12	12	12	16	12	17	12	20	------	------	------	------
	125	12	13	12	17	12	18	12	21	------	------	------	------
	150	12	14	12	18	12	20	13	22	------	------	------	------
	175	12	14	12	19	12	21	14	23	------	------	------	------
	200	12	15	12	20	13	22	14	24	------	------	------	------
30	100	12	13	12	17	12	18	13	21	14	23	14	24
	125	12	14	12	18	12	20	14	23	14	25	15	26
	150	12	15	12	19	13	21	14	24	15	26	16	28
	175	12	15	12	20	14	22	15	25	16	27	17	29
	200	12	16	12	21	14	23	16	26	17	28	18	30

35	100	12	14	12	18	13	20	14	22	15	25	16	26
	125	12	15	12	20	13	21	15	24	16	26	17	28
	150	12	16	12	21	14	23	15	25	16	28	17	30
	175	12	16	12	22	15	24	16	27	17	30	18	31
	200	12	17	13	23	15	25	17	28	18	31	19	32

L.L.—Refers to Light Loading District, Rule 43.2.
H.L.—Refers to Heavy Loading District, Rule 43.1.

TABLE 27

REPLACEMENT GROUND LINE CIRCUMFERENCES IN INCHES OF SOUND SOLID WOOD FOR COMMUNICATION POLES IN GRADE "F" CONSTRUCTION

This table is suitable for poles supporting exchange or local distribution lines of 10 or less open wires. The circumferences given in this table are based on a safety factor of one-half, a modulus of rupture in bending of 5,600 pounds per square inch, and the maximum number of wires (.104 inches in diameter) shown in the headings of the respective columns.

Length of pole, (feet)	Span length, (feet)	Load in number of wires			
		1–4		5–10	
		L. L.	H. L.	L. L.	H. L.
20	100	9	11	9	15
	125	9	12	9	16
	150	9	12	9	17
	175	9	13	9	18
25	100	9	12	9	16
	125	9	13	10	17
	150	9	14	10	18
	175	9	14	10	19
	200	9	15	11	20
30	100	9	13	10	17
	125	9	14	11	18
	150	9	15	11	19
	175	10	15	11	20
	200	10	16	12	21
35	100	10	14	11	18
	125	10	15	12	20
	150	10	16	12	21
	175	11	16	12	22
	200	11	17	13	23

L.L.—Refers to Light Loading District, Rule 43.2.
H.L.—Refers to Heavy Loading District, Rule 43.1.

APPENDIX E

CLEARANCE OF POLES, TOWERS AND STRUCTURES FROM RAILROAD TRACKS

Where poles, towers or other line structures are set in proximity to railroad tracks, the minimum side clearance from the face of a pole, tower or structure to the center line of the tangent railroad track shall be 8 feet 6 inches.

Clearance requirements above railroads are shown in General Order No. 6, in Rules 37, Table 1, 54.4-B, 56.4-B, 57.4-B, 58.2-B2, 74.4-B, 77.4-A, 84.4-B, 86.4-B, 87.4-B and 113.5.

APPENDIX F

TYPICAL PROBLEMS

The application of line construction requirements specified in this Order is exemplified in the following:

Part 1. Crossing Problem—A Class H and a Class C circuit crossing over a major railroad, major Class C circuits and a highway.

Part 2. Dead End Problem—Class H and Class L circuits at a dead end.

Part 3. Angle Pole Problem—Guying a pole supporting Class H and Class L circuits at angles in lines.

The problems are computed on the assumptions of light loading conditions, with Grade "A" construction used for the power circuits and Grade "F" construction used for the communication circuits except in the crossing spans where Grade "B" is required. The construction details specified in these Typical Problems are made to conform to current good practice.

PART 1

CROSSING PROBLEM

A diagram including dimensions is shown attached between pages 328 and 330. The data chosen for the crossing follow:

DATA OF CROSSING

Circuits

Two 3-phase 60,000 volt power circuits. One metallic private Class "C" telephone circuit.

Configuration

Power conductors of each circuit are in vertical planes on opposite ends of the crossarm. Private telephone circuit is in a horizontal plane.

Conductors

Power circuits are 6 No. OO AWG, bare, stranded, hard-drawn copper. Private telephone circuit is 2 No. 8 AWG, bare, solid, hard-drawn copper, except in the crossing span where it is 2 No. 6 AWG, bare, solid, hard-drawn copper.

Insulators

Porcelain, pin type, meeting the requirements of Rule 49.5-A.

Ties

Annealed copper wire to comply with Rules 49.3-B and 49.3-C.

Pins

Power circuits—wrought iron pipe (extra strong), 1½"x18½", to comply with Rules 49.3-B and 49.3-C. Assumed bonded in accordance with the requirements of Rule 53.4.

Communication circuit—1½"x9" locust.

Crossarms

Power circuits—Douglas fir (dense), 4¾" x 5¾" x 12', 1.9" pin holes, 11/16" hole for through bolt.

Communication circuit—Douglas fir (dense), 3¼"x4¼"x42", 1½" pin holes, 11/16" hole for through bolt.

Crossarm Braces

Meeting the requirements of Rule 49.2-C.

Poles

Western red cedar, round, butt treated.

Span Length

Crossing span, 200 feet.

Adjacent spans, 150 feet.

CONSTRUCTION REQUIREMENTS

1. Conductor Sags and Tensions

The conductors are assumed to be strung so that at normal conditions of 60° F. and no wind the tension will be 35% of the ultimate tension of the conductors. From Chart No. 1, Page 299, it will be seen that under these conditions the No. 00 AWG conductor, for a 200-foot span, will have a sag of 1.0 feet, (0.99 when calculated) and the No. 6 AWG conductor will have a sag of 0.90 feet (0.89 when calculated). These sags may be calculated by means of the following approximation formula:

$$\text{Sag} = \frac{wd^2}{8T}$$

Where w = conductor loading, pounds per lineal foot
d = span length, feet
T = assumed allowable conductor tensions at 60° F. and no wind

For No. 00 AWG conductor

$$\text{Sag} = \frac{4109 \times (200)^2}{8 \times 2074} = 0.99 \text{ feet}$$

For No. 6 AWG conductor

$$\text{Sag} = \frac{.0795 \times (200)^2}{8 \times 448} = 0.89 \text{ feet}$$

Maximum conductor load to be met with a safety factor of not less than 2 as specified in Rule 44.1 will occur at the conditions of 25° F. and an 8-pound wind (Rule 43.2). Conductors which have been strung at the normal conditions stated above (60° F, no wind, and 35% ultimate tension) will have sags and tensions at the maximum loading conditions of 25° F and an 8-pound wind as indicated below. Maximum conductor sags will occur at the condition of maximum temperature, 130° F and also are shown in the following tabulation:

	No. 00 AWG		No. 6 AWG	
	Sag (feet)	Tension (pounds)	Sag (feet)	Tension (pounds)
Ultimate conductor tension (see App. B Table No. 18)	......	5925	......	1280
35% Ultimate at 60°F, no wind	0.99	2074	0.89	448
25°F, 8 lb. wind	0.95	2605	1.18	570
130°F, no wind	1.78	1157	1.55	256

From the foregoing it will be seen that by stringing the conductors to 35% of ultimate tension at 60° F and no wind, the safety factor of the conductors at maximum loading (25° F, 8-lb. wind) is somewhat greater than the minimum of 2 required by Rule 44.1.

Lesser sags than those shown above may be used, provided conductor tension, at maximum loading condition specified in Rule 43, does not exceed 50% of the ultimate tension of the conductor. The rules, of course, do not prevent the use of greater sags than are calculated above.

2. Conductor Clearance from Center Line of Pole

Minimum clearances specified in Table 1, Case 8 and Rule 54.4-D2 and the clearances assumed for the purposes of this problem are as follows:

	Minimum	*Used*
60,000 volt circuits	21.5″	5′ 6″
Communication circuit	15″	18″

3. Conductor Separation

Table 2, Case 12, Column H modified by Rule 54.4-C1c, permits a vertical separation of not less than 36 inches between the conductors of a 60,000-volt circuit in vertical configuration. For this problem a separation of 5′ 6″ is used.

The minimum separation between the level of the lowest supply conductor and the communication circuit is 72 inches (Table 2, Case 8, Column H). For the problem a separation of 96″ between crossarm centers is used.

4. Clearances of Conductors Above Crossarms

The minimum clearance of a 60,000-volt conductor from the surface of a crossarm is required (by Table 1, Case 9, Column F,) to be at least ¼ of the pin spacing specified in Table 2, Case 15, Column H, which would be a minimum clearance of 9 inches. For this problem an 18½ inch pin is used which, with its insulator, places the conductor 14 inches above the crossarm.

5. Conductor Clearances Above Highway, Pole Lines and Railroad Tracks

The poles supporting the crossing span are 55 feet in length, set 7 feet (Rule 49.1-C) in the ground. From dimensions of the pole framing diagram the distance of the private telephone circuit above ground is 28′ 4″. For this problem a common elevation has been assumed for the ground line, the railroad tracks and the highway.

The sag of the communication conductors in the crossing span is approximately 11 inches at 60°F and 19 inches at 130°F. Since the allowable variation of 5% for temperature, applied to the ground clearance of 27′5″ (28′4″—11″), or 1′4″, is greater than the difference between the sags at 60°F (11″) and at 130°F (19″), the clearances may be determined at 60°F for all conditions. In the diagram, between Pages 328 and 330, the distances from supporting pole C to the various objects crossed over by the conductors are as follows:

Telephone pole line	37′ 6″
Highway (center)	60′ 0″
Telegraph pole line on RR r/w	97′ 6″
Railroad Tracks (center)	138′ 9″
Railroad Signal pole line	180′ 0″

The total length of crossing span is 200 feet. Therefore the clearance at 60°F of the private communication circuit above the telephone lead at point of crossing is obtained as follows:

Clearance point distance from Pole C is 37′ 6″.

At 37′ 6″, or 18.8% of span, the sag is equivalent to 61% of the center sag (see Chart No. 9 Page 279), or $0.61 \times 11 = 7$ inches sag.

Therefore, the clearance equals:

$28' 4'' - (7'' + 24') = 3' 9''$ clearance.

The minimum required clearance as given in Table 2, Case 3, Column C is 2 feet.

19

In a like manner the clearances, at 60°F, of the private communication circuit conductors at the other points of crossing are as follows:

Points of Crossing	*Clearances*	*Minimum by rule*
Highway (center)	27′ 7″	18′ 0″
Telegraph pole line	3′ 5″	2′ 0″
Railroad Tracks (center)	27′ 7″	25′ 0″
Railroad Signal pole line	6′ 0″	2′ 0″

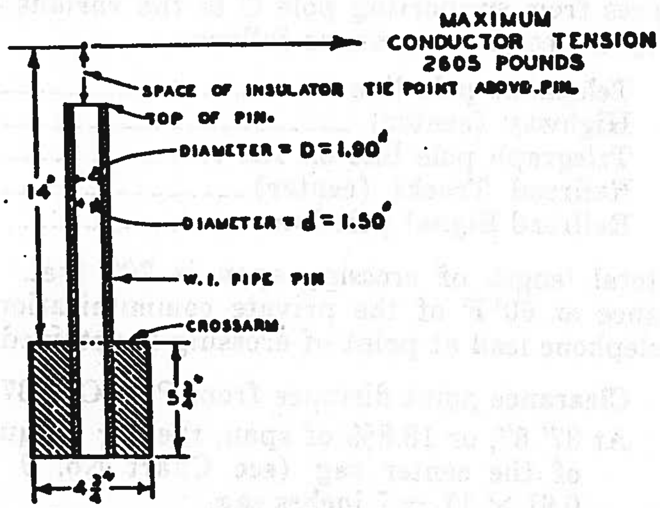
6. Insulators

In addition to the electrical requirements set forth in Rules 55, 104 and 114, the insulators supporting the supply and communication conductors shall have safety factors (mechanical) of 3 and 2, respectively.

7. Pins, Ties and Conductor Fastenings

Ties used in connection with pin-type insulators shall conform to Rule 49.3. In this problem a No. 4 and No. 8 annealed copper wire are used for the No. 00 and No. 8 circuits involved.

Pins used in connection with pin-type insulators shall have sufficient strength to withstand the tension in the conductor. In the case under discussion wrought iron pipe-pins of the dimensions and construction indicated below are to be employed for the power conductors.



Bending moment (at crossarm) $M = 2605 \times 14 = 36{,}470$ pound-inches

Section modulus $E = \dfrac{\pi\,(D^4 - d^4)}{32\ D}$

$$0.0982\ \frac{(1.90^4 - 1.50^4)}{1.90} = 0.412 \text{ inches}^3$$

$$\text{Fiber stress } S = \frac{M}{E} = \frac{36{,}470}{0.412} = 88{,}500 \text{ pounds per sq. in.}$$

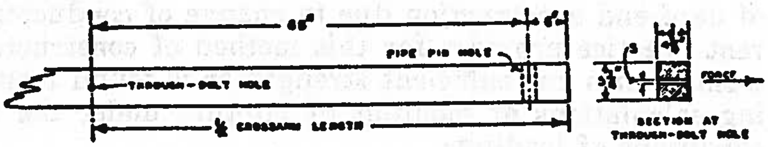
Assuming that the ultimate fiber stress of wrought iron is 48,000 pounds per square inch, a single pin is not sufficient, as it provides a safety factor of 0.542, $\left(\frac{48{,}000}{88{,}500} = 0.542\right)$, for an assumed tension of 2605 pounds in the conductor at maximum loading. Since a safety factor of unity (Rule 47.5) is required, two pins are necessary and therefore double crossarms, pins and insulators are used on the poles supporting the crossing span.

Locust pins are to be used in this case for the private telephone conductors. Although a $1\frac{1}{2}$-inch locust pin would be sufficient to withstand the conductor tension of 570 pounds with a safety factor of at least unity, as required by Rule 47.4, care would be necessary to provide sufficient strength in the conductor fastenings. In this problem the private telephone conductors are considered to be dead-ended at the ends of the crossing span.

8. Crossarms—Horizontal Loads

Power Circuits

The point of maximum bending moment will be at the cross arm through bolt attaching the arm to the pole, at which point the cross section of the arm is reduced by the amount of the bolt hole. Crossarms supporting the 60 kv wires are to be of Douglas fir, dense, dimensions $4\frac{3}{4}'' \times 5\frac{3}{4}'' \times 12'$, bored as illustrated below.



The section through the arm and the method of computing the fiber stress is shown below.

Long-time loading: **Since longitudinal conductor loads are normally balanced, long-time horizontal loading of the power circuit crossarms need not be considered.**

Single arm, Maximum loading, **25° F and an 8 lb. wind**

Bending moment $= 2605 \times 66 = 171{,}930$ pound-inches

Section modulus $= \frac{bd^2}{6}$ where

$$b = 5.75'' - 0.69 = 5.06''$$
$$d = 4.75''$$
$$s = \tfrac{11}{16}'' = 0.69''$$

Section modulus $= \frac{5.06 \times (4.75)^2}{6} = 19.0$ inches^3

Fiber stress = Bending moment divided by section modulus $= \frac{171{,}930}{19.0} = 9050$ lbs. per sq. in.

As the allowable value for modulus of rupture in bending under maximum loading conditions is 6300 lbs. per sq. in. (see Table 5, Page 63), a single crossarm of the size chosen provides a safety factor of only 0.70 for the assumed load at maximum loading conditions, whereas the provisions of Rule 47.5 require a safety factor of unity. Double arms will, therefore, be used in this problem to meet the strength requirements applicable to crossarms at end supports of crossings. Double crossarm construction of this type with separation maintained by space bolts is assumed to have a horizontal strength equivalent to 130% of the sum of the strengths of two single crossarms acting independently.

Maximum loading, 25° F and 8 lb. wind

Bending moment $= 2605 \times 66 = 171{,}930$ pound-inches

Single arm section modulus (same as previously calculated) $= 19.0$ inches³

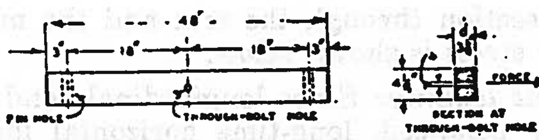
Double arm section modulus $= 19.0 \times 2 \times 1.3 = 49.4$ inches³

$$\text{Fiber stress} = \frac{171{,}930}{49.4} = 3480 \text{ lbs. per sq. in.}$$

As the allowable modulus of rupture for short-time loading is 6300 lbs. per sq. in. then the double crossarms under these conditions will provide a safety factor of 1.81, which meets the unity safety factor required by Rule 47.5.

Private Communication Circuit

At the crossing span, double crossarms are used on account of dead-end construction due to change of conductor size. Current practice provides for this method of construction although a single arm has sufficient strength as is found from the following calculations of modulus of rupture under the two limiting conditions of loading:



Long-time loading, 60° F. and no wind.

Bending moment $= 448 \times 18 = 8064$ pound-inches

$$\text{Section modulus} = \frac{bd^2}{6} = \frac{3.56 \times (3.25)^2}{6} = 6.26 \text{ inches}^3$$

where $d = 3.25''$
$s = 0.69''$
$b = 4.25'' - 0.69 = 3.56''$

$$\text{Fiber stress} = \frac{8064}{6.26} = 1290 \text{ pounds per sq. in.}$$

The allowable value for modulus of rupture in bending is $0.55 \times 6300 = 3465$ pounds per sq. in. and therefore with a single arm the factor of safety under conditions of long-time loading is 2.69.

Maximum loading

Bending moment $= 570 \times 18 = 10{,}260$ pound-inches
Section modulus $= 6.26$ inches^3 (as per calculations above)

$$\text{Fiber stress} = \frac{10{,}260}{6.26} = 1640 \text{ pounds per sq. in.}$$

The allowable value for modulus of rupture in bending, under maximum loading conditions, is 6,300 pounds per sq. in., therefore a single arm provides a safety factor of 3.84 under these maximum loading conditions.

9. Crossarms—Vertical Loads

The vertical load on crossarms, where supports are approximately at the same elevation, is due to the vertical load of conductors in each adjacent span plus 200 pounds at the outer pin position. In the problem under consideration the conductor supports on the crossing poles (C and D) are at the same elevation, and the supports at the adjacent poles (B and E) are 4.5 feet lower in elevation, which difference in elevation is greater than the normal sag. Then the conductor loading on a crossing span support would be one-half the weight of the conductor of the crossing span plus one-half the conductor weight of a hypothetical span, the curve of which passes through the points of support.

Half the length of the hypothetical span may be calculated as follows:

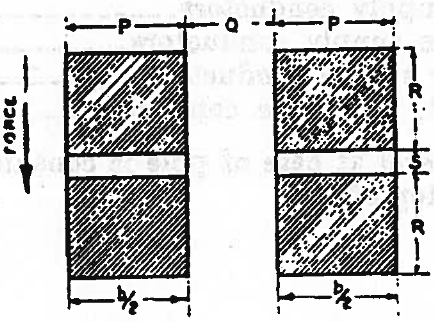
$$X = \frac{D}{2} + \frac{hT}{Dw}$$

Where $X = \frac{1}{2}$ the hypothetical span in feet.
$D =$ horizontal distance between supports in feet.
$h =$ difference in elevation of supports in feet.
$T =$ conductor tension in pounds.
$w =$ weight of conductor in pounds per foot.

The total crossing support-load is calculated as follows:

$$0.411 \times \frac{200}{2} + 0.411\left(\frac{150}{2} + \frac{4.5 \times 2074}{150 \times 0.411}\right) + 200 = 334 \text{ pounds}$$

The bending moment is
$334 \times 66 = 22{,}040$ pound-inches



The method of calculating the unit fiber stress of the double crossarms acting as a simple beam is as follows:

$$\text{Section modulus} = \frac{b}{6} \times \frac{(d^3 - d_1^3)}{d}, \text{ where}$$

$$b = P + P = 9.50''$$
$$d = R + S + R = 5.75''$$
$$d_1 = S = 0.69''$$

$$\text{Section modulus} = \frac{9.50}{6}\left(\frac{(5.75)^3 - (0.69)^3}{5.75}\right) = \frac{9.50}{6} \times \frac{189.8}{5.75} = 52.3 \text{ inches}^3$$

$$\text{Fiber stress} = \frac{\text{Bending moment}}{\text{Section modulus}} = \frac{22{,}040}{52.3} = 420 \text{ pounds per sq. in.}$$

Long-time loading

As the allowable modulus of rupture in bending is 0.55 $\times$ 6300 lbs. per sq. in. or 3465 lbs. per sq. in. (see Table 5), the double crossarms of the size chosen provide a safety factor of 8.2.

The fiber stress in the double crossarms of the private telephone circuit, similarly calculated, is found to be 196 lbs. per sq. in. These arms obviously meet the strength requirements for vertical loads on crossarms.

Shear, compression, and torsion stresses are not considered in this problem as they are negligible and likewise the effect of reduction of cross section due to bolt holes is not considered except for the through bolt holes.

10. Poles

The crossing poles are western red cedar and their dimensions are as follows:

Length	55	feet
Height above ground	48	feet
Circumference at top	28	inches
Diameter at top	8.9	inches
Circumference at ground line	49	inches
Diameter at ground line	15.6	inches

Distance from ground line to conductors supported is given as follows:

Top supply conductors	48′ 9″
Middle supply conductors	43′ 3″
Lower supply conductors	37′ 9″
Private telephone conductors	28′ 4″

Ground level at base of pole is considered to be at the same elevation as top of rail.

Dimensions of adjacent poles B and E are:

Length	50 feet
Height above ground	43.5 feet
Circumference of top	28 inches
Diameter of top	8.9 inches
Circumference at ground line	47 inches
Diameter at ground line	15.0 inches

11. Transverse Load on Crossing Poles C and D

The moment at the ground due to an 8 pound wind pressure on the conductors, is:

$$Mc = Ln\ P_h\left(\frac{S_1 + S_2}{2}\right) \text{pound-feet}$$

Where

L = Height of conductors above ground in feet

n = Number of wires

S_1 and S_2 = Length of crossing and adjacent spans, respectively

P_h = Horizontal load per lineal foot due to an 8 pound wind pressure on projected area of wire

P_h = 0.276 pounds per lineal foot for 00 AWG bare, stranded copper
= 0.108 pounds per lineal foot for 6 AWG bare, solid copper
= 0.085 pounds per lineal foot for 8 AWG bare, solid copper

M_{c0} = Moment due to pressure on top supply conductors

M_{c1} = Moment due to pressure on middle supply conductors

M_{c2} = Moment due to pressure on lower supply conductors

M_{c3} = Moment due to pressure on telephone conductors

$$M_{c0} = 48.75 \times 2 \times .276 \times \left(\frac{150 + 200}{2}\right) = 4710 \text{ lb.-ft.}$$

$$M_{c1} = 43.25 \times 2 \times .276 \times \left(\frac{150 + 200}{2}\right) = 4180 \text{ lb.-ft.}$$

$$M_{c2} = 37.75 \times 2 \times .276 \times \left(\frac{150 + 200}{2}\right) = 3650 \text{ lb.-ft.}$$

$$M_{c3} = 28.33 \times 2 \times .108 \times \left(\frac{200}{2}\right) = 610 \text{ lb.-ft.}$$

$$M_{c3} = 28.33 \times 2 \times .085 \times \left(\frac{150}{2}\right) = 360 \text{ lb.-ft.}$$

Total moment due to wind pressure on conductors 13,510 lb.-ft.

The moment at the ground due to an 8 pound wind pressure on the pole is

$$M_p = PH^2 \left(\frac{D_1 + 2D_2}{72}\right) \text{ pound-feet}$$

Where

M_p	= Moment due to wind pressure on pole
P	= Pressure in lbs. per sq. ft. on projected area of pole (8 lbs./sq. ft.)
H	= Height of pole above ground in feet (48′)
D_1	= Diameter of pole at ground in inches (15.6″)
D_2	= Diameter of pole at top in inches (8.9″)
M_p	$= \frac{8\ (48)^2 \times (15.6 + 2 \times (8.9))}{72} = 8550$ lb.-ft.

Total moment = 13,510 + 8,550 = 22,060 lb.-ft.

$$\text{Moment of resistance of pole} = M = \frac{FI}{c}$$

Where

F	= Fiber stress in pounds per sq. in.
I	= Moment of inertia of section $= \frac{\pi D_1^4}{64 \times 12}$
c	= Distance from neutral axis to outer fiber $= \frac{D_1}{2}$

$$M = \frac{\pi F D_1^3}{384} = \frac{F D_1^3}{122}$$

$$F = \frac{122\,M}{D_1^3} = \frac{122 \times 22.060}{(15.6)^3} = 710 \text{ lbs. per sq. in.}$$

The allowable fiber stress for western red cedar poles to provide a factor of safety of 4 is 1400 pounds per sq. in., hence the crossing poles are not required to be side guyed since they have a factor of safety of 7.9 for transverse load.

12. Side Guying

If side guying were required for the crossing poles C and D the method of computing the same would be as follows:

Side guys are designed to take the entire transverse load of the pole, the pole acting merely as a strut.

The transverse force acting on the poles will be due to wind pressure on poles C and D and the transverse wind pressure on the conductors supported. The length of conductor used in computing this transverse force will be equal to one-half the distance between the guyed poles C and D, plus one-half the length of the span adjacent to these poles.

The total wind pressure is computed as follows:

On Conductors

$$3 \times 2 \times 0.276 \times \frac{150 + 200}{2} = 289.8 \text{ pounds}$$

$$2 \times 0.108 \times \frac{200}{2} = 21.6 \text{ pounds}$$

$$2 \times 0.085 \times \frac{150}{2} = 12.8 \text{ pounds}$$

On Pole

$$\frac{(D_1 + D_2)\ H\ P}{24}$$

$$\frac{(15.6 + 8.91)\ 48 \times 8}{24} = \underline{392.2} \text{ pounds}$$

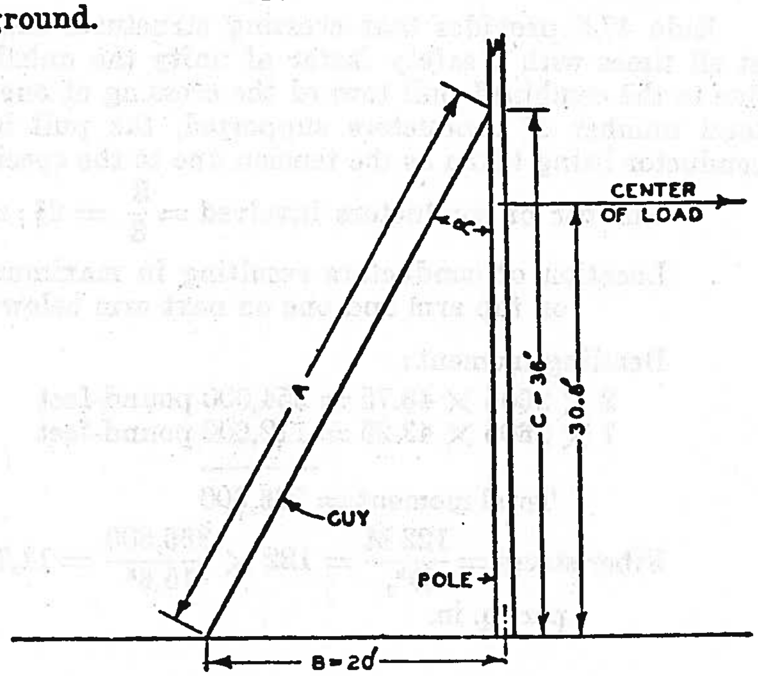
Total Wind Pressure $= 716.4$ pounds

The total moment on the poles is the same as developed for "Transverse load on poles" which was 22,060 pound-feet.

Therefore, the center of load would be:

$$\frac{22{,}060}{716.4} = 30.8 \text{ feet above ground}$$

A side guy could not be attached at this center of load and provide the required clearances from the communication line; therefore, for construction purposes the guy is assumed attached just below the lowest supply crossarm at a distance of 36 feet above ground.



Let M_t = Total moment on pole = 22,060 pound-feet
C = Height of guy attachment above ground = 36 feet (assumed)
B = Distance of guy anchor from base of pole = 20 feet (assumed)
T = Tension in guy wire in pounds
A = Length of guy = $\sqrt{20^2 + 36^2}$ = 41.2 feet

$$T = \frac{M_t}{C \sin \alpha}$$

$$\sin \alpha = \frac{B}{A} \text{ where}$$

$$A = \sqrt{B^2 + C^2}$$

$$\sin \alpha = \frac{20}{\sqrt{20^2 + 36^2}} = .485$$

$$T = \frac{22{,}060}{36 \times .485} = 1260 \text{ pounds}$$

The specified safety factor for guys (Table 4) is 2 and, therefore, a guy having an ultimate strength of not less than 2520 pounds is required. One ¼-inch Siemens-Martin or a $\frac{5}{16}$-inch common galvanized-steel strand would meet the requirements for transverse load.

13. Longitudinal Load on Crossing Poles C and D

Rule 47.5 provides that crossing structures shall withstand at all times with a safety factor of unity the unbalanced stress due to the combined pull toward the crossing of one-third of the total number of conductors supported, the pull in each such conductor being taken as the tension due to the specified loading.

Number of conductors involved = $\frac{8}{3}$ = $2\frac{2}{3}$; use 3

Location of conductors resulting in maximum load—two on top arm and one on next arm below

Bending moment:

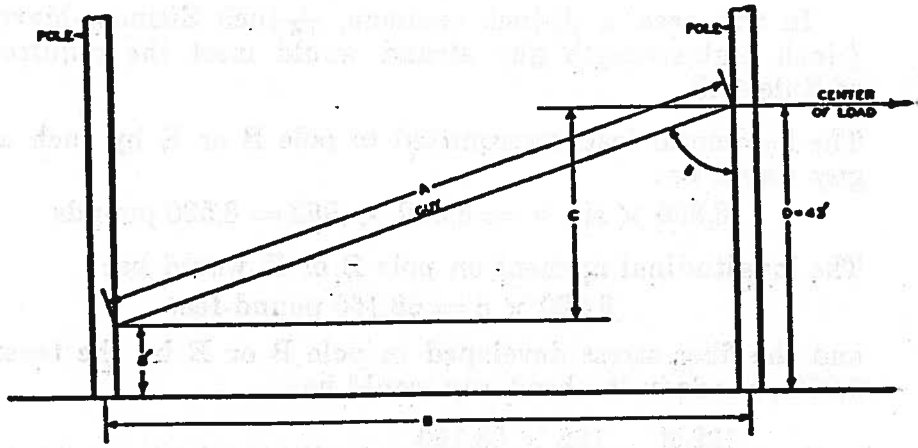
$2 \times 2605 \times 48.75 = 254{,}000$ pound-feet
$1 \times 2605 \times 43.25 = 112{,}600$ pound-feet

Total moment = 366,600

$$\text{Fiber stress} = \frac{122\,M}{D_1^3} = 122 \times \frac{366{,}600}{15.6^3} = 11{,}780 \text{ pounds}$$

per sq. in.

The allowable value of modulus of rupture under this load is 5600 lbs. per square inch, hence poles C and D must be head guyed for the longitudinal load.



The head guy should be attached approximately at the normal center of load, therefore:

The bending moment under full longitudinal load would be:

$$\begin{aligned}
48.75 \times 2 \times 2605 &= 254{,}000 \text{ pound-feet}\\
43.25 \times 2 \times 2605 &= 225{,}300 \text{ pound-feet}\\
37.75 \times 2 \times 2605 &= 196{,}700 \text{ pound-feet}\\
28.33 \times 2 \times 570 &= 32{,}300 \text{ pound-feet}\\
\hline
\text{Total moment} &= 708{,}300 \text{ pound-feet}
\end{aligned}$$

The total longitudinal load would be:

$$\begin{aligned}
3\ (2 \times 2{,}605) &= 15{,}630 \text{ pounds}\\
2 \times 570 &= 1{,}140 \text{ pounds}\\
\hline
\text{Total wire tensions} &= 16{,}770 \text{ pounds}
\end{aligned}$$

Therefore the center of longitudinal load is:

$$D = \frac{\text{Longitudinal Bending Moment}}{\text{Longitudinal Load}}$$

$$= \frac{708{,}300}{16{,}770} = 42.2 \text{ ft. (load center above ground)}$$

use 43 feet (to avoid contact with arm)

$B =$ 150 ft.

$C = 43 - 8 =$ 35 ft.*

$$A = \sqrt{B^2 + C^2} = \sqrt{(43)^2 + (150)^2} = 156.0$$

$$\text{Sin } \alpha = \frac{B}{A} = \frac{150}{156.0} = 0.962$$

---

* Lower end of guy assumed 8 feet above ground on Poles A and E.

A guy attached at a point 43 feet above ground on pole C or D and at a point 8 feet above ground on pole B or E, respectively, would be required to withstand a load of:

$$\frac{366{,}600}{43 \times 0.962} = 8{,}860 \text{ pounds}$$

In this case, a $\frac{9}{16}$-inch common, $\frac{7}{16}$-inch Siemens-Martin, or $\frac{3}{8}$-inch high-strength guy strand would meet the requirements of Rule 47.5.

The horizontal load transmitted to pole B or E by such a head guy would be:

$$8{,}860 \times \sin \alpha = 8{,}860 \times .962 = 8{,}520 \text{ pounds}$$

The longitudinal moment on pole B or E would be:

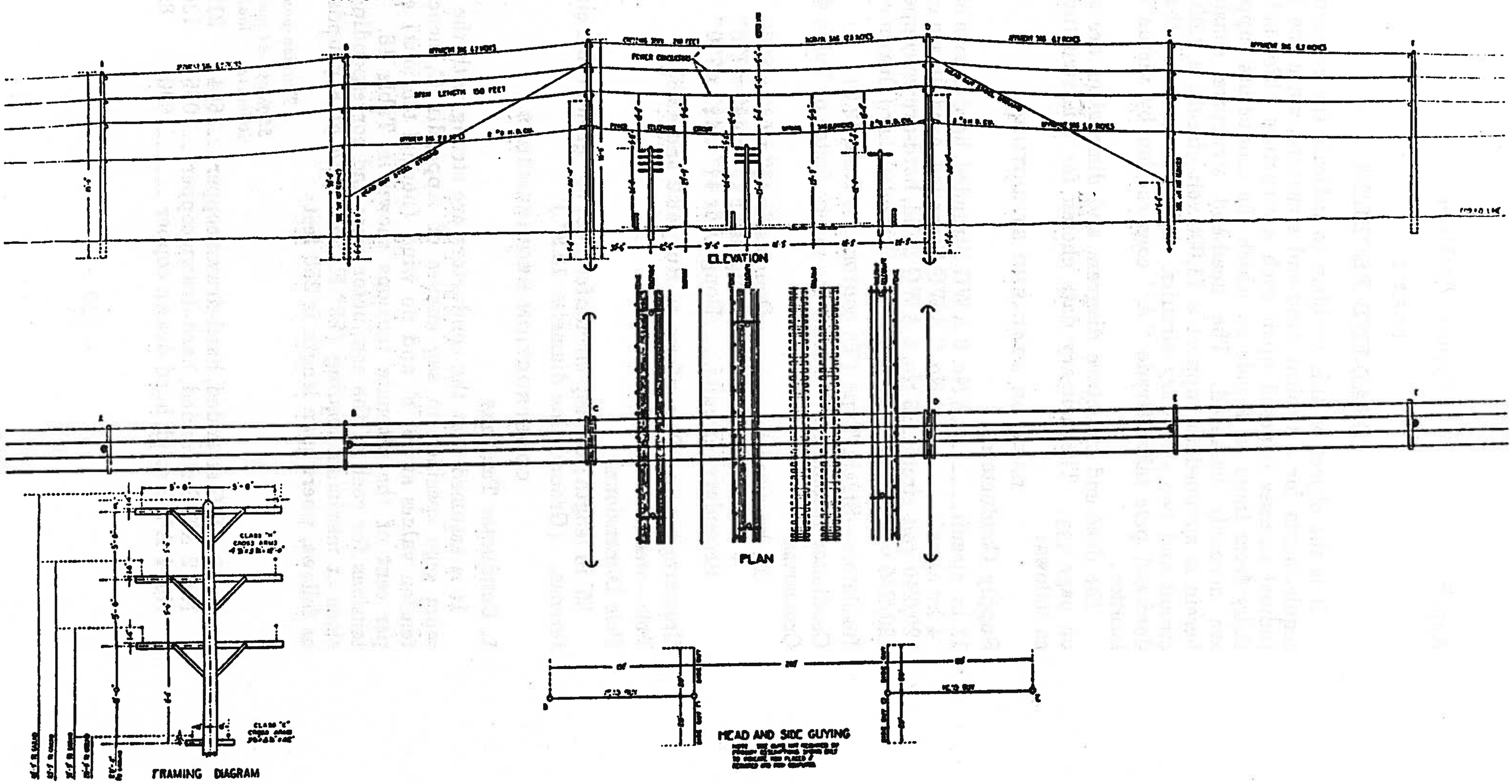
$$8{,}520 \times 8 = 68{,}160 \text{ pound-feet}$$

and the fiber stress developed in pole B or E by the tension of 9,070 pounds in the head guy would be:

$$F = \frac{122M}{D^3_1} = \frac{122 \times 68{,}160}{(15.0)^3} = 2{,}460 \text{ pounds per square inch}$$

Poles B and E would, therefore, be adequate to hold the contemplated guy tension with a safety factor of unity as required by Rule 47.5.

CROSSING OF CLASS 'H' SUPPLY LINE OVER MAJOR RAILROAD AND MAJOR COMMUNICATION LINES



PART 2

DEAD-END PROBLEM

It is the object of this problem to indicate the construction requirements for a typical dead-end structure, since the longitudinal stresses imposed upon such a structure differ substantially from those on a pole on which the conductors supported are normally balanced. The dead-end structure considered herein is assumed to support a 11,000-volt circuit, a 4,000-volt circuit and two secondary circuits. It is also assumed that the dead-end pole takes Grade "A" construction by virtue of its location.

The dead-end structure diagram and dimensions are shown on page 333. The primary data chosen for this structure are as follows:

DATA OF DEAD-END STRUCTURE

Supply Conductors.

11 kv circuit--------3 No. 0 AWG Stranded, hard-drawn copper
4 kv circuit--------4 No. 2 AWG Stranded, hard-drawn copper
120/240 volt circuit--3 No. 4 AWG Solid, hard-drawn copper
120/240 volt circuit--3 No. 2 AWG Stranded, hard-drawn copper

Insulators—Strain Type (To conform to Rule 49.5).

Conductor fastenings (To meet the safety factor of Table 4).

Crossarms.

11 kv circuit----------Douglas fir 4¾" x 5¾" x 8′ 0″
4 kv circuit----------Douglas fir 4¾" x 4¾" x 7′ 8″
Secondary circuits----Douglas fir 4¾" x 4¾" x 7′ 0″

Crossarm braces (To conform to Rule 48.2 and 49.8).

Pole—western red cedar.

Pole Dimensions.

55′ in length; 25″ top circumference; 50″ ground line circumference. (Ground line diameter 15.9″.)

CONSTRUCTION REQUIREMENTS

1. Conductor Tensions

It is assumed that the conductors are strung with the minimum sags specified in sag curves of Appendix C, hence the tension values at 60° F. and no wind (normal tensions) are 35 per cent of the ultimate tensions shown in Table 18. These tensions for each of the conductor sizes and corresponding tensions at maximum loading (25° F. and wind of 8 pounds) are as follows, where span length is 250 feet:

	Tension-pounds	
	35% of ultimate	*At maximum loading*
No. 0 AWG stranded, hard-drawn copper	1664	2125
No. 2 AWG stranded, hard-drawn copper	1065	1360
No. 4 AWG solid, hard-drawn copper	690	890

2. Crossarms

Spacings assumed are shown on the pole framing diagram on page 333. Double crossarms of Douglas fir, dense, are employed for each of the four different circuits.

Computations of the fiber stresses imposed upon the various crossarms by the unbalanced wire loads of conductors in the physical configuration shown on the diagram are made in accordance with the method outlined in Part I to show these stresses under the conditions of long-time loading and maximum loading. Furthermore, double crossarm construction of this type with separation maintained by space bolts is assumed to have a horizontal strength equivalent to 130% of the sum of the strengths of two single crossarms acting independently The stresses computed in this manner are:

	Fiber stress—lbs. per sq. in.	
	Long-time loading	*Maximum loading*
Top crossarms	1412	1804
Second crossarms	1598	2040
Third crossarms	932	1202
Fourth crossarms	1438	1811

Since a factor of safety of 2 permits a maximum stress of modulus of rupture in bending of 1732 lbs. per sq. in. $\left(\frac{6300 \times 0.55}{2}\right) = 1732$ under the conditions of long-time loading (60° F. and no wind) and 3150 lbs. per sq. in. $\left(\frac{6300}{2}\right)$ at maximum loading (see Table 5), the crossarms chosen are satisfactory.

3. Pole (See page 333)

Rule 44 provides that poles supporting unbalanced longitudinal loads in Grade "A" construction shall have a safety factor of 4 against such loads. Rule 47.3 specifies that guys used to support unbalanced longitudinal loads shall have a safety factor of 2 for all grades of construction. (Where guys are used they must take the entire load with the designated safety factor, the pole being considered merely as a strut.)

Using the values given above for tensions at maximum loading, the following moments due to dead ending the conductors are obtained:

$$
\begin{aligned}
3 \times 2125 \times 47.3 &= 301{,}500 \text{ pound-feet} \\
4 \times 1360 \times 38.3 &= 208{,}400 \text{ pound-feet} \\
3 \times 890 \times 30.3 &= 80{,}900 \text{ pound feet} \\
3 \times 1360 \times 25.3 &= 103{,}200 \text{ pound feet} \\
\hline
\text{Total moments} &= 694{,}000 \text{ pound-feet}
\end{aligned}
$$

The total dead-end stress, using the tension values for maximum loading given above, will be:

$$\begin{aligned} 3 \times 2125 &= 6{,}380 \text{ pounds} \\ 4 \times 1360 &= 5{,}440 \text{ pounds} \\ 3 \times 890 &= 2{,}670 \text{ pounds} \\ 3 \times 1360 &= 4{,}080 \text{ pounds} \\ \text{Total} &= 18{,}570 \text{ pounds} \end{aligned}$$

$$\text{Center of load} = \frac{694{,}000}{18{,}570} = 37.4 \text{ feet above ground}$$

The tension in a single guy with a lead to height ratio of 1 to 1 (assumed) and a safety factor of 2 would be:

$$T = \frac{\text{safety factor} \times \text{total load}}{\cos\theta} = \frac{2 \times 18{,}570}{\cos\theta} = 52{,}500 \text{ pounds}$$

A stranded guy attached at the center of load could be used provided the allowable fiber stress of the pole is not exceeded. The stress due to guying at this point would be as follows:

The center of load (37.4′ above ground) would be
9.9 ft. (118.8 inches) below the top conductors (11 kv) and
0.9 ft. (10.8 inches) below the second crossarm (4 kv)

The fiber stress in the pole at the center of load due to the tension in the conductors above the center of load is computed as follows:

$$\begin{aligned} \text{Bending moment } 3 \times 2125 \times 118.8 &= 757{,}400 \text{ pound-inches} \\ 4 \times 1360 \times 10.8 &= 58{,}800 \text{ pound-inches} \\ \text{Total moment} &= 816{,}200 \text{ pound-inches} \end{aligned}$$

The section modulus of a solid circular section is

$$E = \frac{\pi d^3}{32} = 0.0982\, d^3$$

The diameter of the pole at the center of load is

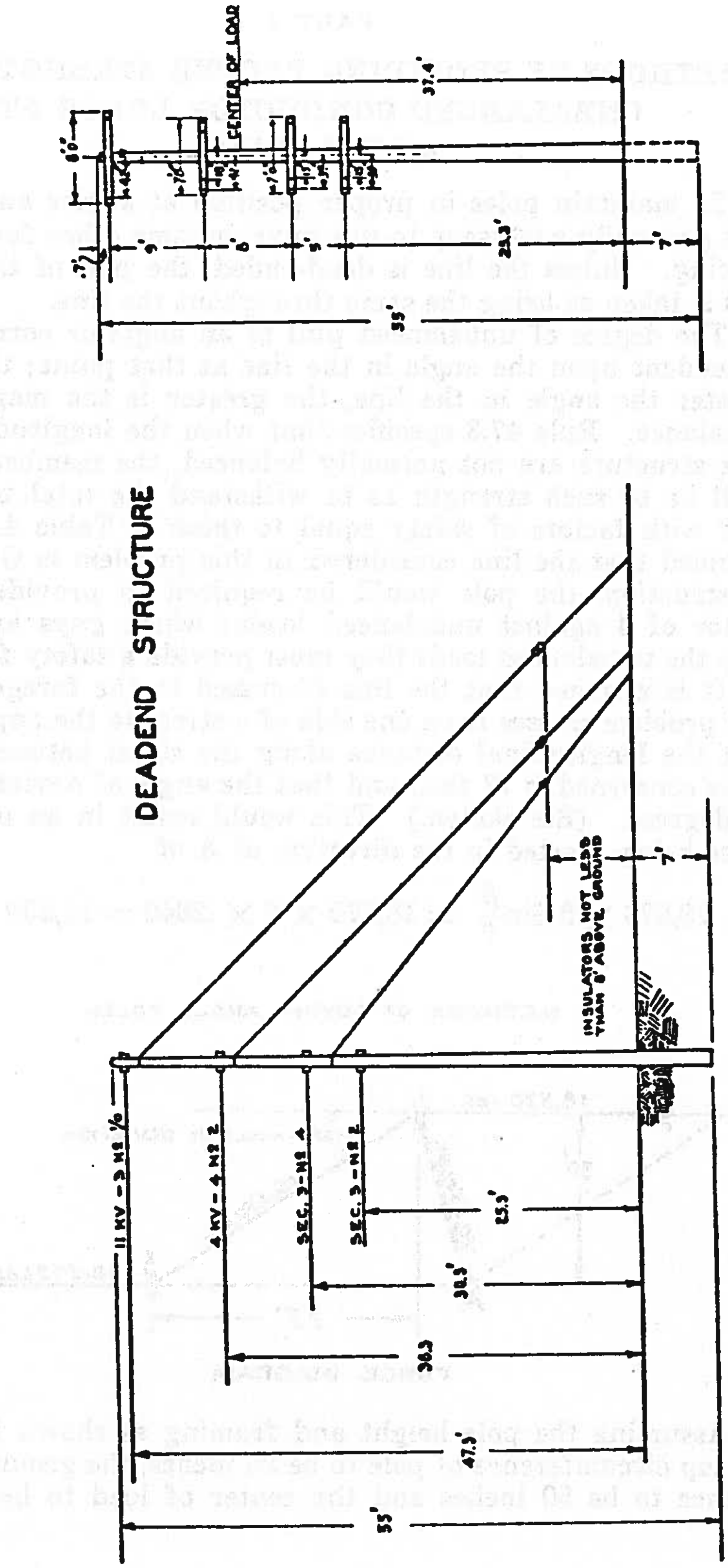
$$d = 9.7 \text{ inches}$$

Then

$$E = 0.0982 \times (9.7)^3 = 89.6 \text{ in.}^3$$

$$\text{Fiber stress} = \frac{\text{Bending moment}}{\text{Section modulus}} = \frac{816{,}200}{89.6} = 9110 \text{ lbs. per sq. in.}$$

Since a pole in Grade "A" construction must have a safety factor of 4, the allowable value of fiber stress would be $\frac{5600}{4} = 1400$ pounds per sq. in.; therefore the pole can not be guyed by a single guy but can be guyed as illustrated on page 333.


DEADEND STRUCTURE
CENTER OF LOAD
37.4'
23.3'
35'
INSULATORS NOT LESS THAN 8' ABOVE GROUND
11 KV - 3 NO 6
4 KV - 4 NO 2
SEC. 3 - NO 4
SEC. 3 - NO 2
25.3'
38.3'
47.3
55'

PART 3

METHODS OF PROVIDING PROPER STRENGTH FOR UNBALANCED CONDUCTOR LOADS AT ANGLE POLES

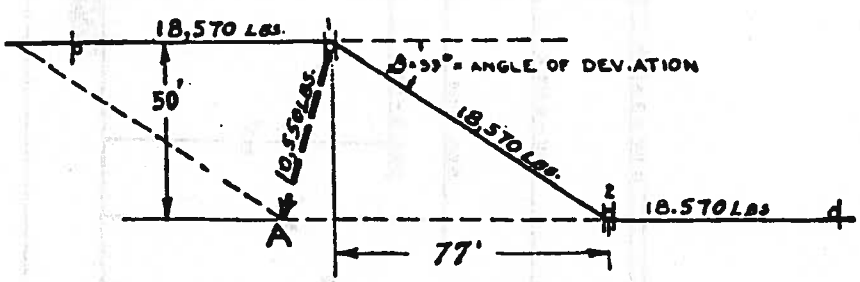
To maintain poles in proper position at angles and corners, it is generally necessary to use guys or some other form of pole bracing. Unless the line is dead-ended, the pull of the conductors is taken as being the same throughout the line.

The degree of unbalanced pull at an angle or corner pole is dependent upon the angle in the line at that point; that is, the greater the angle in the line, the greater is the magnitude of unbalance. Rule 47.3 specifies that when the longitudinal loads in a structure are not normally balanced, the members stressed shall be of such strength as to withstand the total unbalanced load with factors of safety equal to those of Table 4. As it is assumed that the line considered in this problem is Grade "A" construction, the pole would be required to provide a safety factor of 4 against unbalanced loads; where guys are used to take the unbalanced loads they must provide a safety factor of 2.

It is assumed that the line discussed in the foregoing dead-end problem crosses from one side of a street to the opposite side, that the longitudinal distance along the street between the two poles concerned is 77 feet, and that the angle of deviation (β) is 33 degrees. (See sketch.) This would result in an unbalanced force being exerted in the direction of A of

$$18{,}570 \times 2 \operatorname{Sin}\frac{\beta}{2} = 18{,}570 \times 2 \times .2840 = 10{,}550 \text{ pounds}$$

METHODS OF GUYING ANGLE POLES



FORCE DIAGRAM

Assuming the pole height and framing as shown in Part 2, the top circumference of pole to be 25 inches, the ground circumference to be 50 inches and the center of load to be 37.4 feet

above ground line (as determined in Part 2), the fiber stress on the pole at the ground line is as follows:

Bending moment, $M = 37.4 \times 10{,}550 = 394{,}400$ pound-feet

Fiber stress $= \dfrac{122\,M}{d^3}$

where circumference $= 50$ inches and $d = 15.9$ inches

Fiber stress $= \dfrac{122 \times 394{,}400}{(15.9)^3} = 11{,}970$ **lbs. per sq. in.**

As a safety factor of 4 is required, the allowable working stress is $\dfrac{5600}{4}$ or 1400 lbs. per sq. in., and therefore the use of guys is necessary.

A single guy attached at the center of load could be used provided the modulus of rupture with a safety factor of 4 is not exceeded. The stress due to guying at this point is as follows:

Bending moments

Top arm: $3 \times 2125 \times 118.8 \times 2 \sin\dfrac{\beta}{2} = 430{,}200$ **pound-inches**

Second arm: $4 \times 1370 \times 10.8 \times 2 \sin\dfrac{\beta}{2} = \underline{33{,}400}$ **pound-inches**

Total moment $= 463{,}600$ pound-inches

Section modulus, E

The section modulus (E) at 37.4 ft. above ground is 89.6 inches cubed, which is the value computed in Problem 2

Fiber stress

The fiber stress is

$$F = \frac{M}{E} = \frac{463{,}600}{89.6} = 5{,}170 \text{ pounds per sq. in.}$$

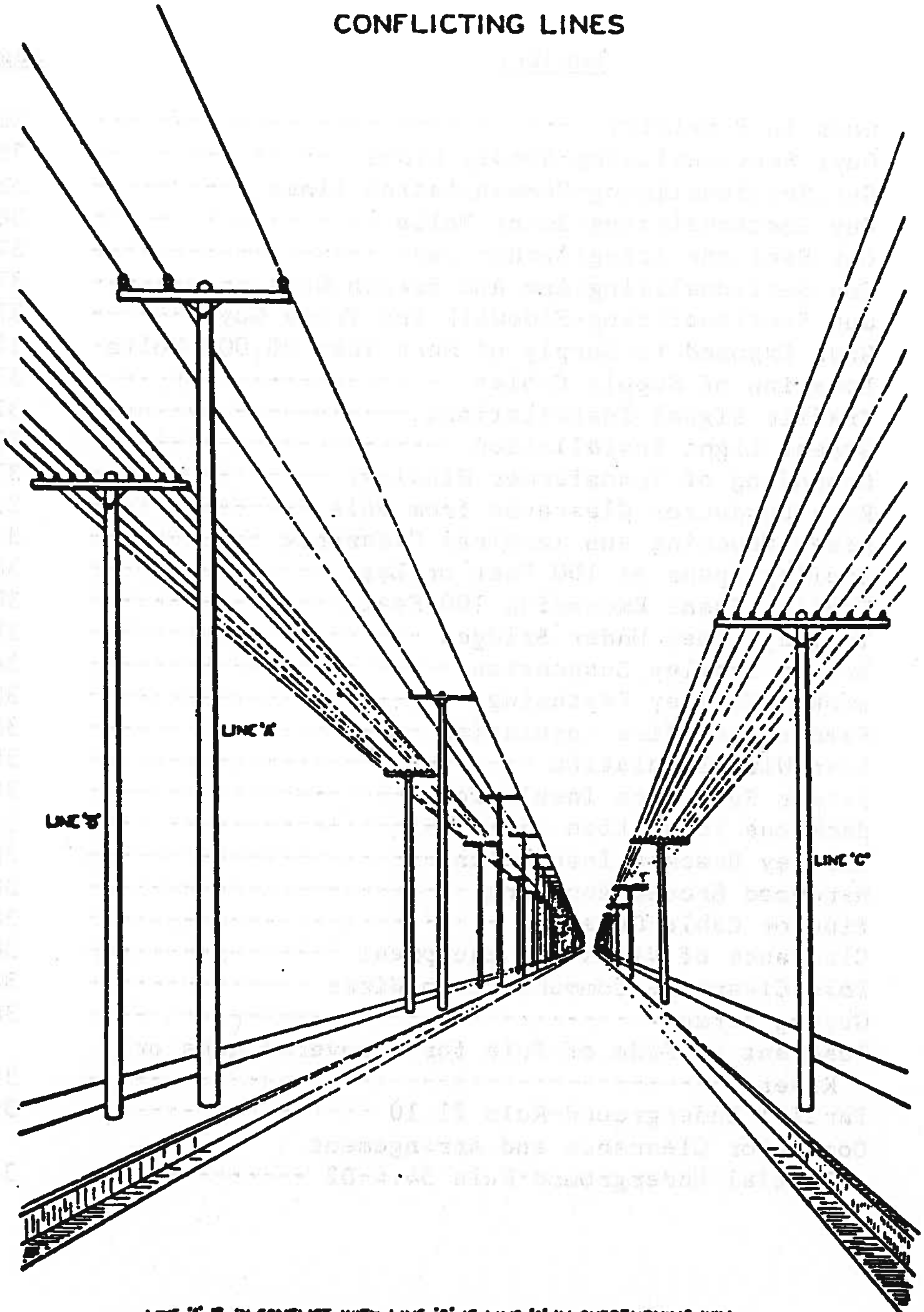
Since this stress exceeds the allowable stress of 1400 lbs. per sq. in. for the pole, it is necessary to place guys at more than one point on the pole, and therefore, they are attached at positions similar to the guys shown in the diagram on page 333.

APPENDIX G

TYPICAL ILLUSTRATIVE DIAGRAMS OF RULES

These diagrams illustrate the requirements of certain rules and are to be used as a guide only for the application of such rules. Under no conditions shall these diagrams be given precedence over the rules as written.

CONFLICTING LINES

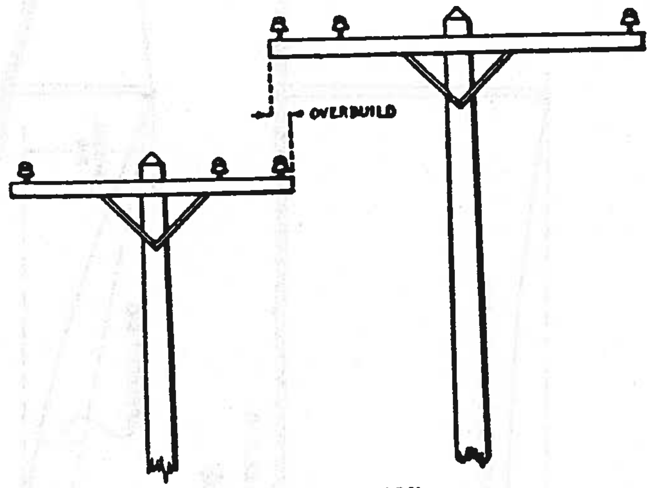


LINE "A" IS IN CONFLICT WITH LINE "B" IF LINE "A" IN OVERTURNING WILL RESULT IN CONTACT WITH CONDUCTORS OF LINE "B". LINE "A" IS NOT IN CONFLICT WITH LINE "C" PROVIDED THAT LINE "C" IS ON OPPOSITE SIDE OF HIGHWAY STREET OR ALLEY AND SEPARATED BY A DISTANCE EQUAL TO 60% OF THE HEIGHT OF THE TALLER POLE LINE, BUT IN NO CASE LESS THAN 20 FEET.

SEE DEFINITION 21.7-A

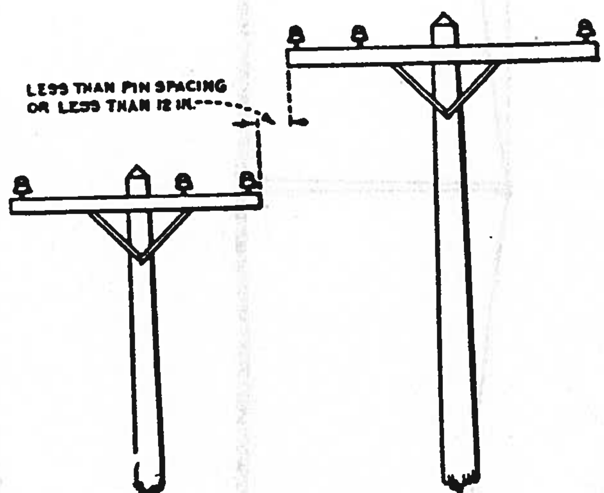
FIG. 1.

CO-LINEAR LINES



SEE DEFINITION
21.7-B

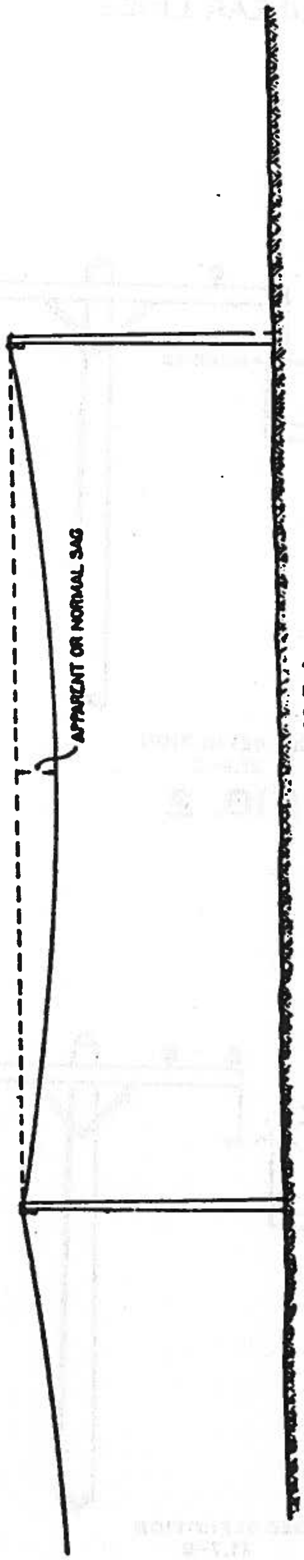
FIG. 2



SEE DEFINITION
21.7-B

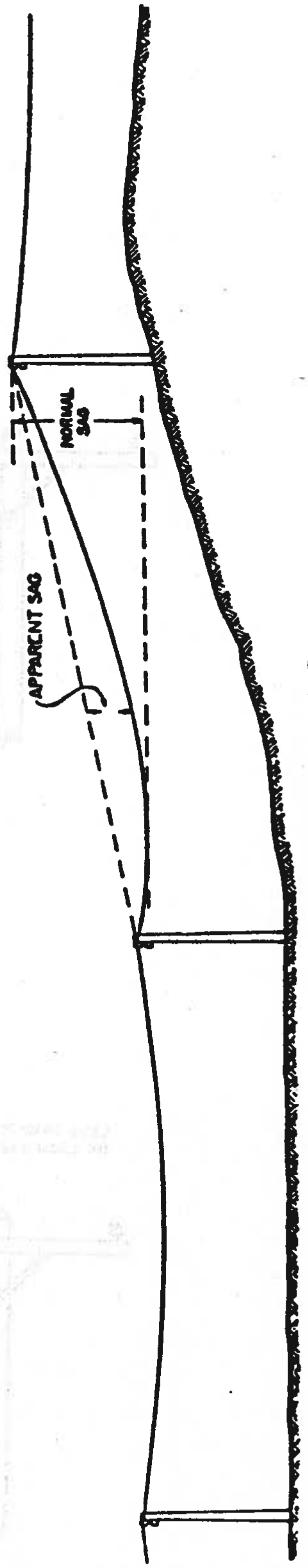
FIG. 3

SAG—NORMAL AND APPARENT



SEE DEFINITION 22.7—A

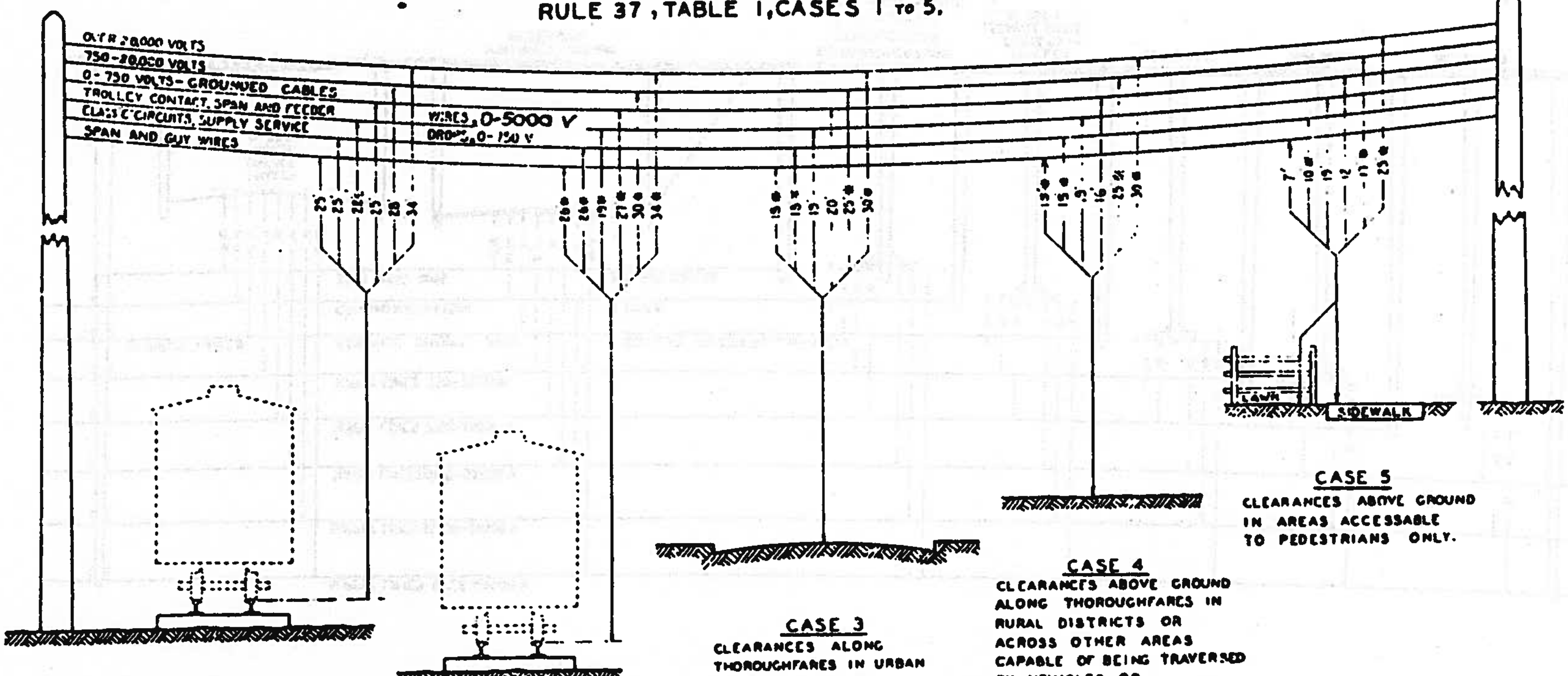
FIG. 4



SEE DEFINITION 22.7—B

FIG. 5

CLEARANCE OF WIRES ABOVE RAILROAD TRACKS, HIGHWAYS ETC.
RULE 37, TABLE 1, CASES 1 TO 5.



CASE 1
CLEARANCES ABOVE TRACKS OF RAILROADS WHICH TRANSPORT OR PROPOSE TO TRANSPORT FREIGHT CARS WHERE NOT OPERATED BY OVERHEAD CONTACT WIRE

CASE 2
CLEARANCES AT CROSSINGS OF TRACKS OR ALONG AND ABOVE TRACKS OR SURFACE OF STREETS OF RAILROADS OPERATED BY OVERHEAD TROLLEY CONTACT WIRES.

CASE 3
CLEARANCES ALONG THOROUGHFARES IN URBAN DISTRICTS OR CROSSING THOROUGHFARES IN RURAL DISTRICTS.

CASE 4
CLEARANCES ABOVE GROUND ALONG THOROUGHFARES IN RURAL DISTRICTS OR ACROSS OTHER AREAS CAPABLE OF BEING TRAVERSED BY VEHICLES OR AGRICULTURAL EQUIPMENT.

CASE 5
CLEARANCES ABOVE GROUND IN AREAS ACCESSABLE TO PEDESTRIANS ONLY.

* FOR MODIFICATIONS SEE RULE 37, TABLE 1, CASES 1-5

FIG. 6

CLEARANCE OF WIRES AT POINT OF CROSSING
RULE 38, TABLE 2, CASES 1 to 7.

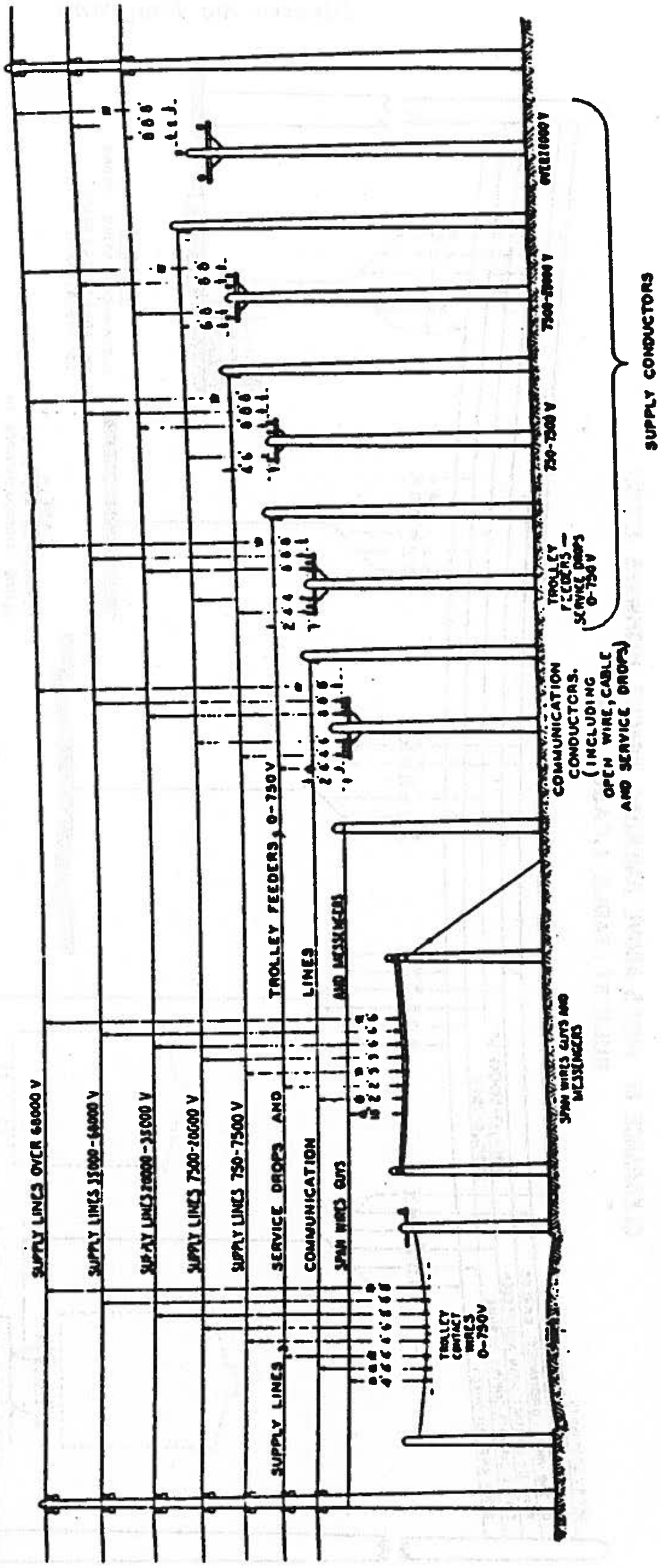


FIG. 7

NOTE: ✱ FOR MODIFICATIONS SEE RULE 38, TABLE 2, CASES 1 to 7.

VERTICAL SEPARATION OF WIRES ON DIFFERENT CROSSARMS OF THE SAME POLE.
RULE 38, TABLE 2, CASES 8 to 13.

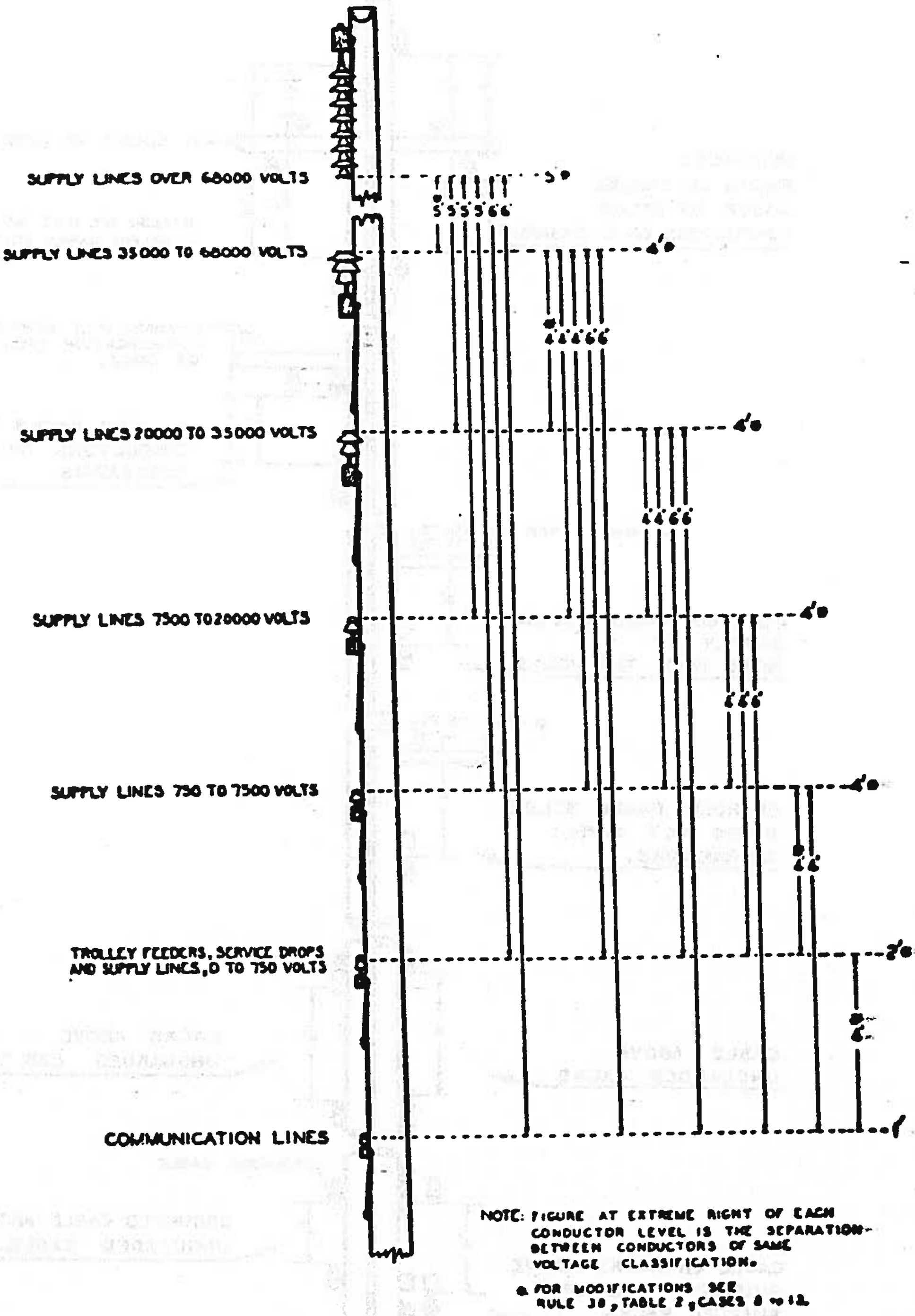


FIG. 8

MINIMUM VERTICAL SEPARATION
BETWEEN CABLES, LOW VOLTAGE RACK CONDUCTORS AND OTHER CONDUCTORS
ON JOINTLY USED POLES
ILLUSTRATING RULE 92.1-A & 92.1-B

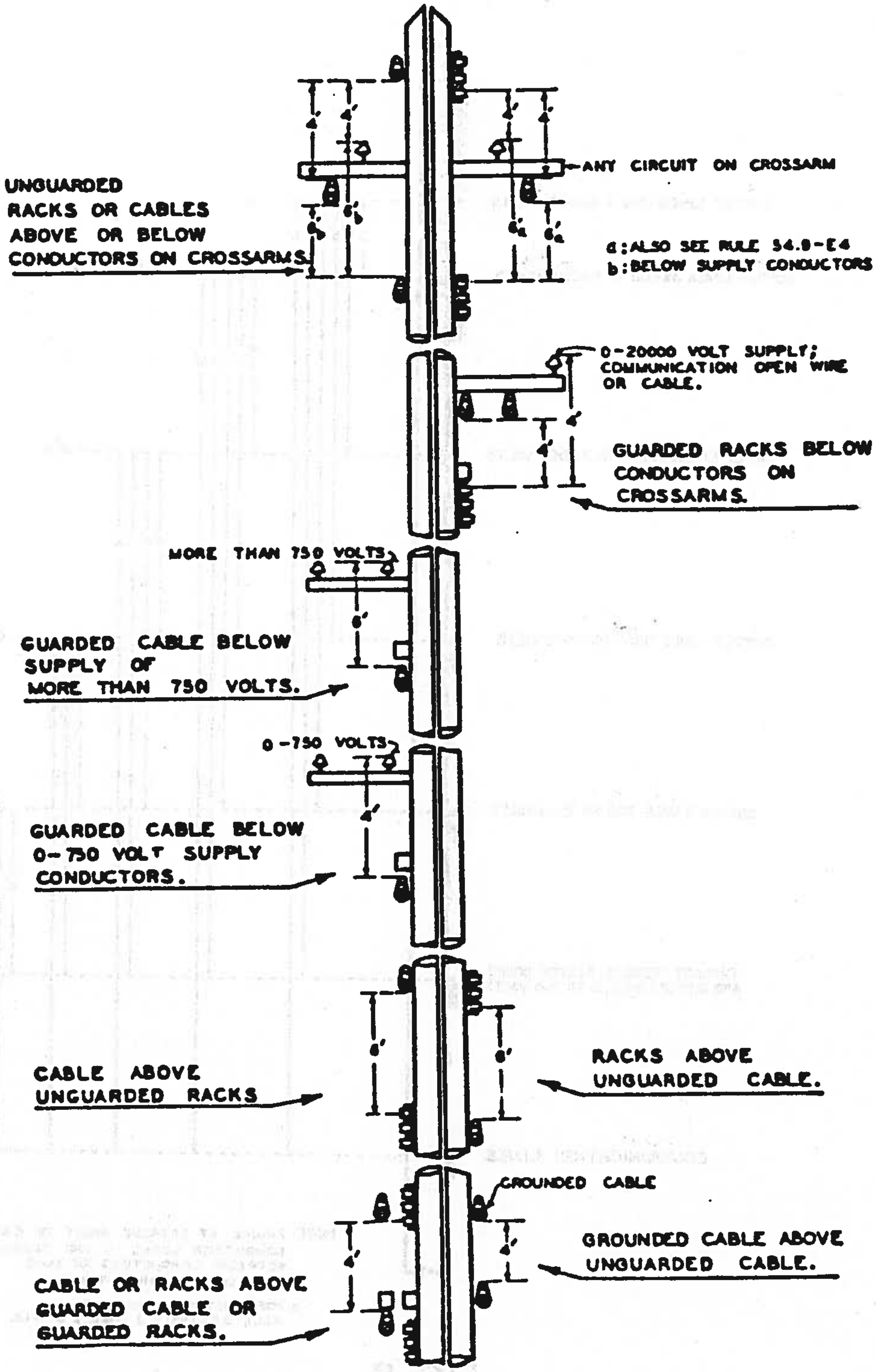


FIG. 9

MINIMUM VERTICAL CLEARANCES IN LINEARM AND BUCKARM CONSTRUCTION.

RULE 38, TABLE 2, CASES 8 TO 14.

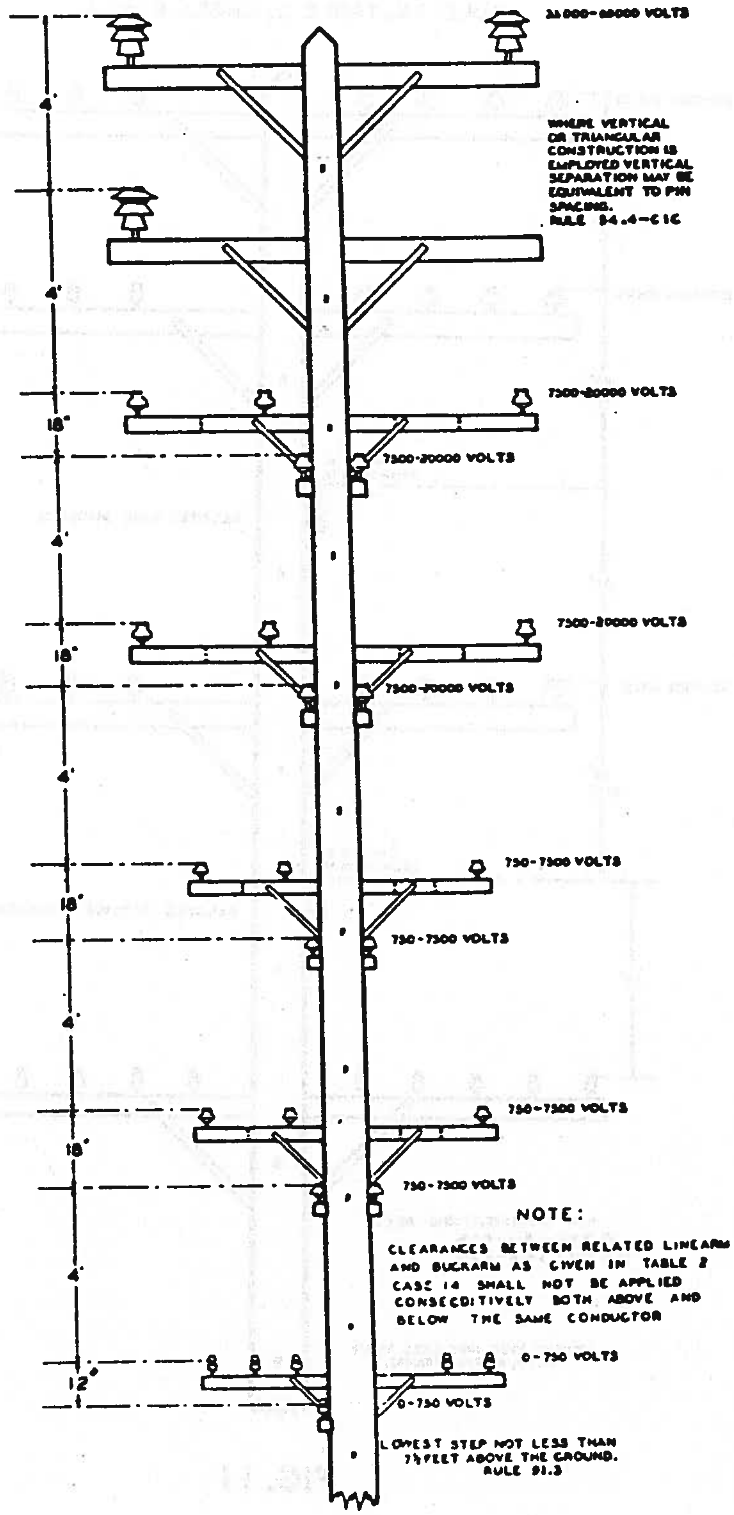


FIG 10

MINIMUM VERTICAL CLEARANCES IN COMBINATION LINEARM AND COMBINATION BUCKARM CONSTRUCTION

RULE 38, TABLE 2, CASES 8 TO 14.

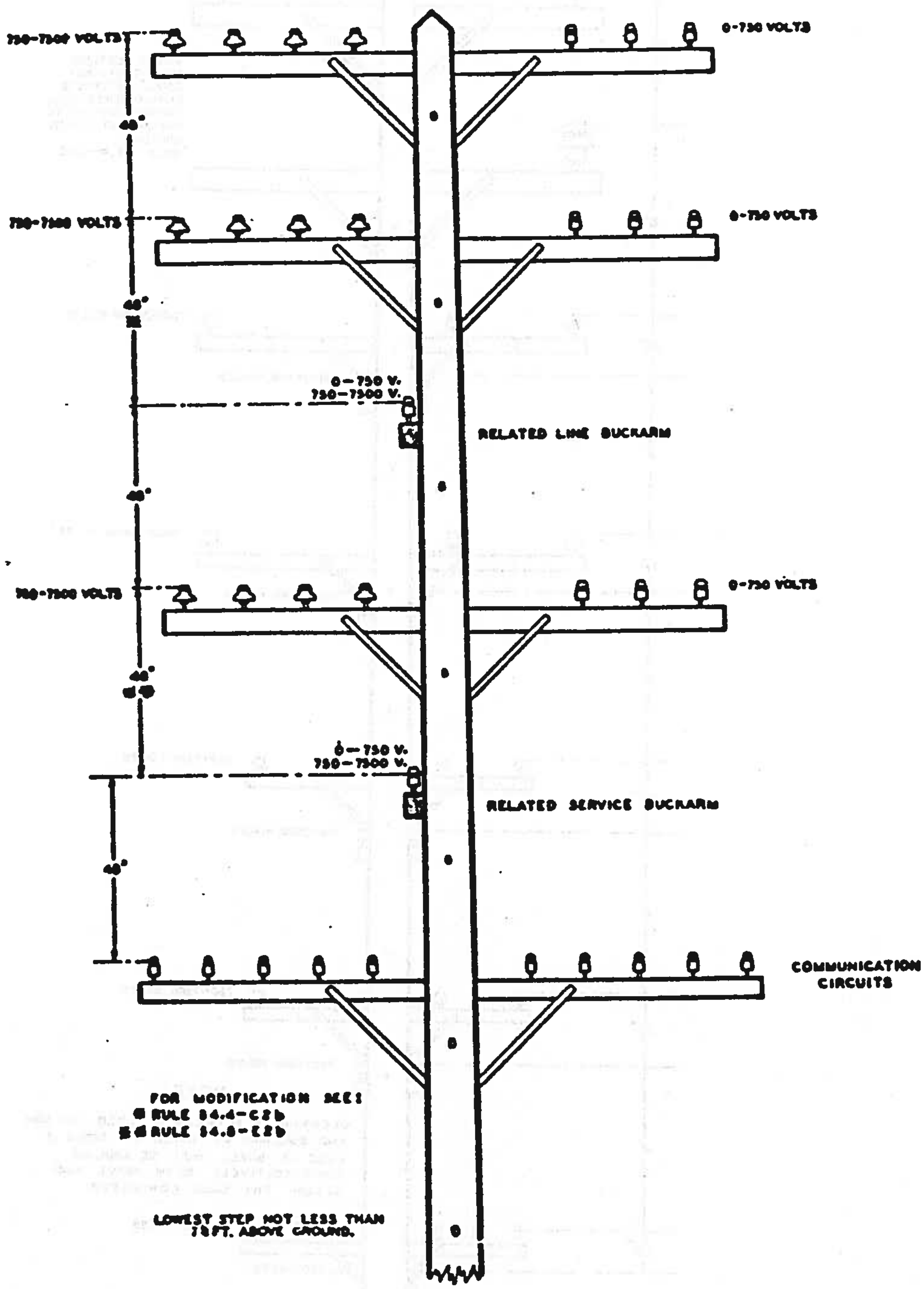


FIG. 11

MINIMUM
HORIZONTAL CONDUCTOR SPACING
TABLE 1, CASE 8 AND TABLE 2, CASE 15

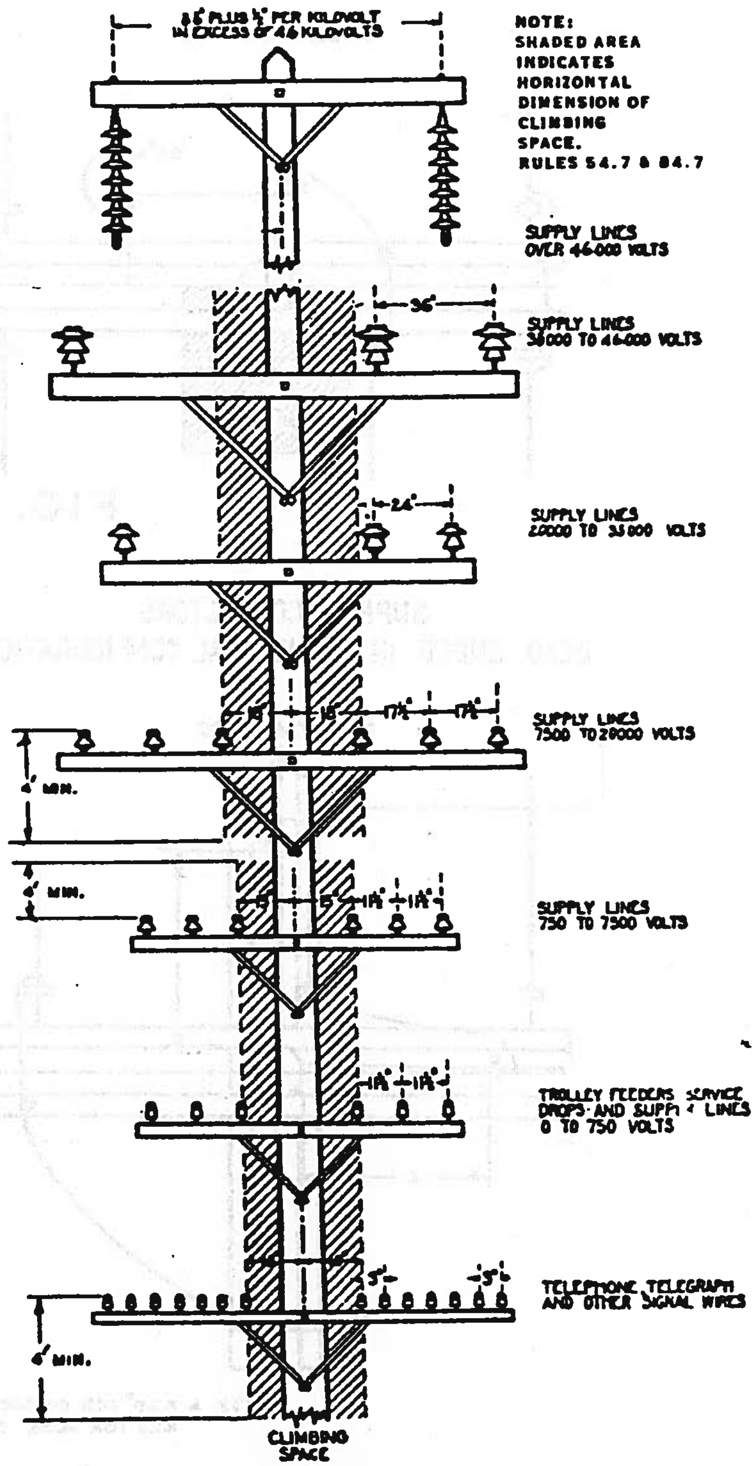


FIG. 12

SUPPLY CONDUCTORS
DEAD ENDED IN HORIZONTAL CONFIGURATION
0-7500 VOLTS

RULE 54.4-D7a

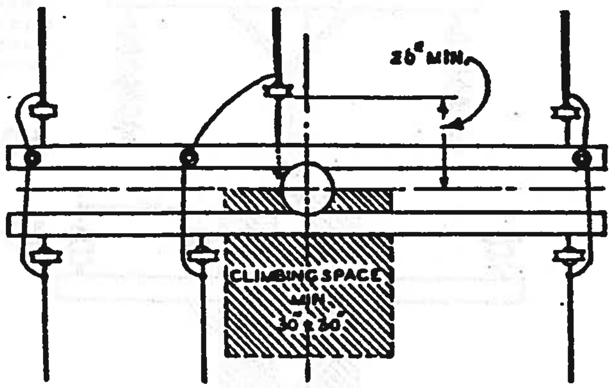


FIG. 13

SUPPLY CONDUCTORS
DEAD ENDED IN HORIZONTAL CONFIGURATION

RULE 54.4-D7

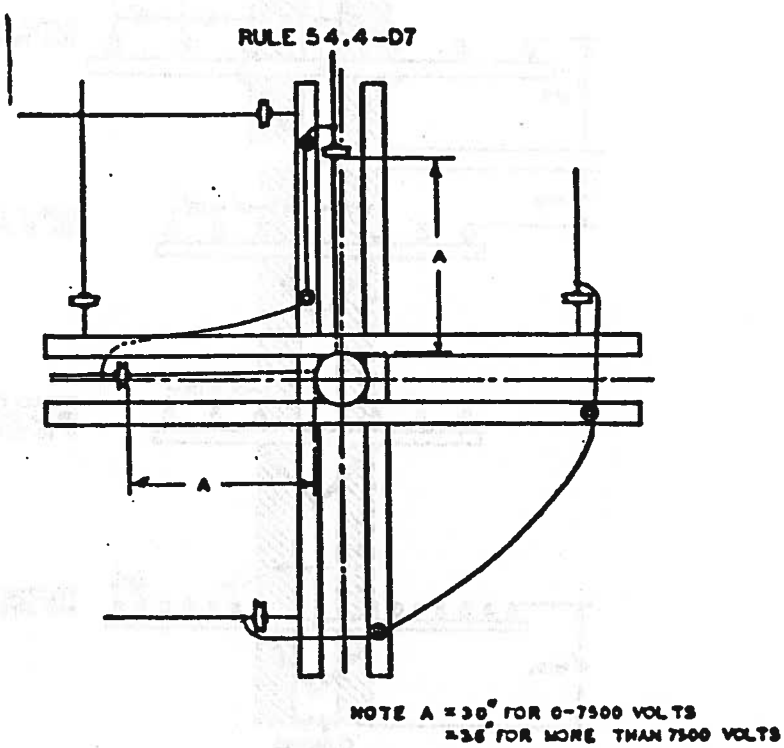
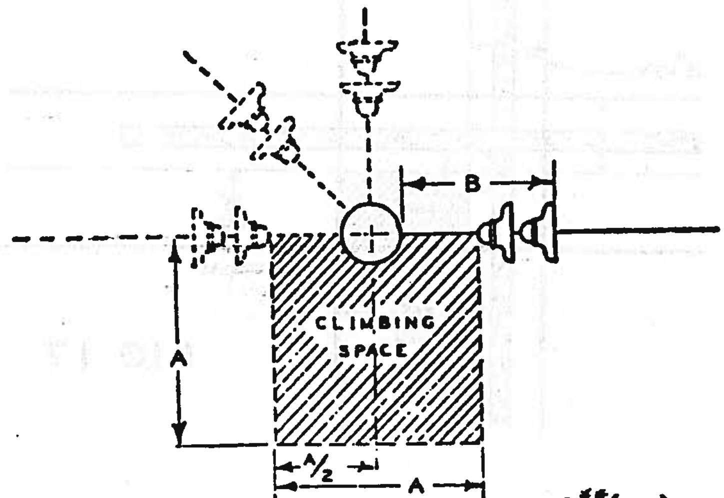


FIG. 14

CLIMBING SPACE FOR DEAD ENDING IN VERTICAL CONFIGURATION

RULE 54.7 -A1



VOLTAGE OF CIRCUIT	A (MIN.)	B** (MIN.) TOP CIRCUIT	B** (MIN.) BELOW TOP CIRCUIT
750 — 7500 VOLTS	30" *	15"	24"
7500 — 46000 VOLTS	36" *	18"	36"
MORE THAN 46000 VOLTS	36" PLUS 1/2" PER KV OVER 46 KV*	18"	36"

* UNOBSTRUCTED BY DEADEND INSULATORS ETC. (RULE 54.7-A4)
** SEE RULE 54.4-D6b

FIG. 15

CLIMBING SPACE LINE ARMS ONLY

RULE 54.7 — A2

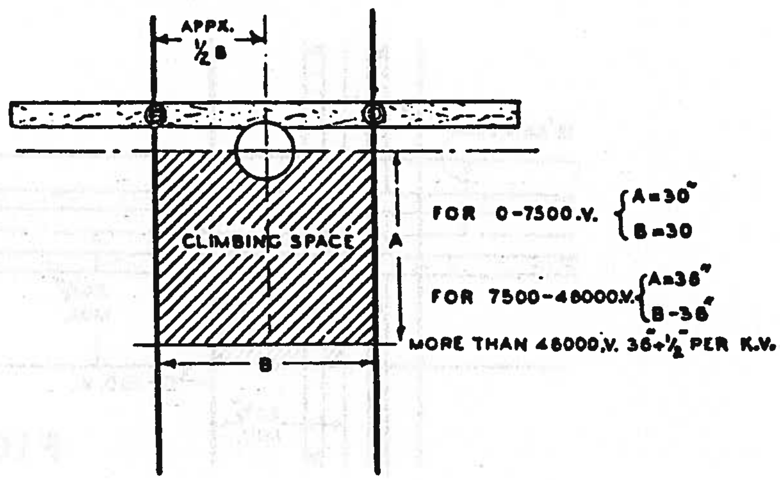


FIG. 16

CLIMBING SPACE
LINEARM AND RELATED BUCKARM
0-750 VOLT CONDUCTORS

RULE 54.7-A3a

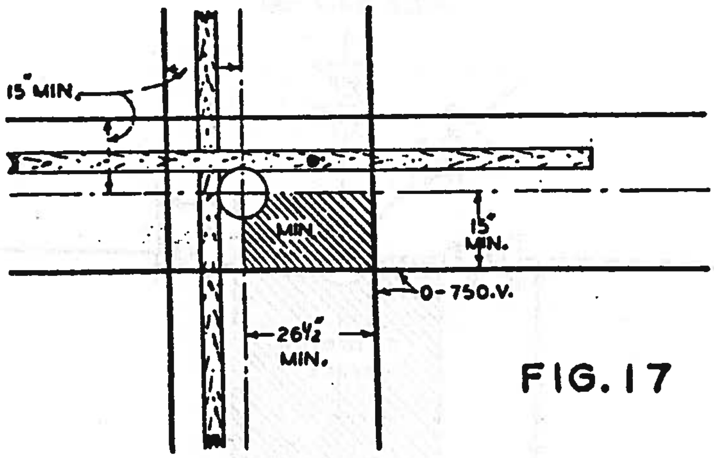


FIG. 17

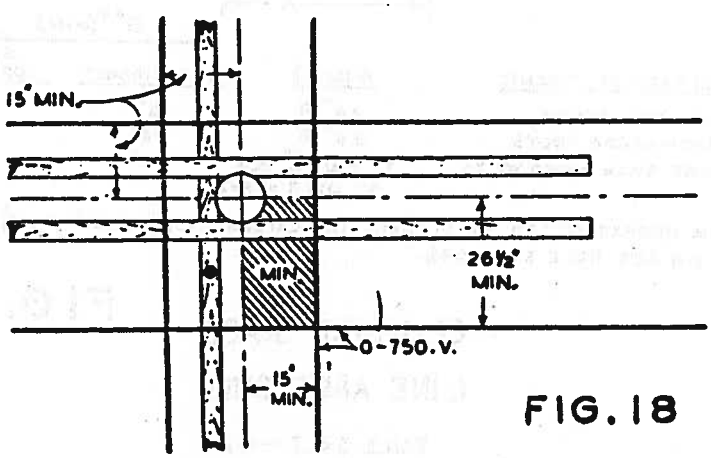


FIG. 18

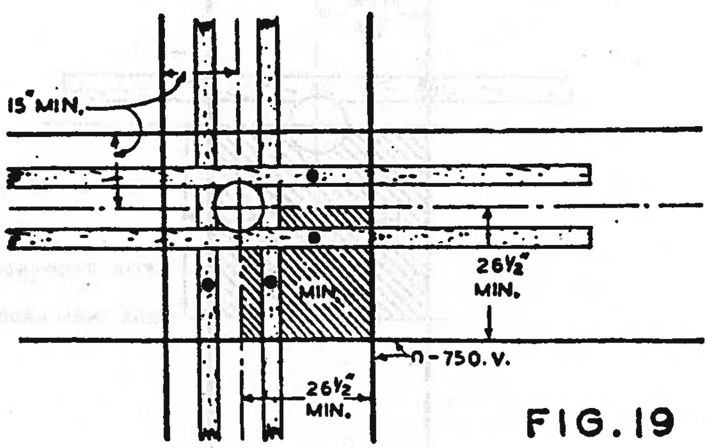


FIG. 19

CLIMBING SPACE

LINEARM AND RELATED BUCKARM

750 TO 20000 VOLT CONDUCTORS

RULE 54.7–A3b

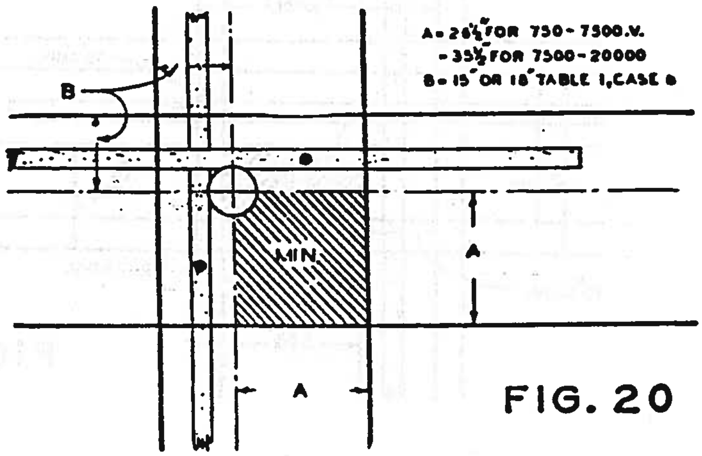


FIG. 20

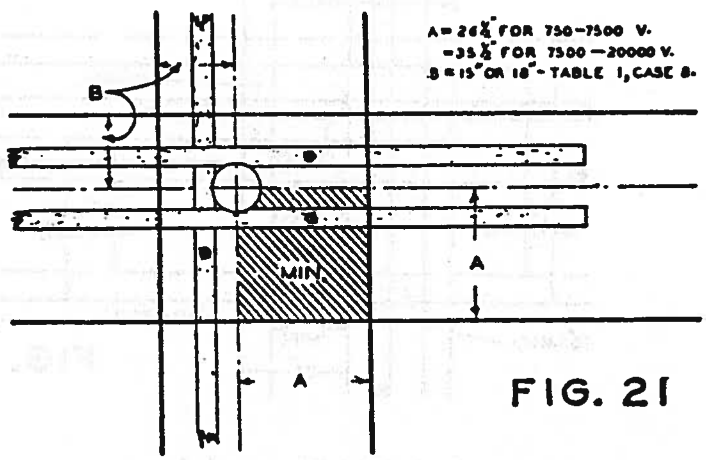


FIG. 21

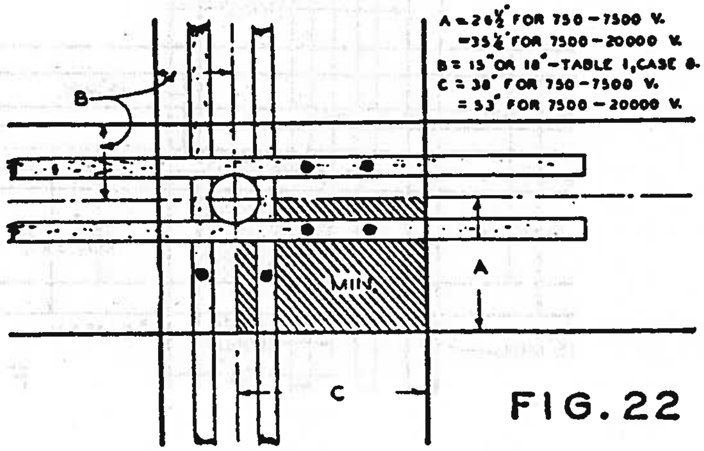


FIG. 22

CLIMBING SPACE
FOR COMBINATION ARM CONSTRUCTION

RULE 54.7–A3c

CONDITIONS: CLIMBING SPACE IN 0–750 VOLT QUADRANT.
SEPARATION BETWEEN LINEARM AND RELATED BUCKARM 4 FT. OR MORE.

NOTE: HEAVY LINES, SOLID OR DASHED, SHOW ALTERNATIVE CONDUCTOR POSITIONS NEAREST POLE.

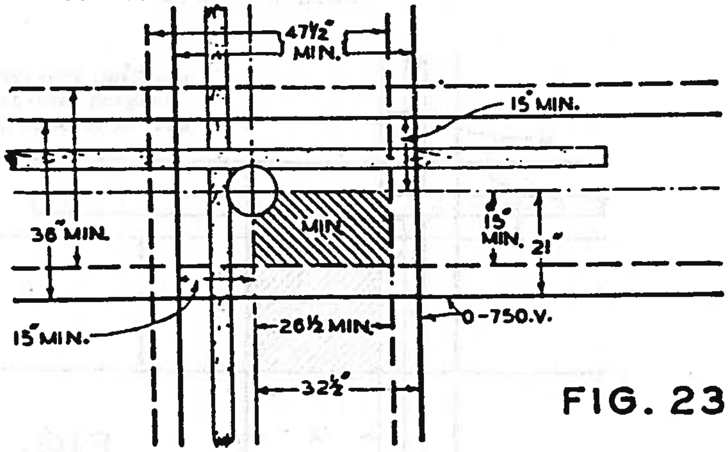


FIG. 23

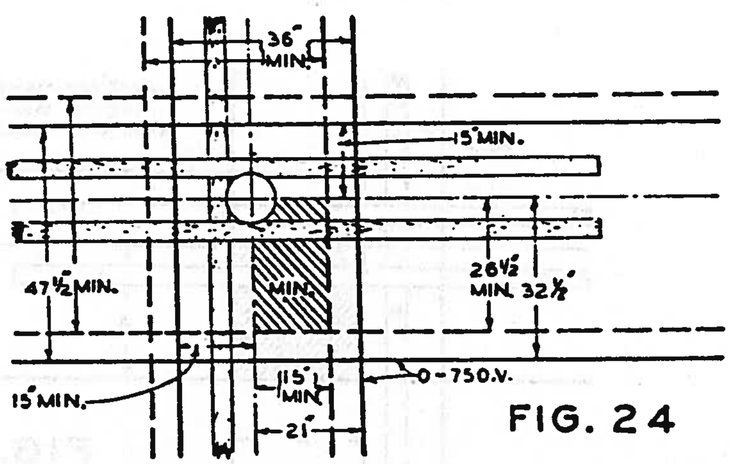


FIG. 24

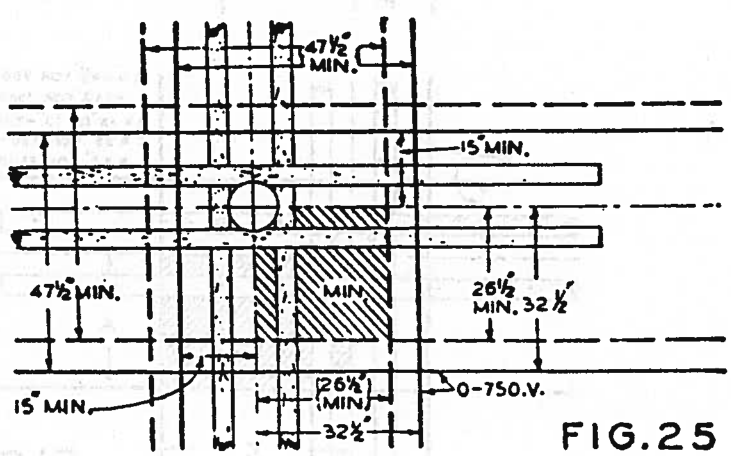


FIG. 25

CLIMBING SPACE
FOR COMBINATION ARM CONSTRUCTION
RULE 54.7-A3c
CONDITIONS: CLIMBING SPACE IN 750-7500 VOLT QUADRANT
SEPARATION BETWEEN LINEARM AND RELATED BUCKARM
4 FT. OR MORE.
NOTE: HEAVY LINES, SOLID OR DASHED, SHOW ALTERNATIVE
CONDUCTOR POSITION NEAREST POLE.

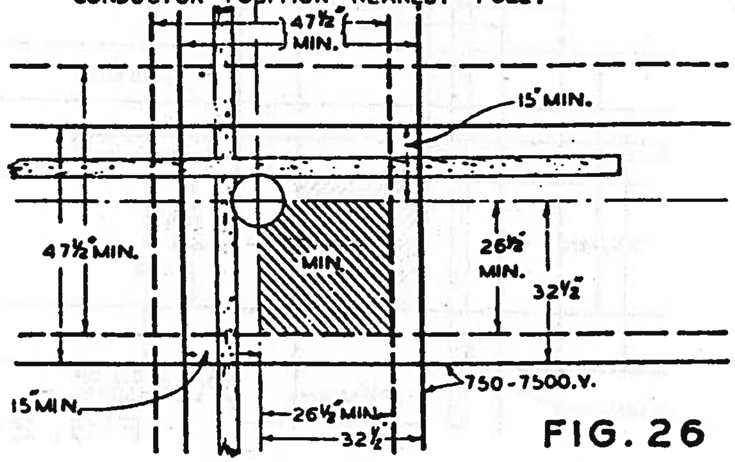


FIG. 26

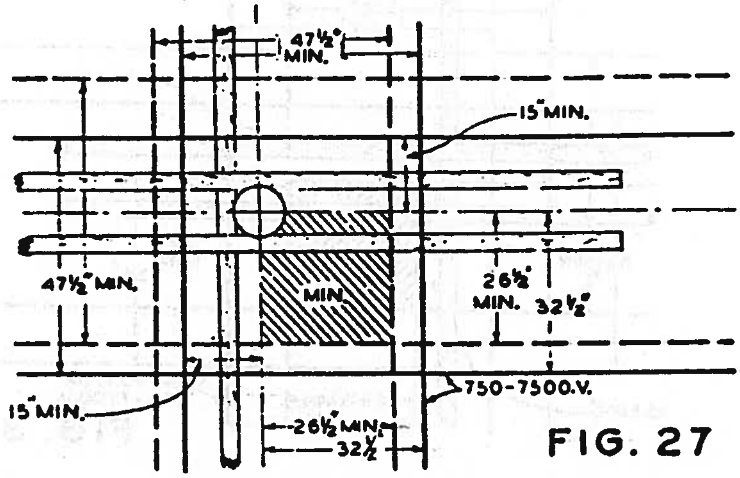


FIG. 27

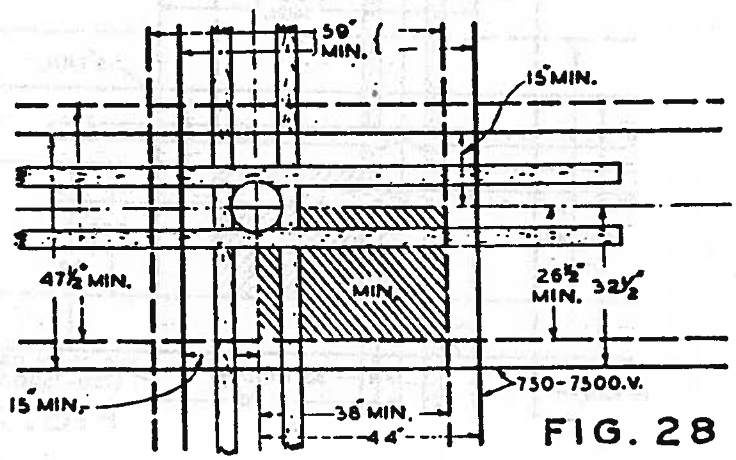


FIG. 28

CLIMBING SPACE
FOR COMBINATION ARM CONSTRUCTION

RULE 54.7-A3c

CONDITIONS: CLIMBING SPACE IN 0-750 VOLT OR 750-7500 VOLT QUADRANT. SEPARATION BETWEEN LINEARM AND RELATED BUCKARM LESS THAN 4 FT. BUT NOT LESS THAN 2 FT.

NOTE: HEAVY LINES, SOLID OR DASHED, SHOW ALTERNATIVE CONDUCTOR POSITION NEAREST POLE.

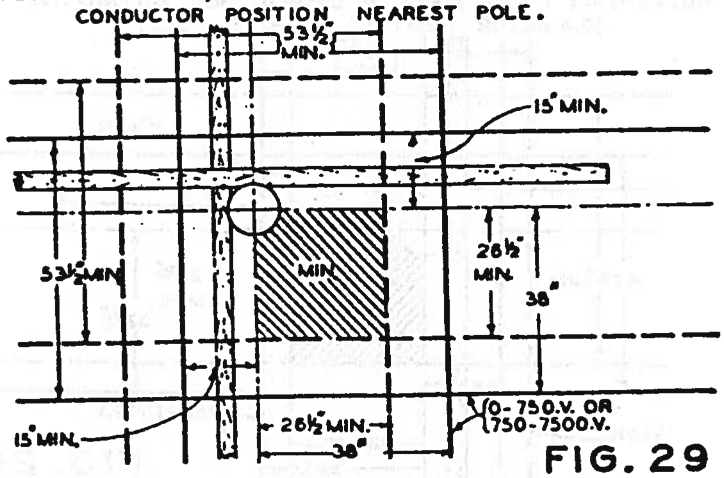


FIG. 29

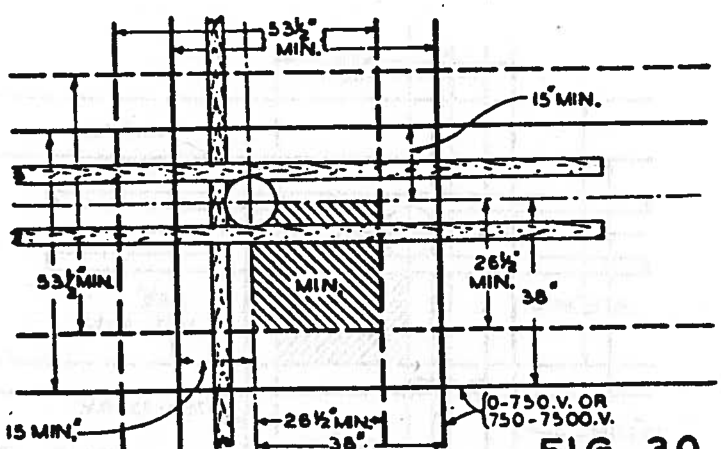


FIG. 30

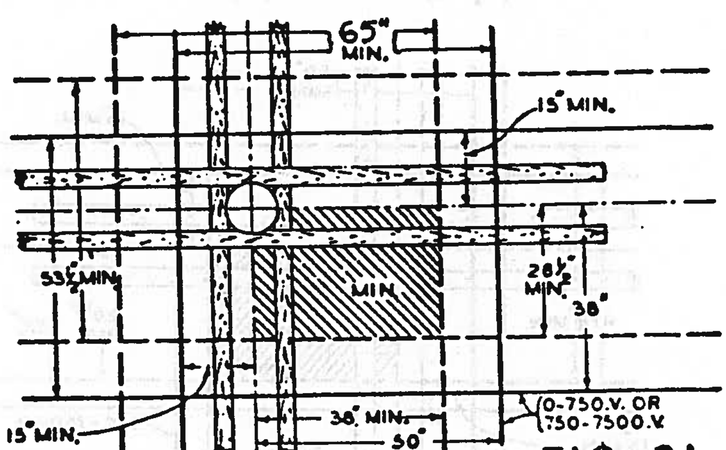


FIG. 31

CLIMBING SPACE
LOW VOLTAGE RACKS
0–750 VOLTS
RULE 54.9–F

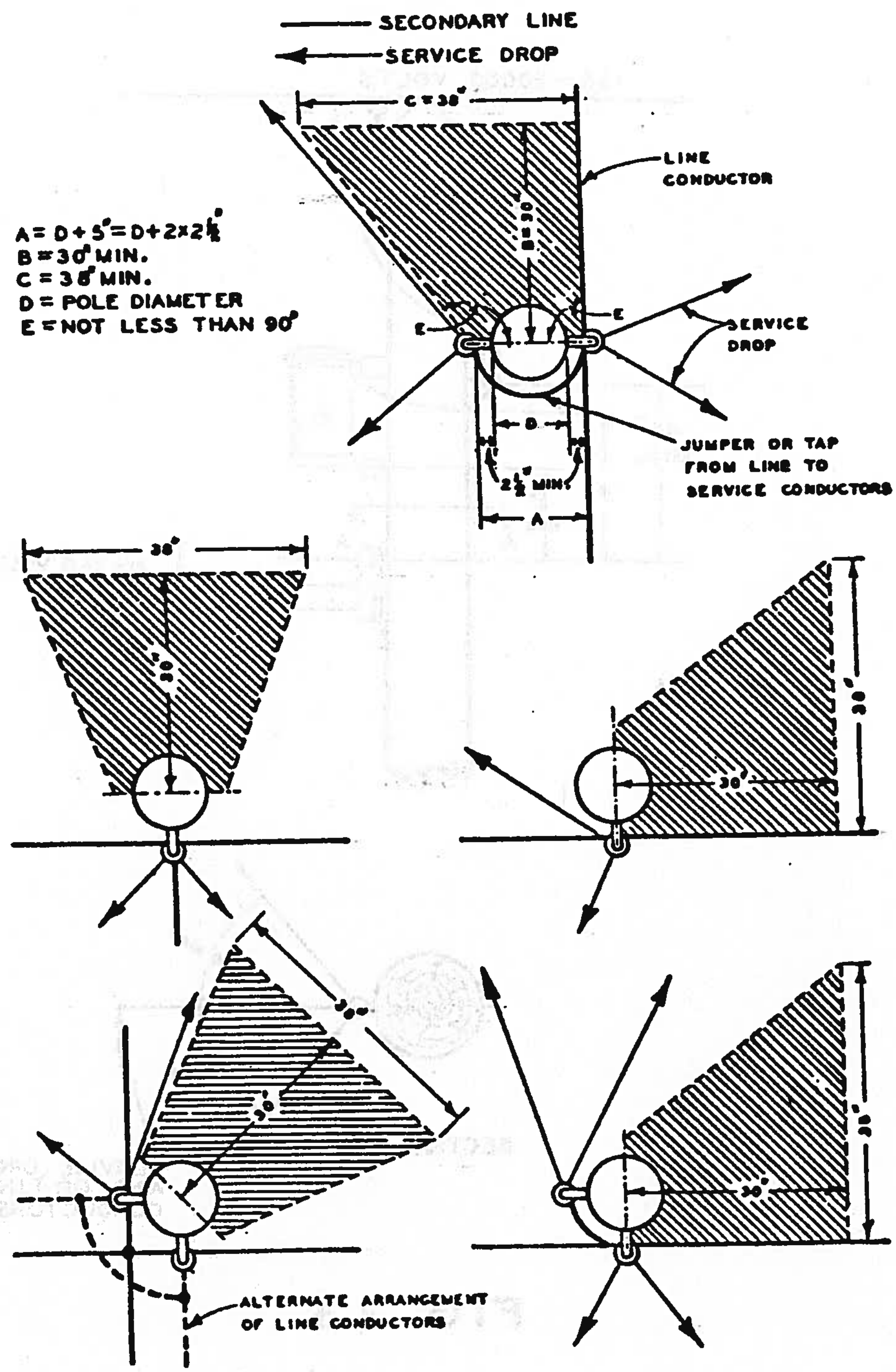


FIG. 32

LOW VOLTAGE RACKS

CONDUCTOR CLEARANCE BELOW TRANSFORMERS

RULE 54.9-E3

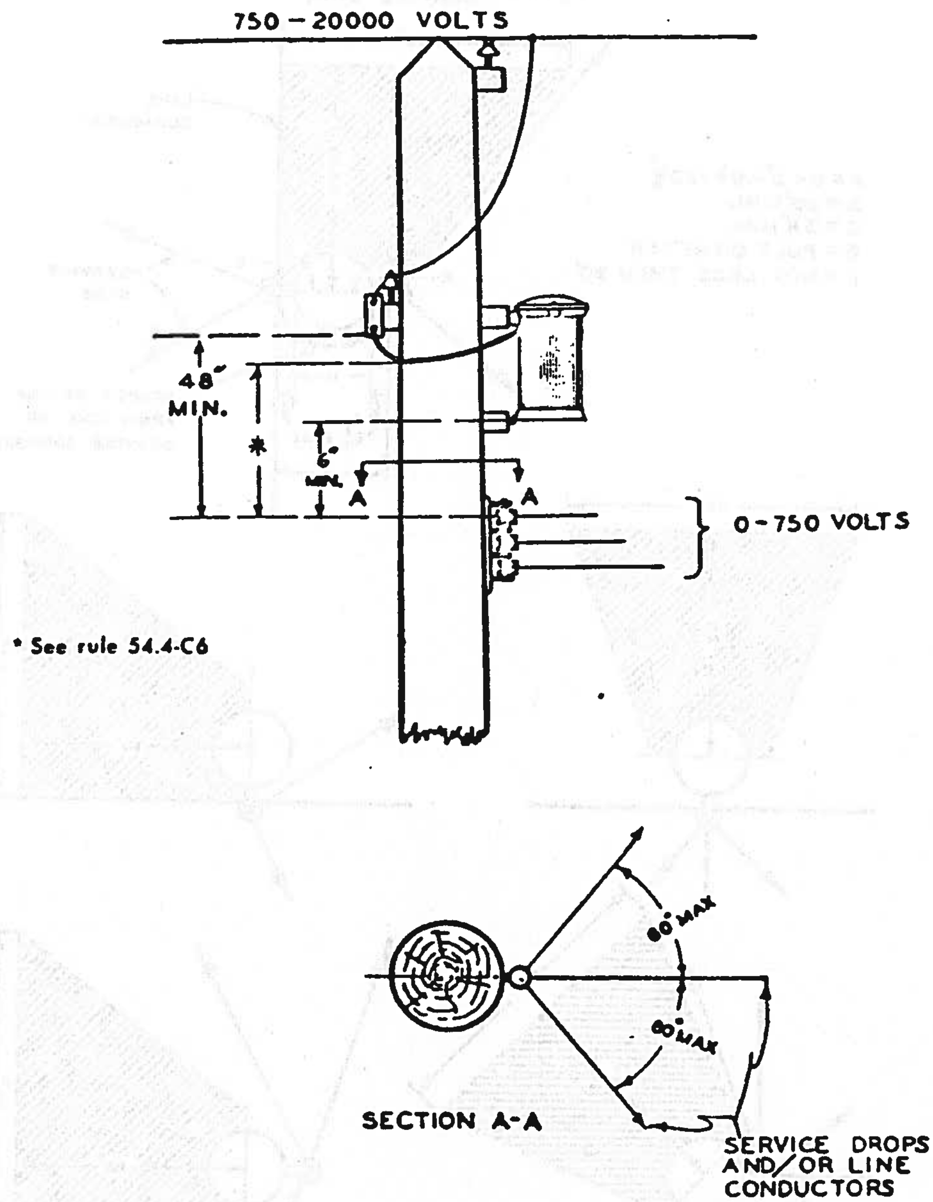


FIG. 33

CLIMBING SPACE

COMMUNICATION CONDUCTORS ON LINEARMS

RULES 84.4-D5 AND 84.7-A

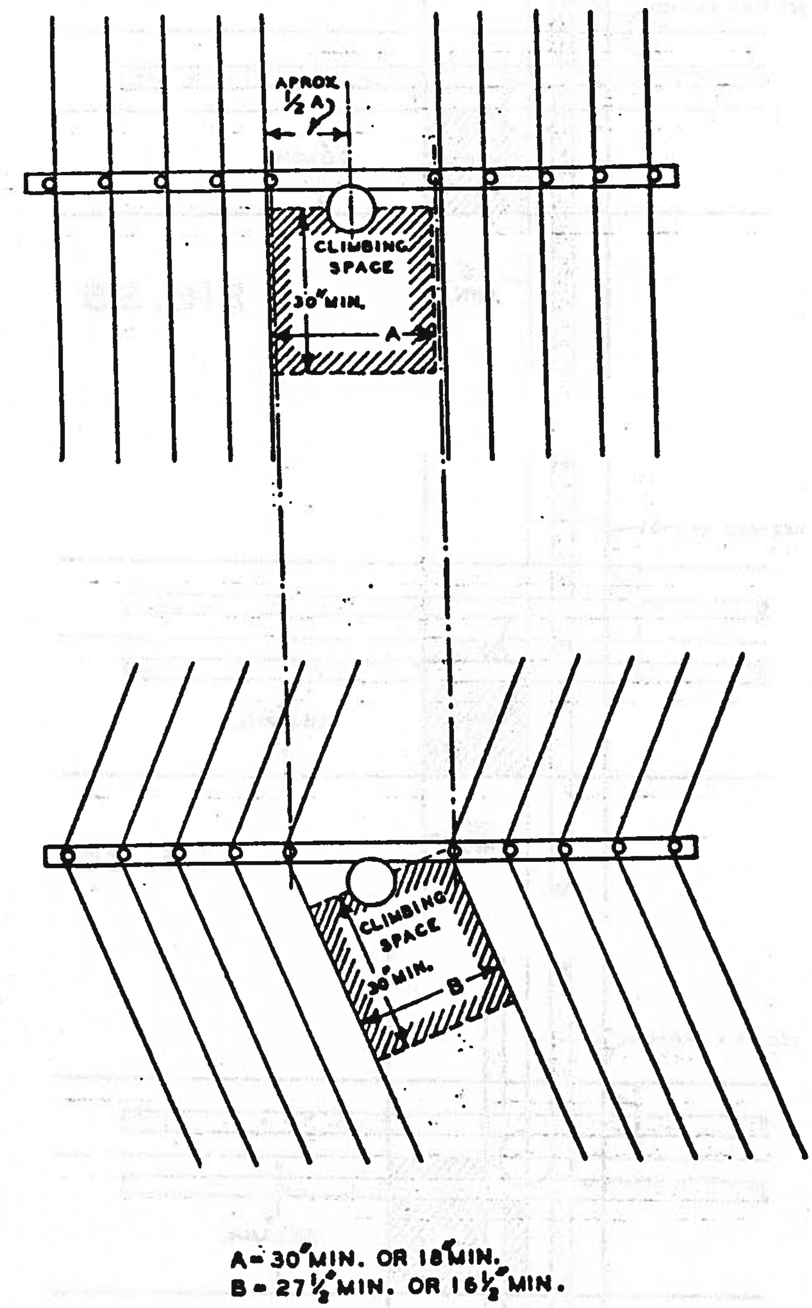


FIG. 34

CLIMBING SPACE
COMMUNICATION CONDUCTORS ON LINEARM AND RELATED BUCKARM
RULE 84.7-B

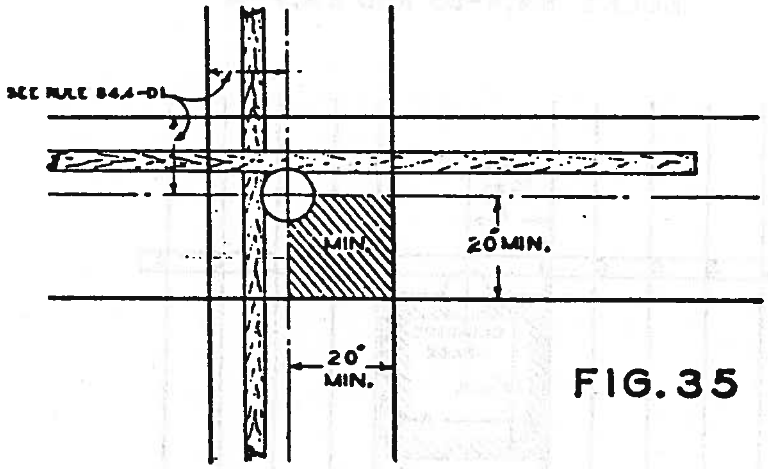


FIG. 35

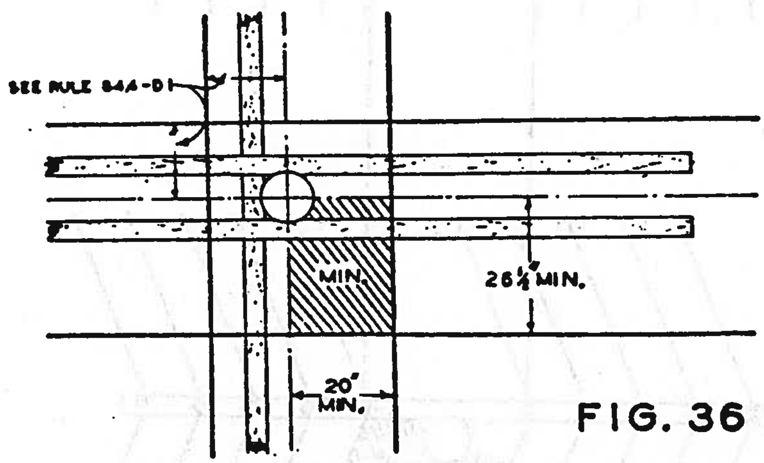


FIG. 36

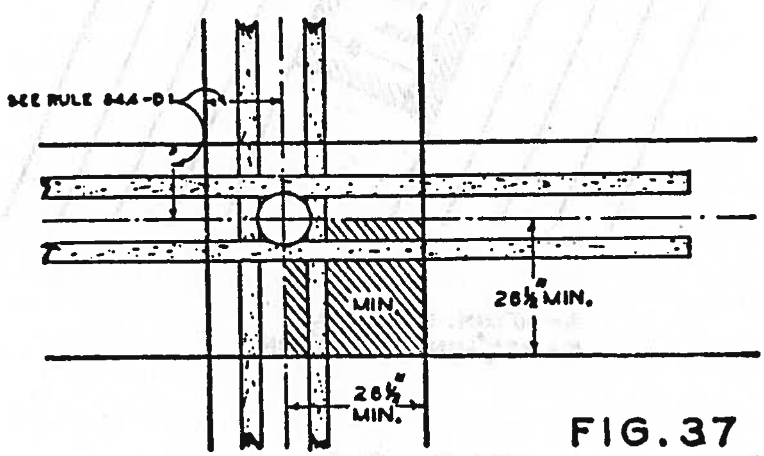
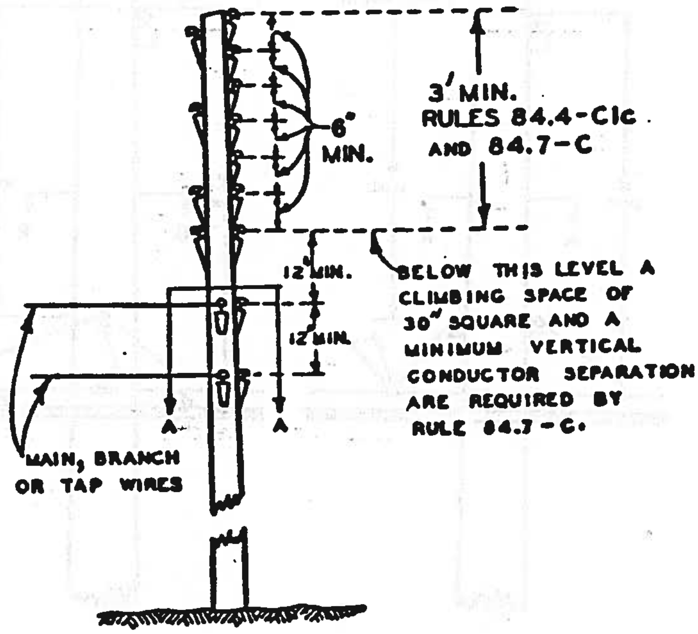


FIG. 37

COMMUNICATION CONDUCTORS NOT ON CROSSARMS



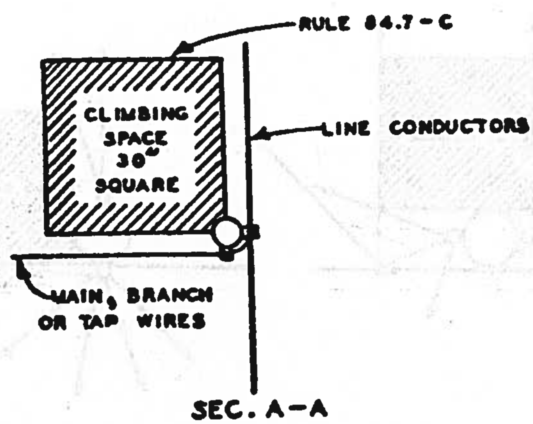
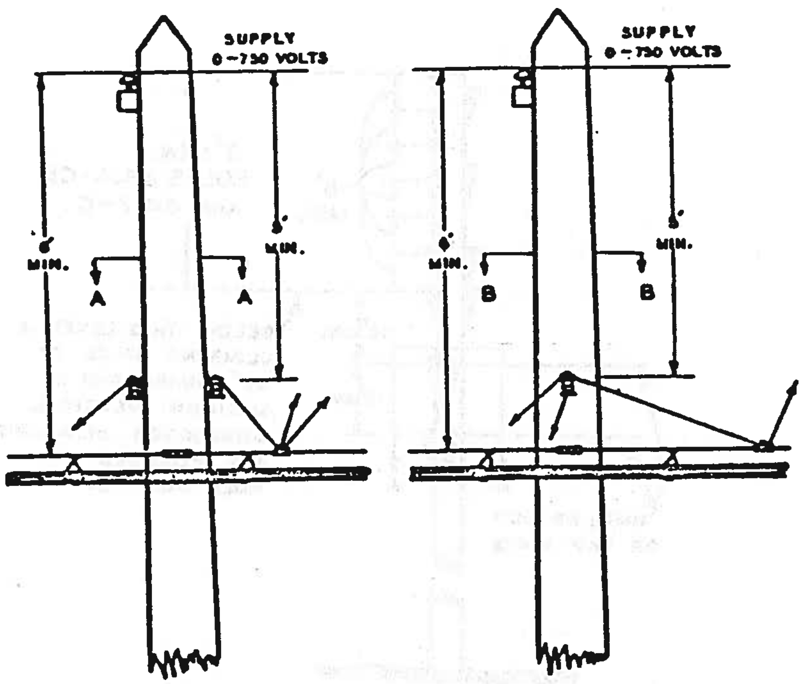


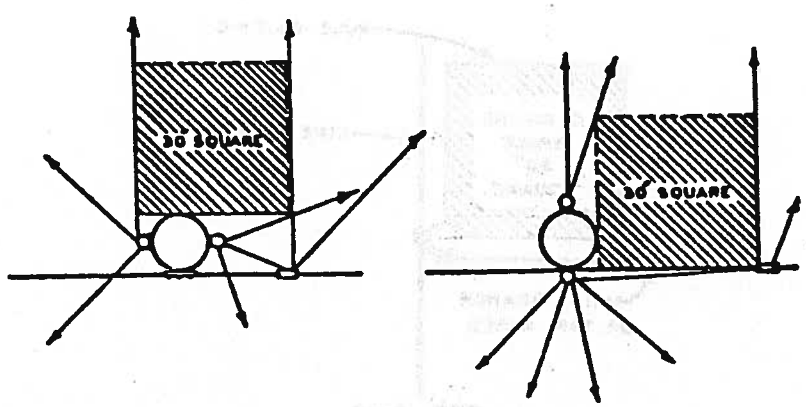
FIG. 38

CLIMBING SPACE

COMMUNICATION SERVICE DROPS NOT ON CROSSARMS

RULE 84.7–D





SECTION A-A SECTION B-B

FIG. 39

CLEARANCE ATTACHMENTS
0-750 VOLT SERVICE DROPS
RULE 54.8-C2

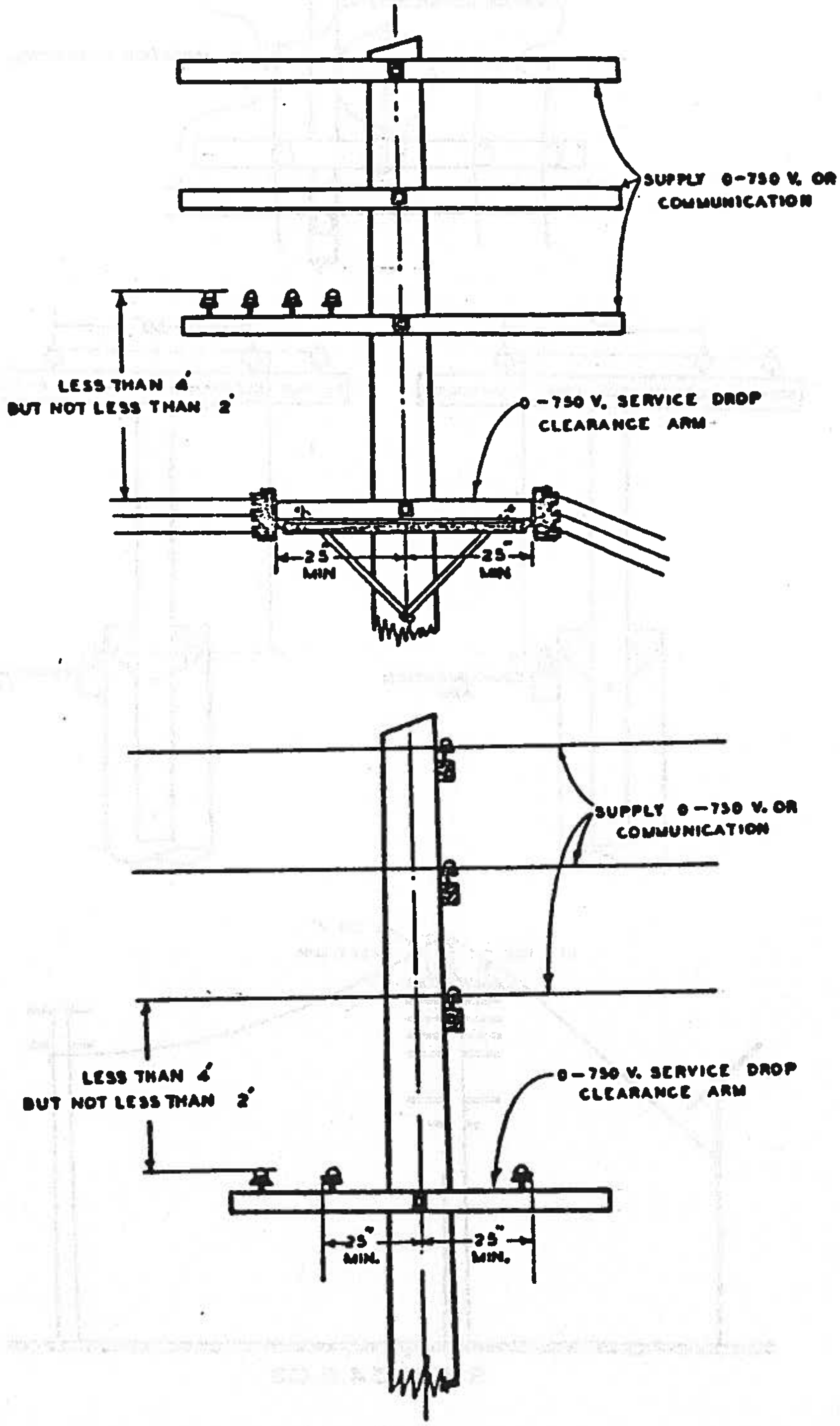
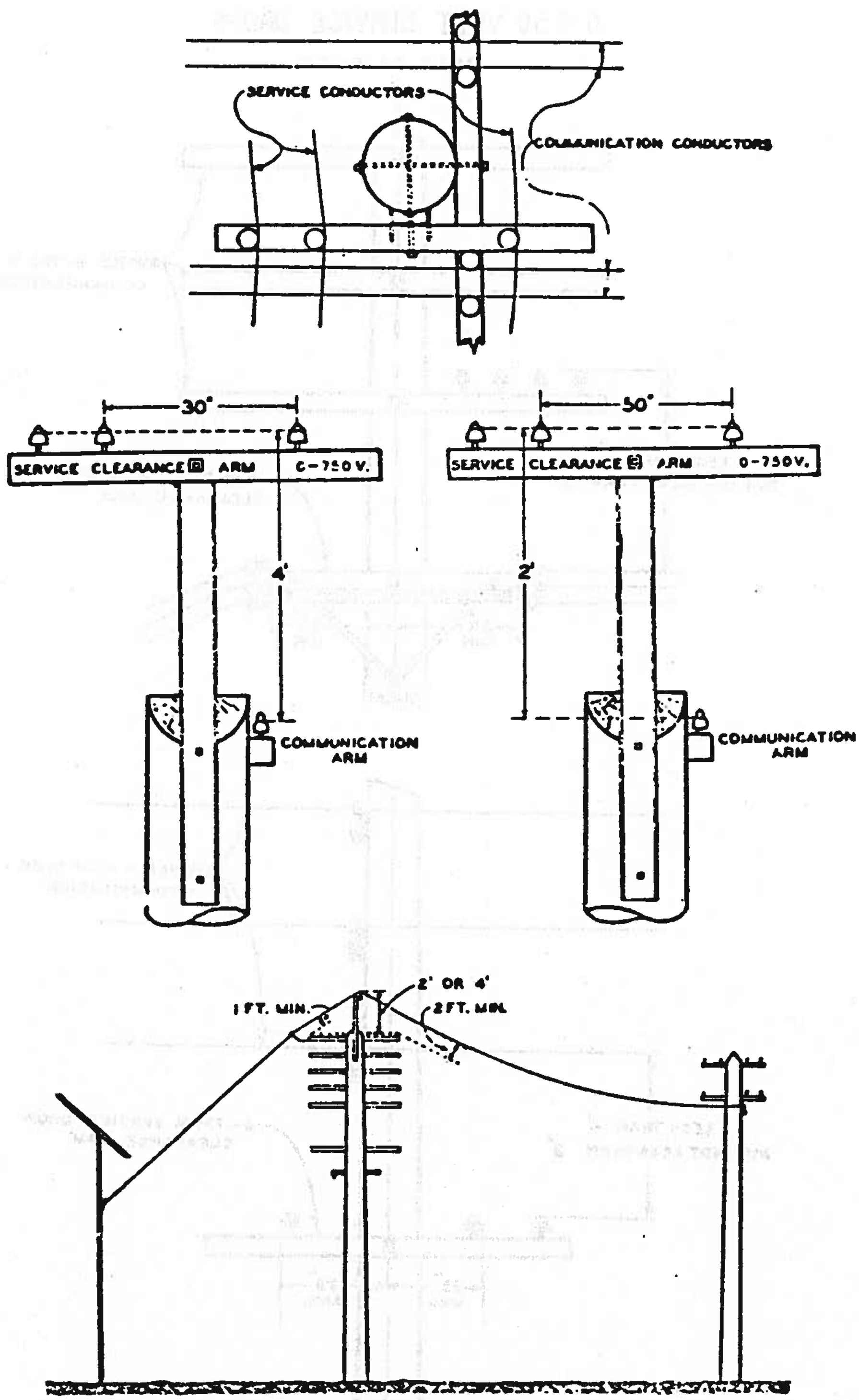


FIG. 40

SUPPLY SERVICE DROPS 0–750 VOLTS
CROSSING CLASS "C" LINE



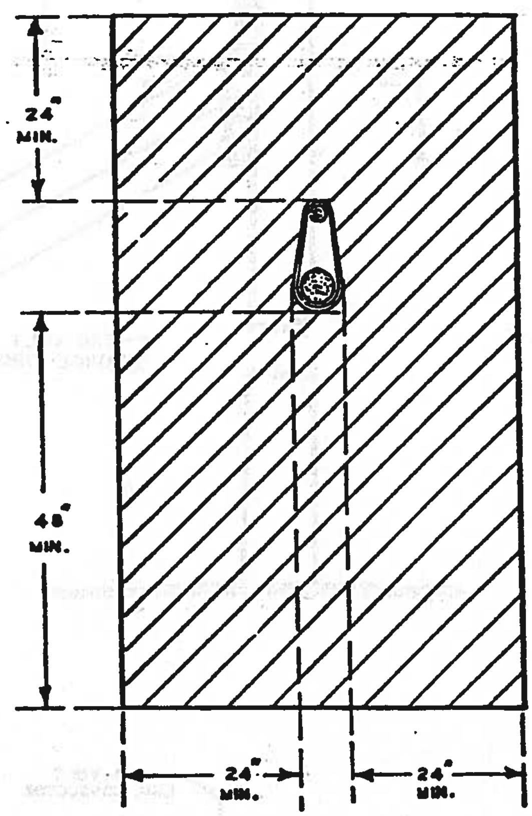
RULE 54.8-C3

FIG. 41

CLEARANCES OF SUPPLY SERVICE DROPS

FROM CONDUCTORS SUPPORTED BY MESSENGERS

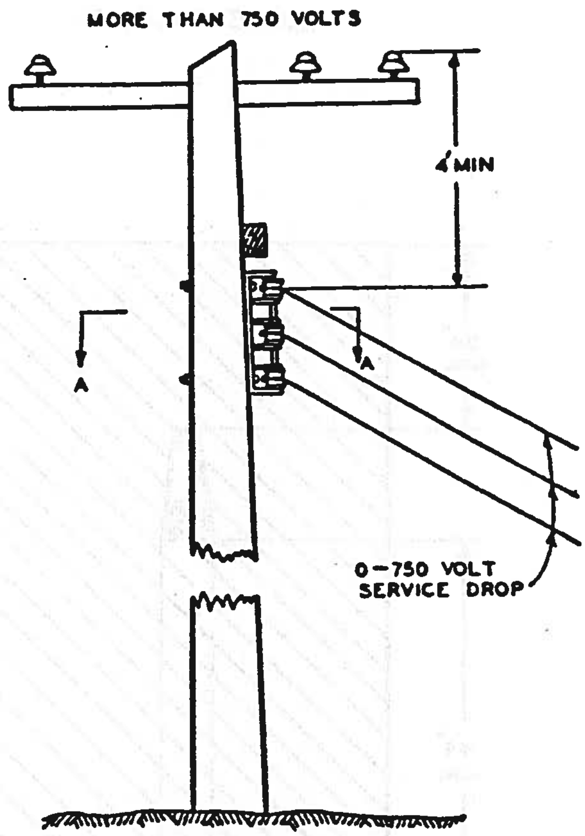
RULE 54.8-C1



NOTE
NO SUPPLY SERVICE DROP
WITHIN SHADED AREA.
SEE RULE 57.4
FOR METHOD OF MEASUREMENT

FIG. 42

SUPPLY SERVICE DROPS
FROM GUARDED RACK CONDUCTORS
RULE 54.9-E 1



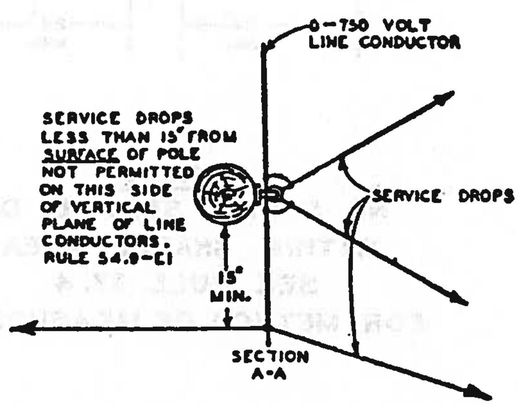


FIG. 43

EXPOSED COMMUNICATION GUYS

NOT IN PROXIMITY TO SUPPLY CONDUCTORS ON WOOD POLES.

RULES 21.3-C AND 86.6

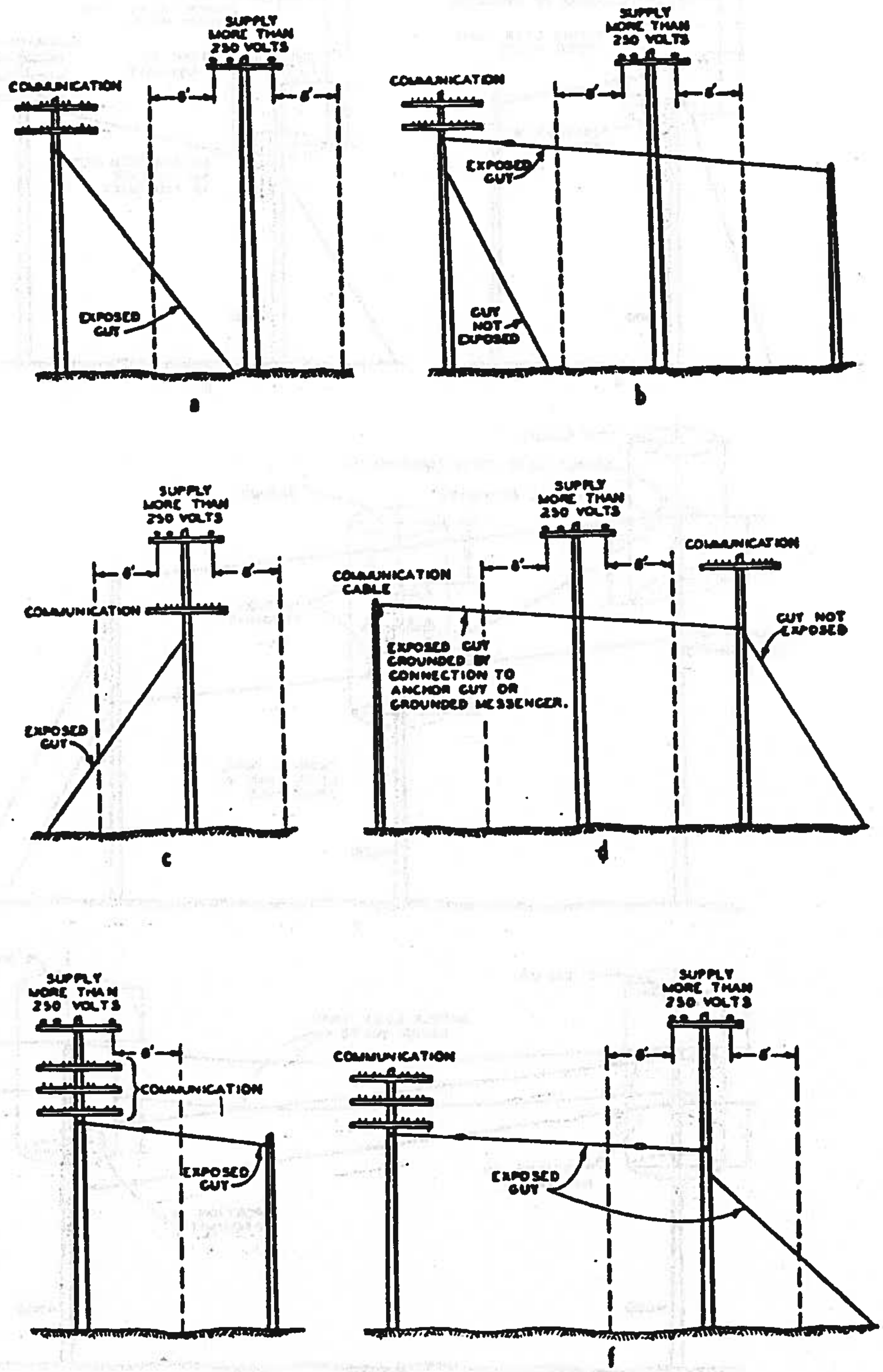


FIG. 44

GUYS IN PROXIMITY TO WOOD POLES AND SUPPLY CONDUCTORS OF 20,000 VOLTS OR LESS.

RULES 21.3-D, 56.6-A AND 86.6.

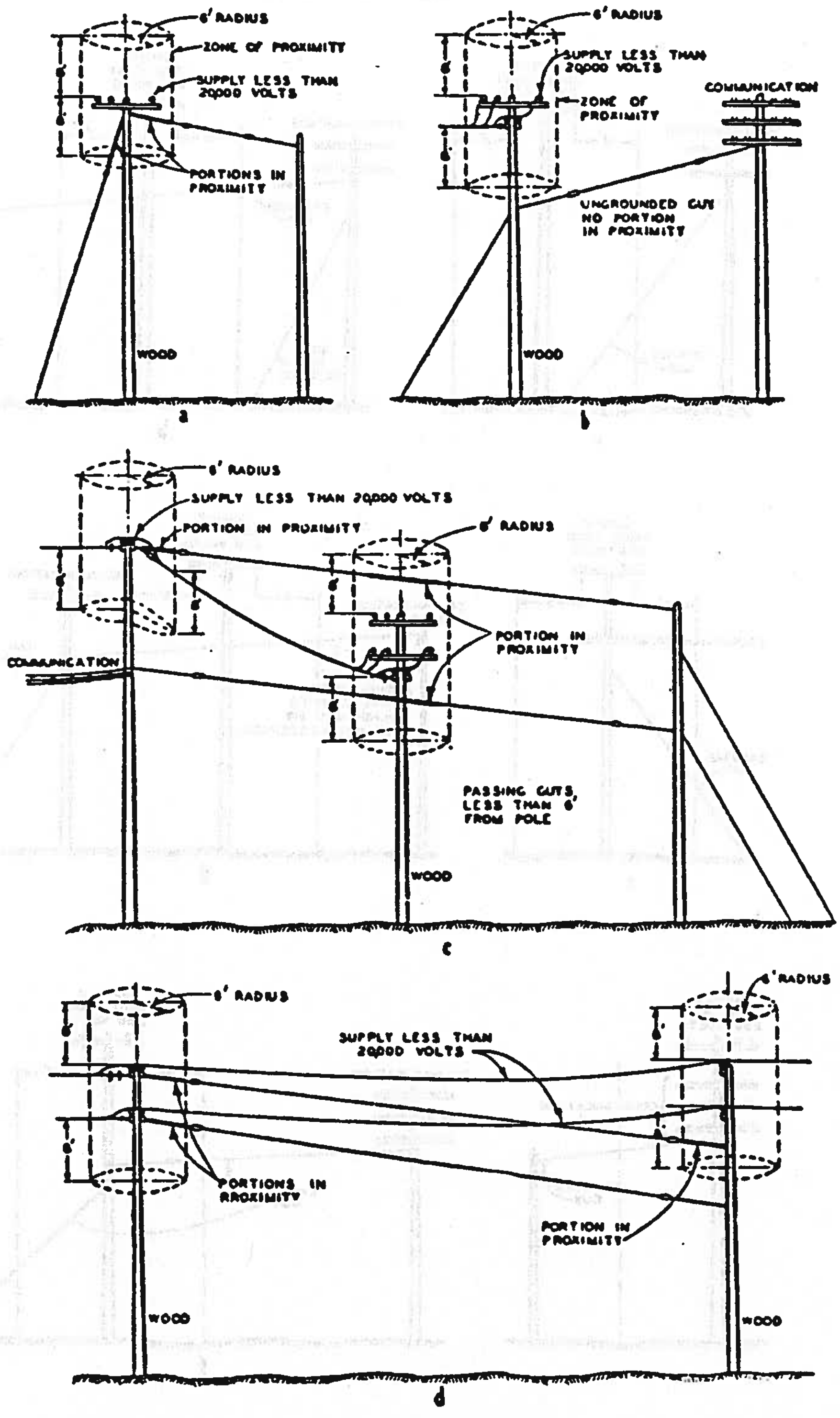
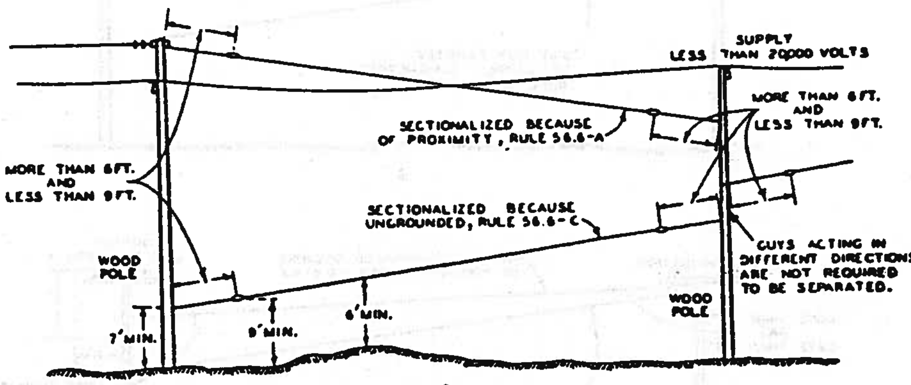


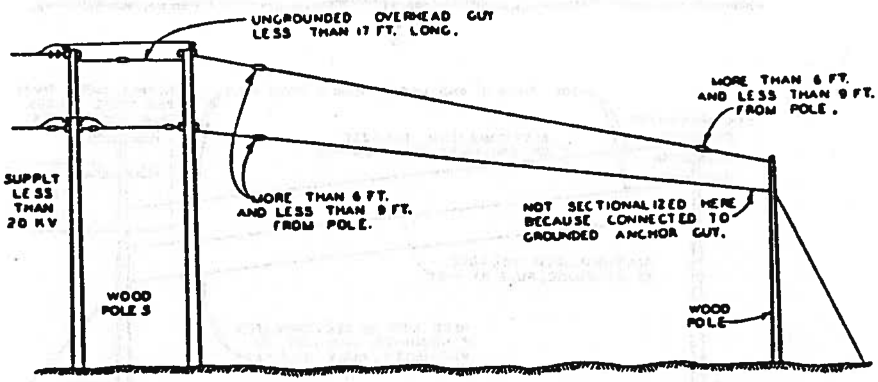
FIG. 45

22

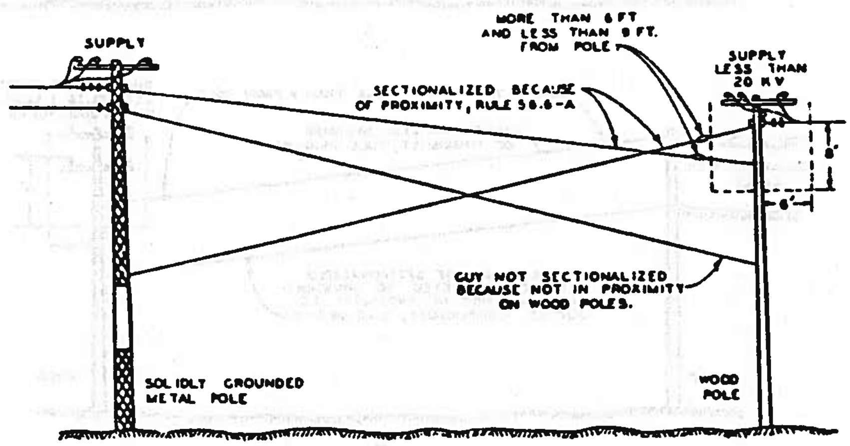
SECTIONALIZATION OF OVERHEAD GUYS
ON SUPPLY LINES
RULE 56.7-A



a



b



c

FIG. 46

SECTIONALIZATION OF OVERHEAD GUYS
ON COMMUNICATION LINES
RULE 86.7-A

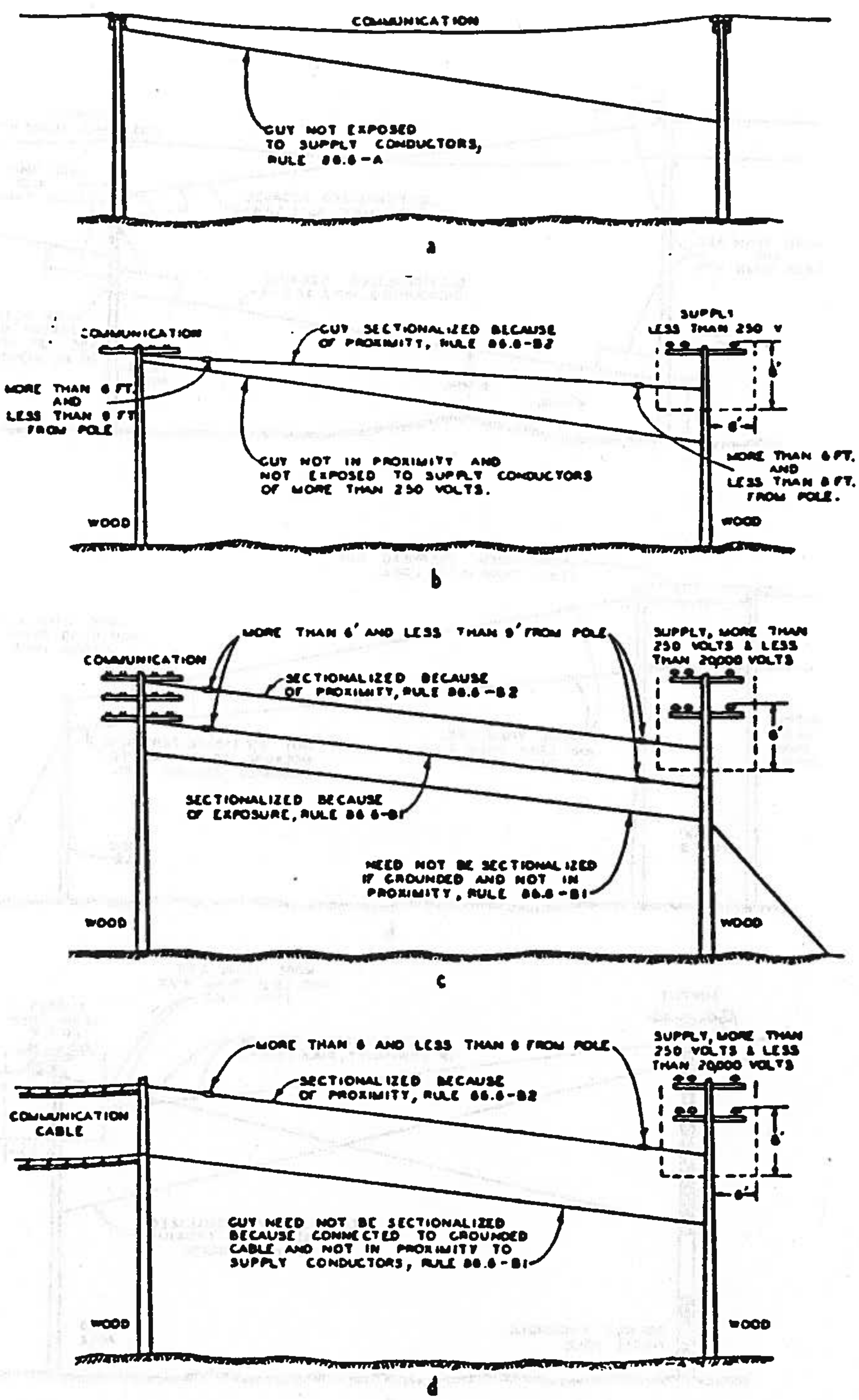


FIG. 47

SECTIONALIZATION OF OVERHEAD GUYS
ON JOINTLY USED POLES
RULES 56.7-A AND 86.7-A

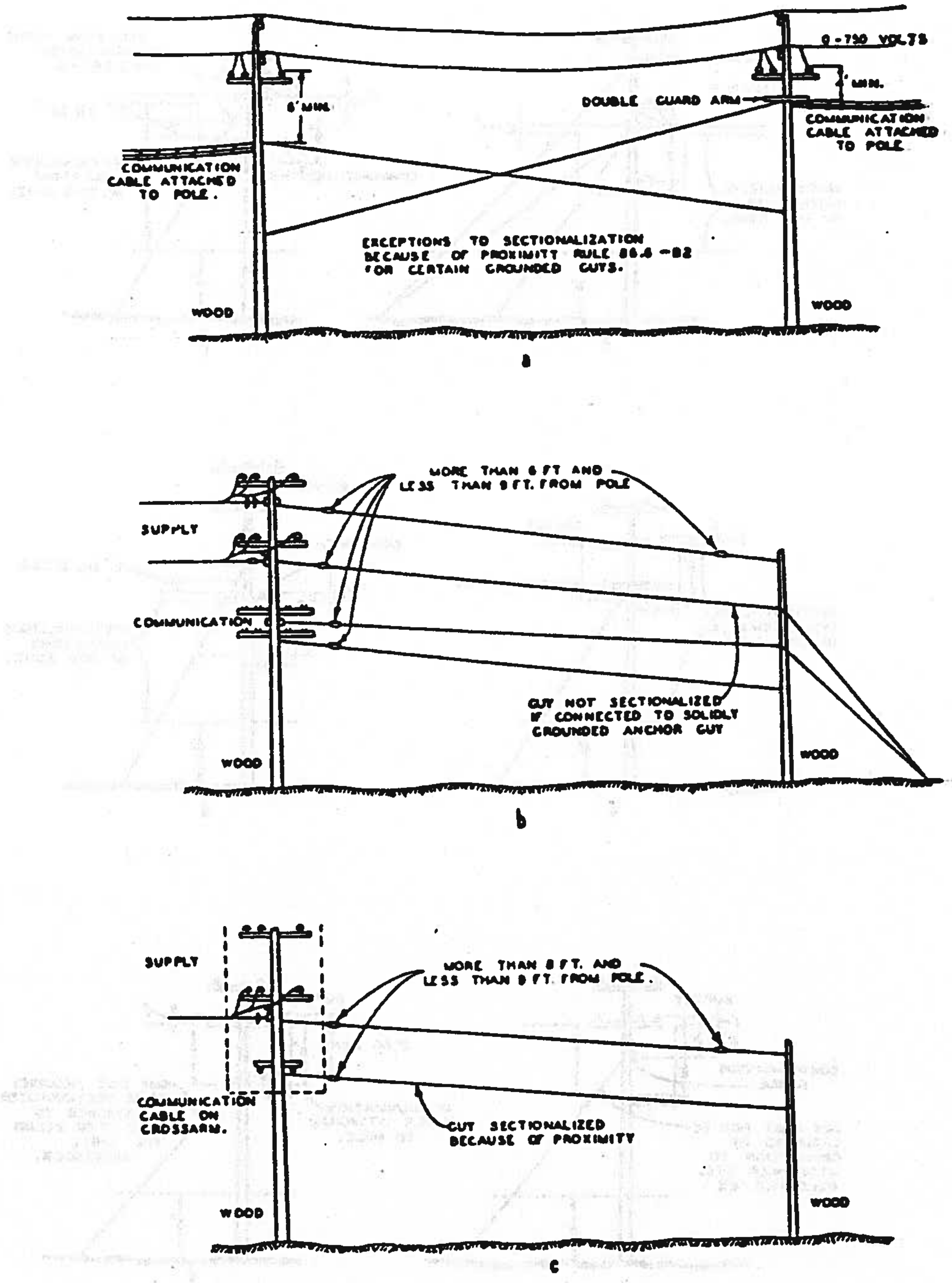


FIG. 48

SECTIONALIZATION OF ANCHOR GUYS

RULES 56.7-B & 86.7-B

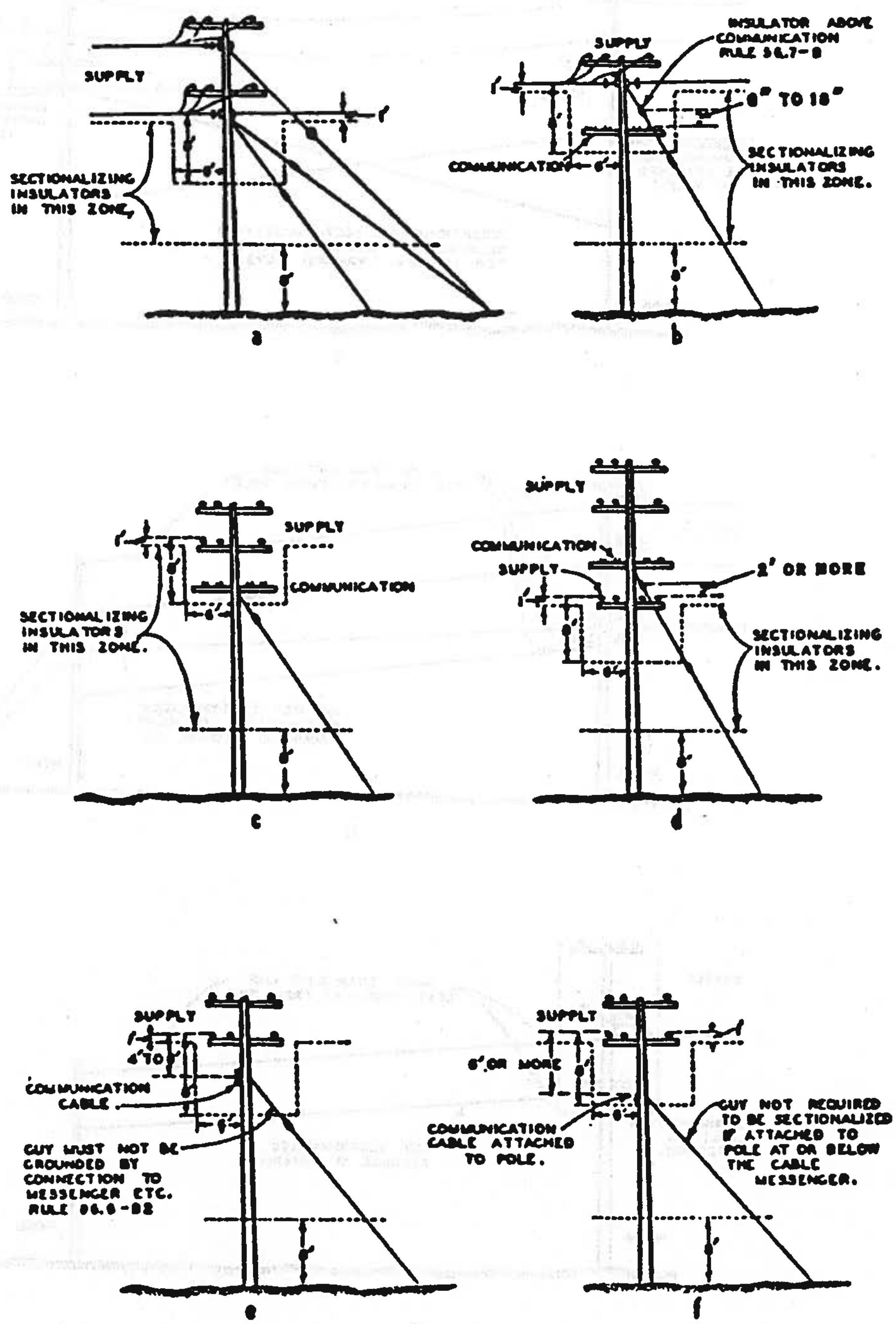


FIG. 49

SECTIONALIZATION OF ARM GUYS AND BRANCHED GUYS

RULE 56.7-A

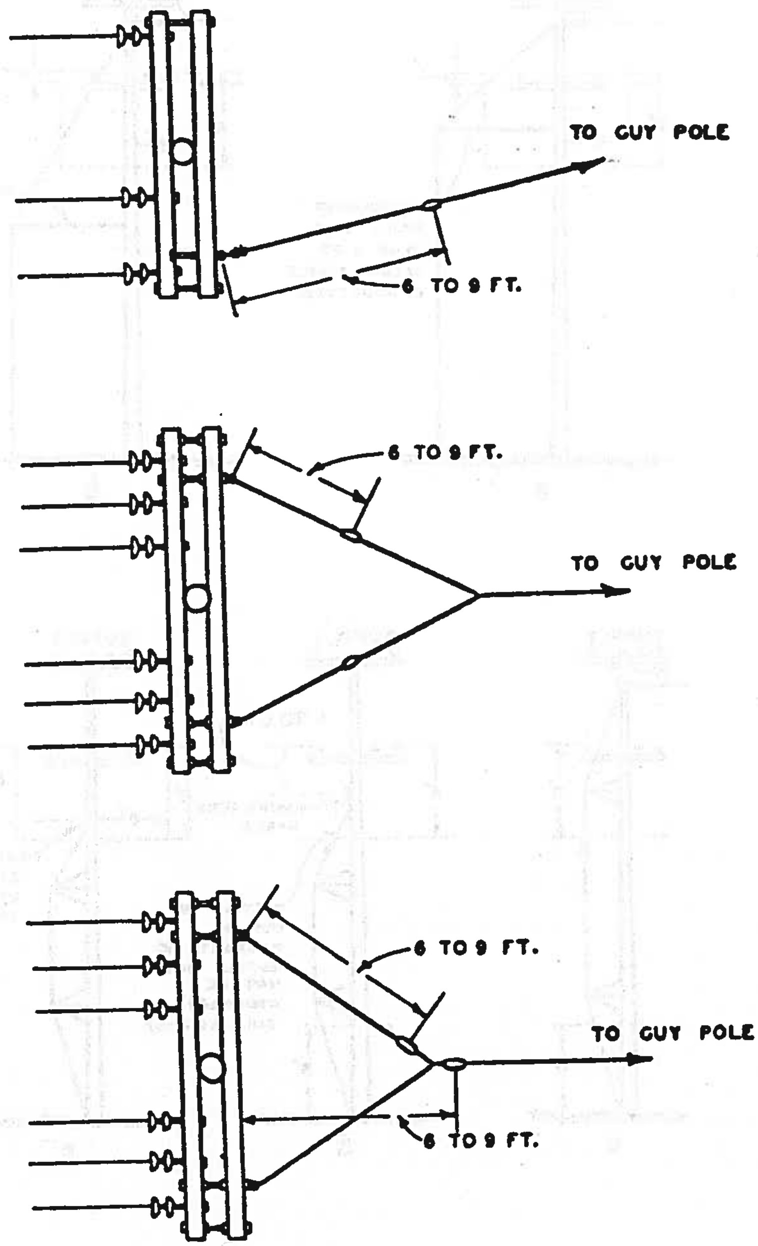


FIG. 50

SECTIONALIZATION OF SIDEWALK GUYS AND TRUSS GUYS

RULES 56.7-B, 56.7-C, 86.7-B & 86.7-C.

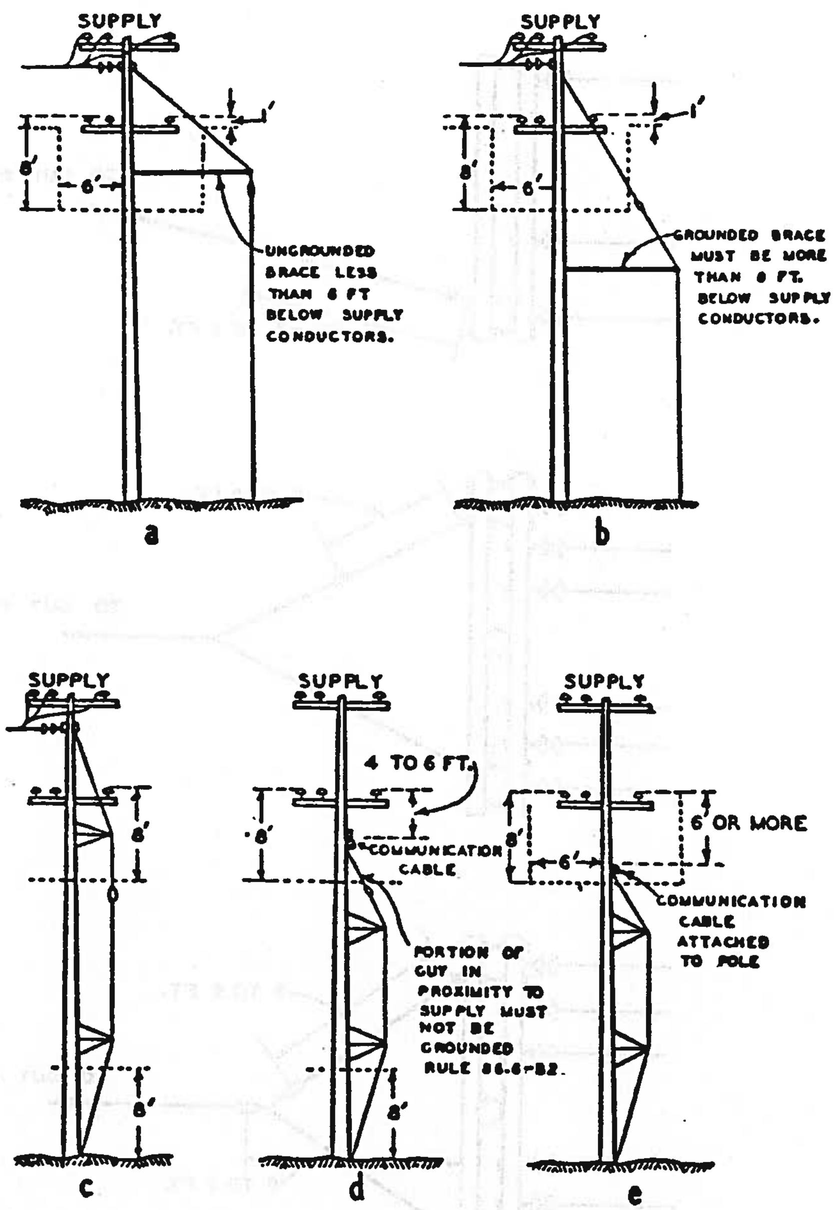


FIG. 51

GUYS EXPOSED TO SUPPLY CONDUCTORS
OF MORE THAN 20,000 VOLTS
RULES 56.8-D & 86.8-C

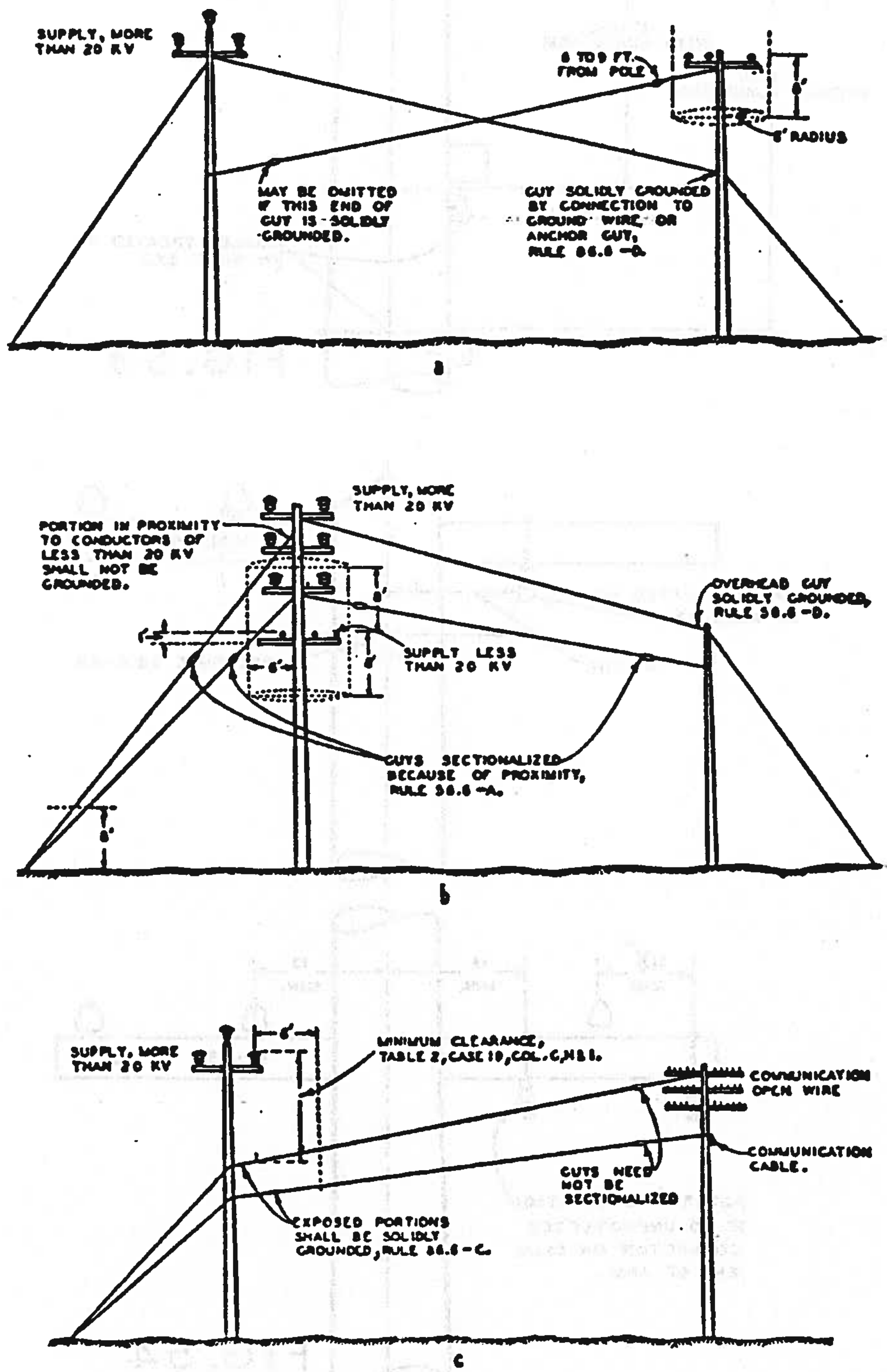


FIG. 52

SUPPLY CABLES
RULE 57.4-F

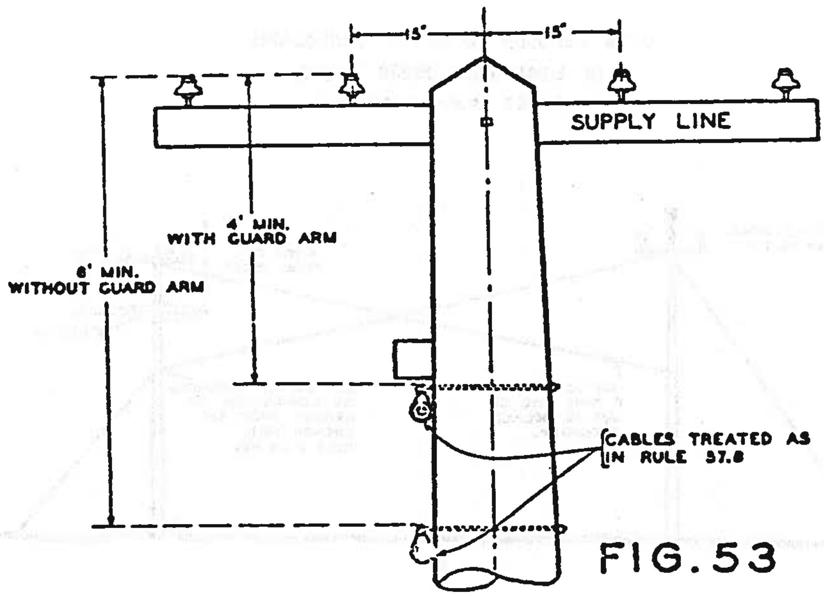


FIG. 53

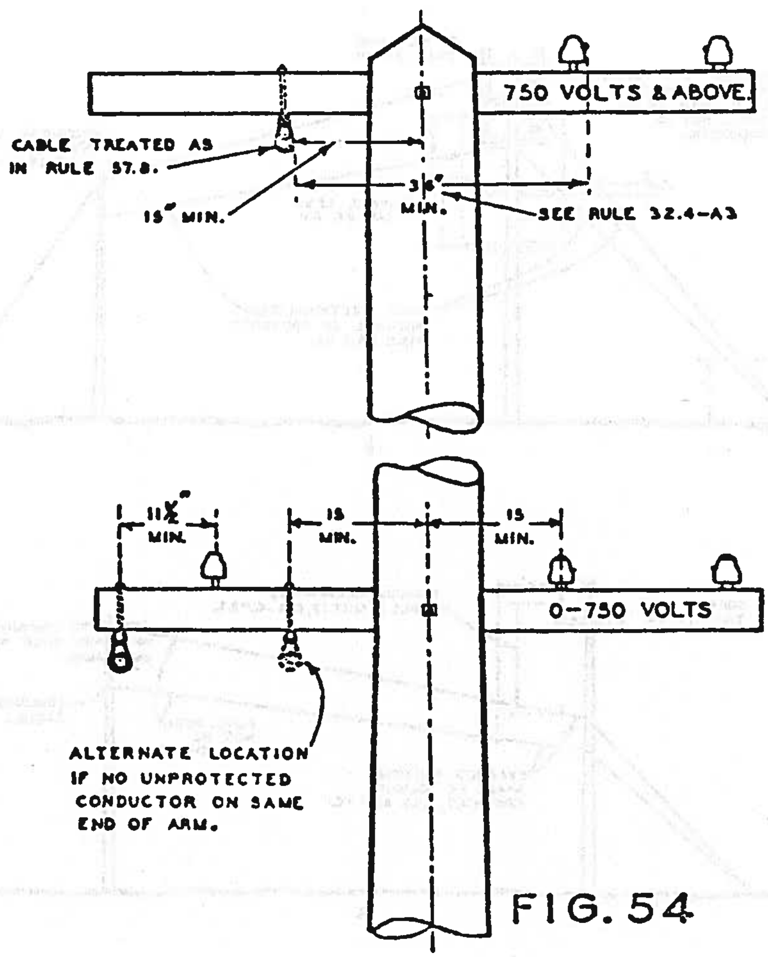
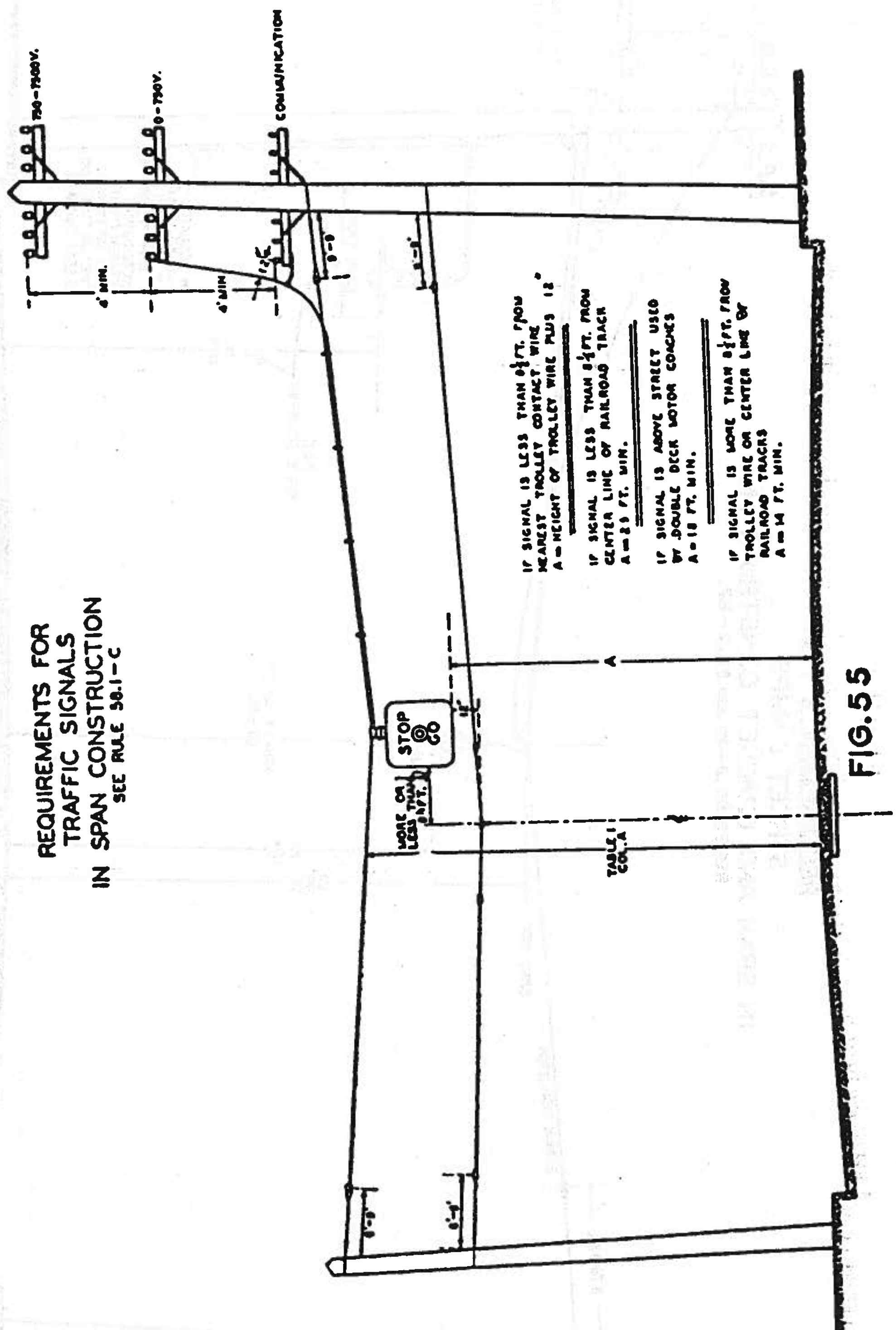


FIG. 54



REQUIREMENTS FOR TRAFFIC SIGNALS IN SPAN CONSTRUCTION
SEE RULE 58.1-C

FIG. 55

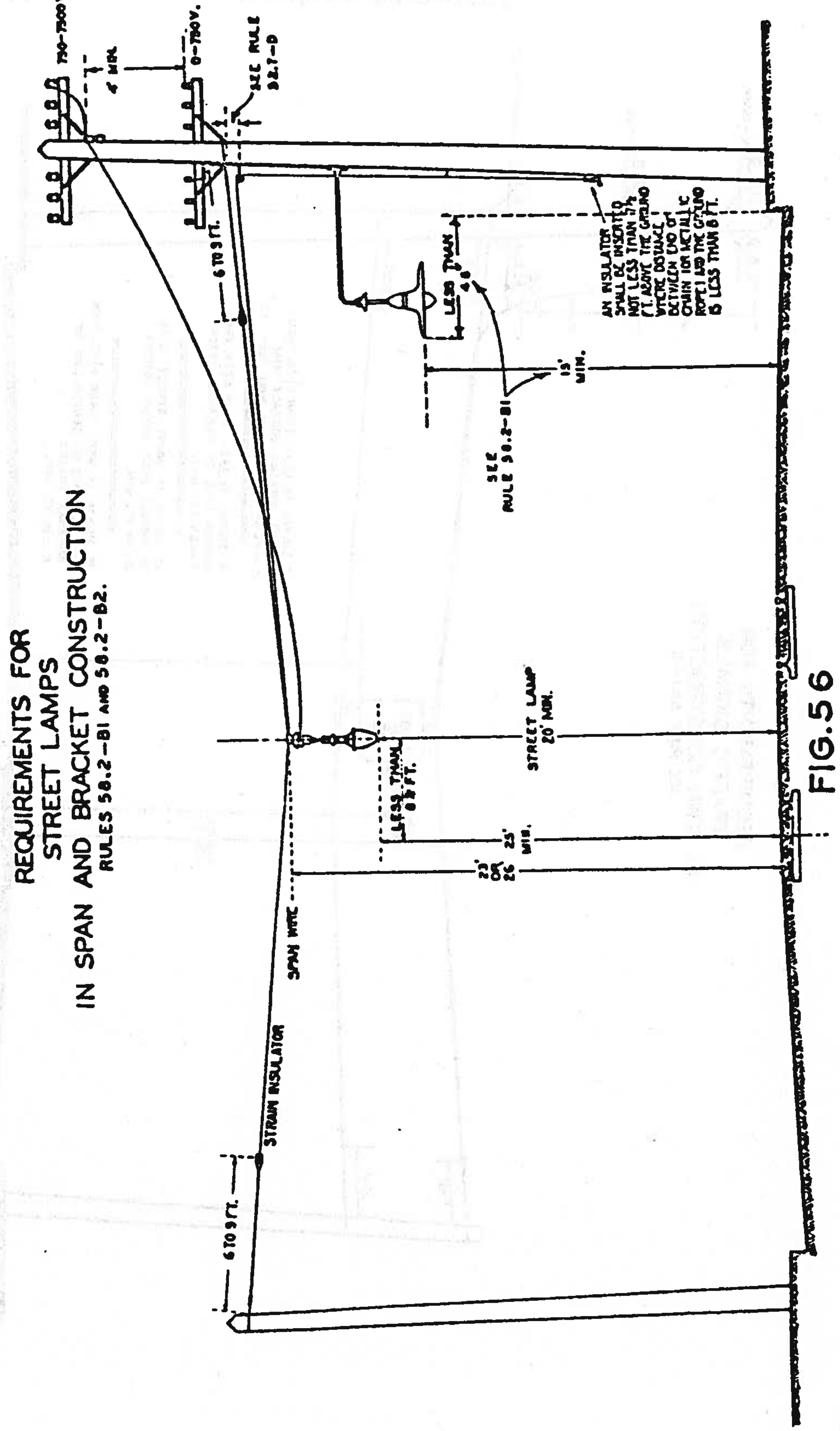

REQUIREMENTS FOR
STREET LAMPS
IN SPAN AND BRACKET CONSTRUCTION
RULES 58.2–B1 AND 58.2–B2.
750-7500 V.
4' MIN.
0-750 V.
6 TO 9 FT.
LESS THAN 8'
15' MIN.
SEE RULE 58.2-B1
STREET LAMP 20' MIN.
LESS THAN 8½ FT.
25' MIN.
SPAN WIRE
STRAIN INSULATOR
6 TO 9 FT.

FIG. 56

GROUNDING OF TRANSFORMER WINDINGS

RULE 58.3-C1

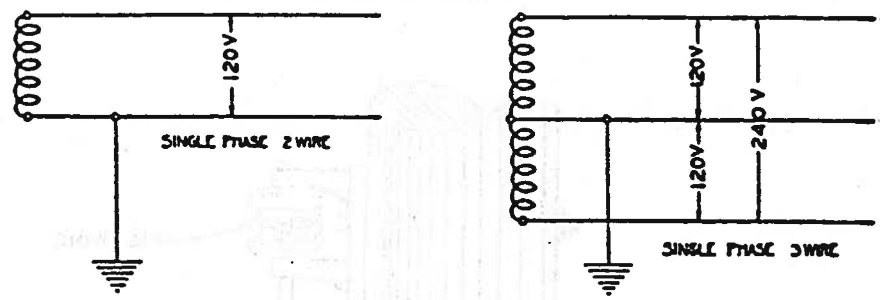


FIG. 57

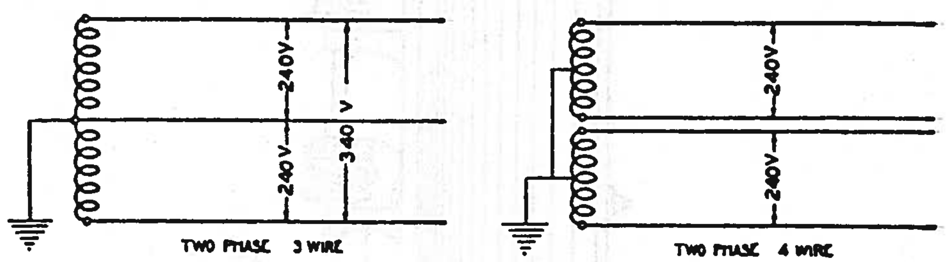


FIG. 58

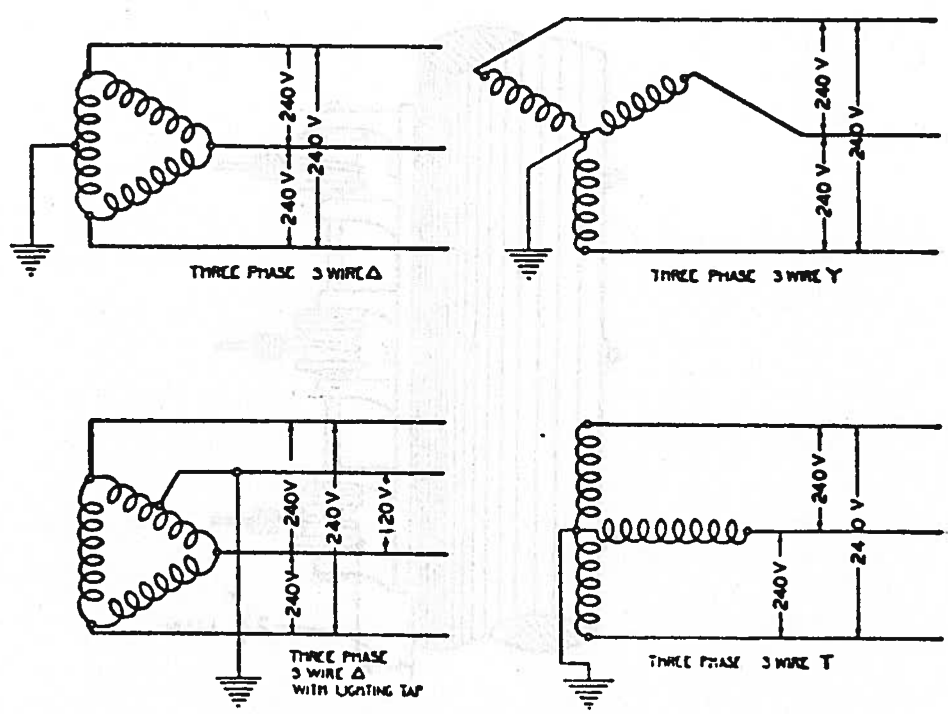


FIG. 59

RACK CONDUCTOR CLEARANCE
FROM SURFACE OF POLE
RULE 54.9-B1

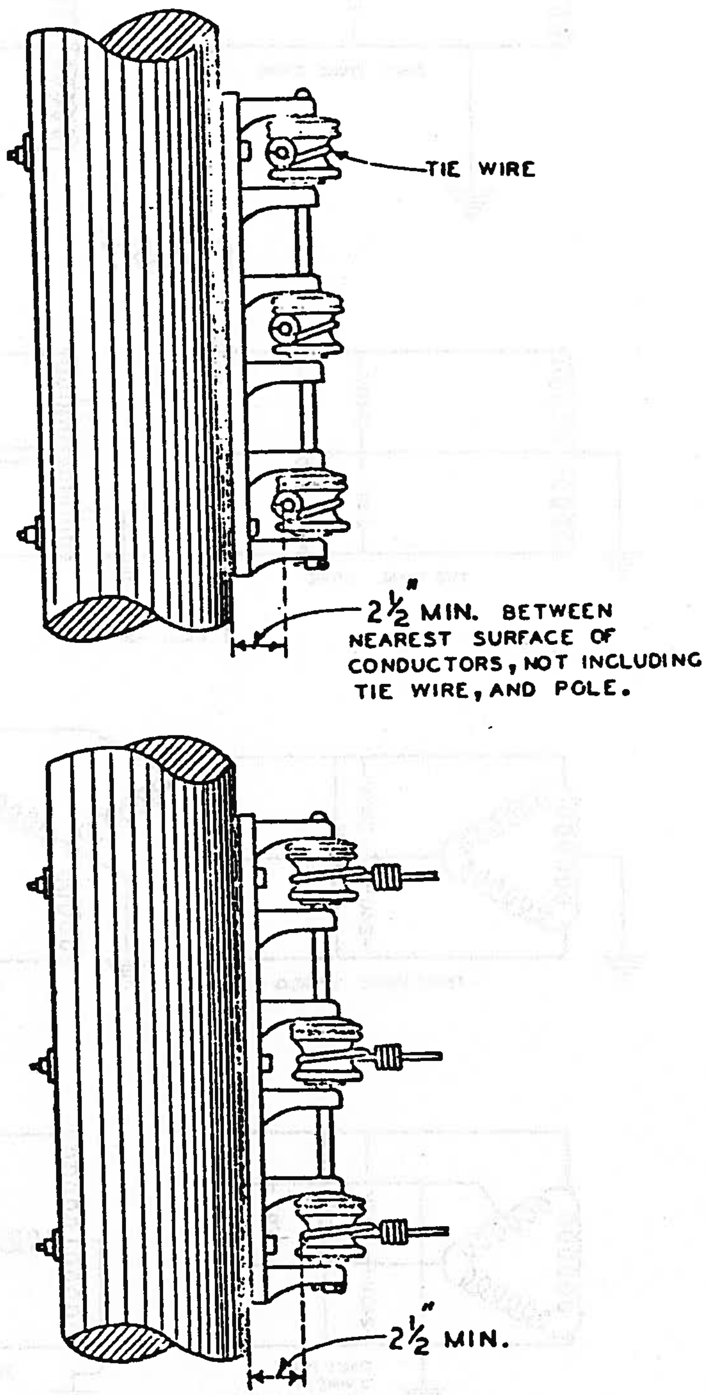


FIG. 60

SUPPLY RISERS AND TERMINALS

RULES 54.6-E AND 54.6-F

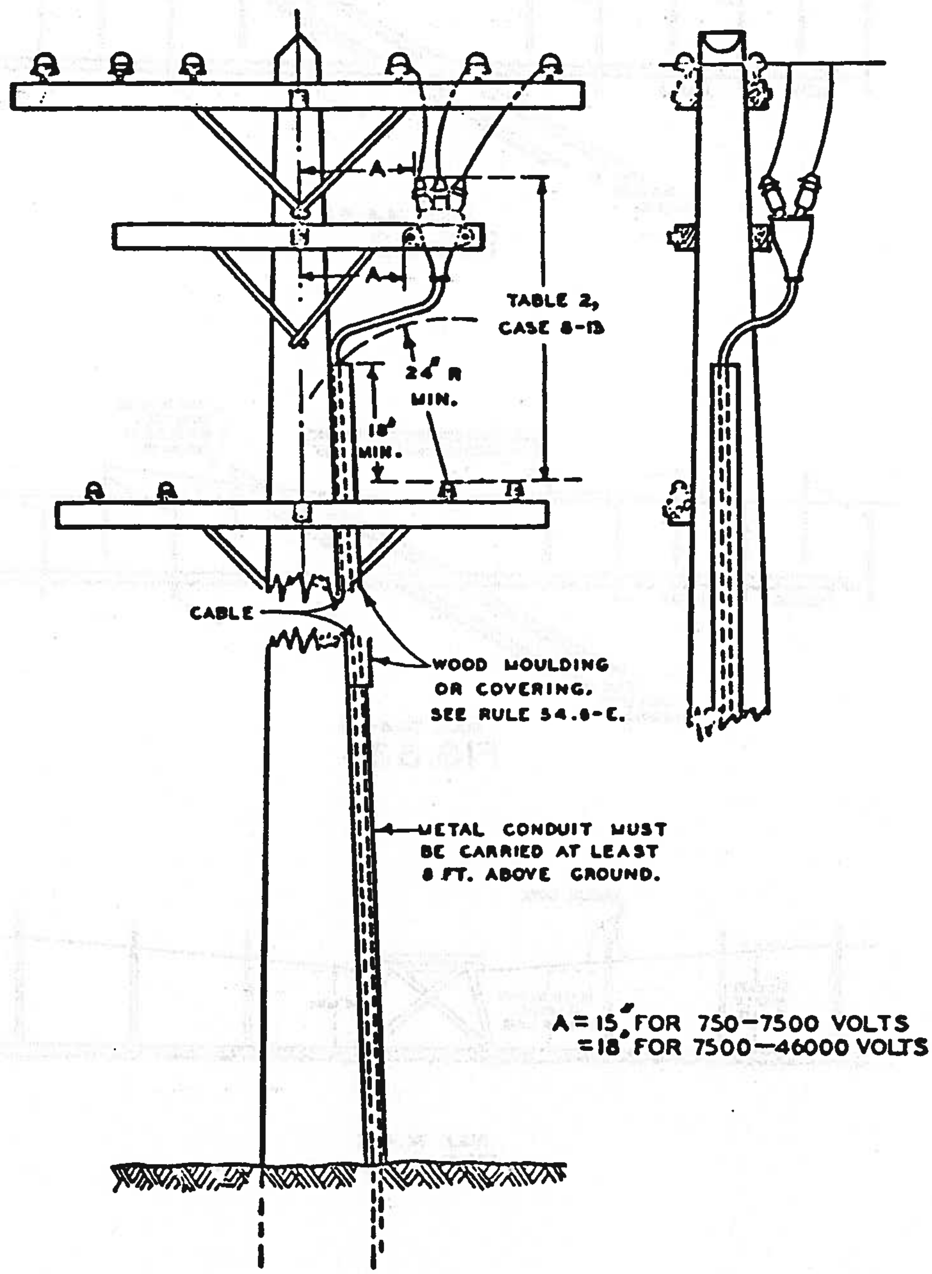
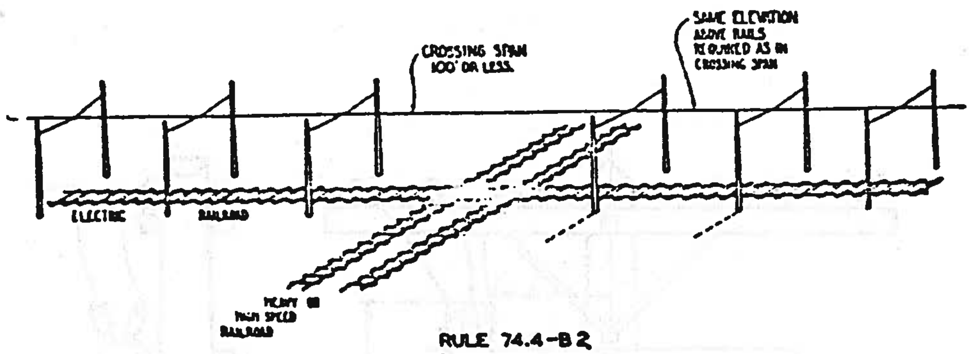


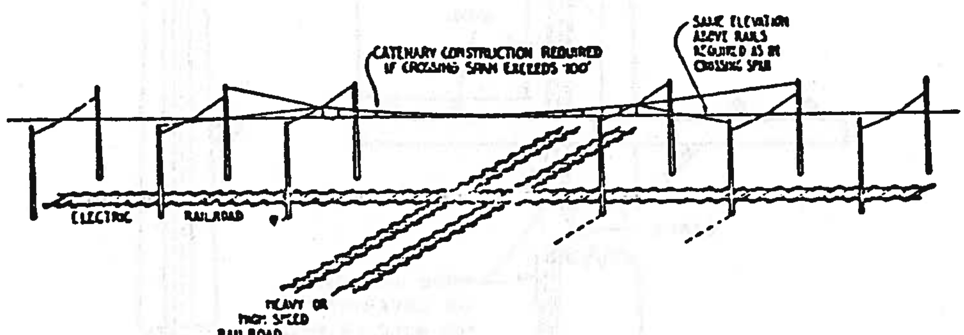
FIG. 61

CONSTRUCTION REQUIREMENTS OF TROLLEY CONTACT CONDUCTORS



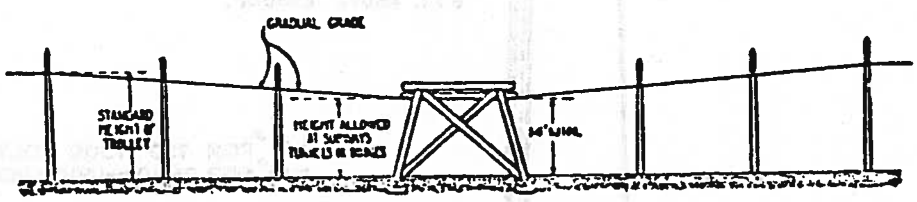
RULE 74.4-B2

FIG. 62



RULE 74.4-B2

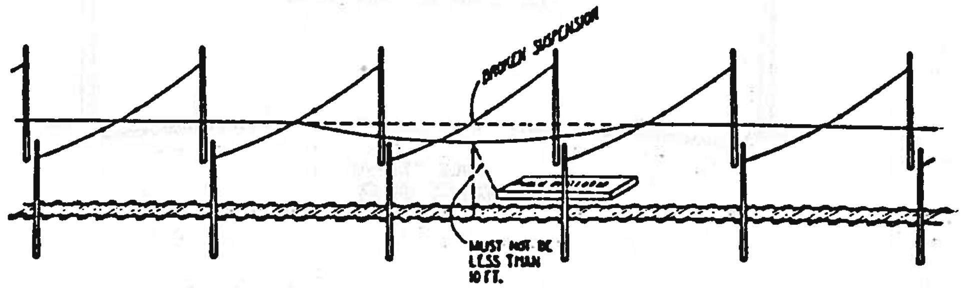
FIG. 63



RULE 74.4-E

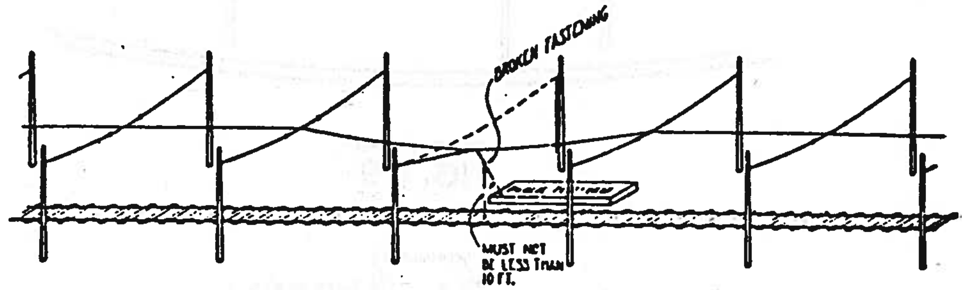
FIG. 64

SPAN WIRE INSULATORS FOR TROLLEY CONDUCTORS



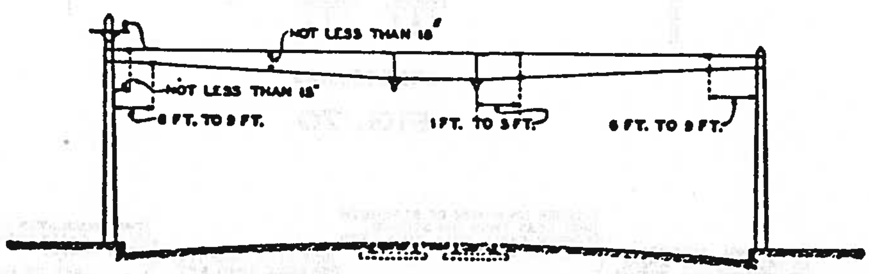
RULE 74.4-F

FIG.65



RULE 74.4-F

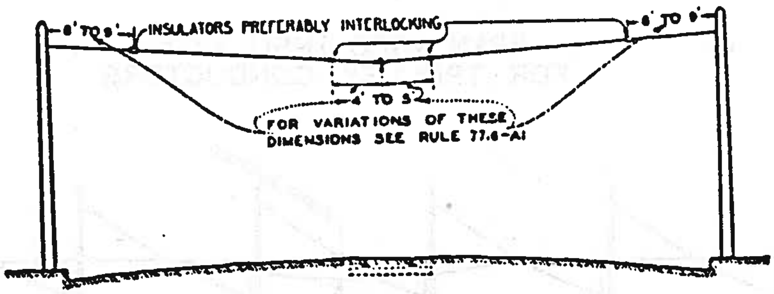
FIG.66



RULES 74.4-G3 AND 77.6-A5

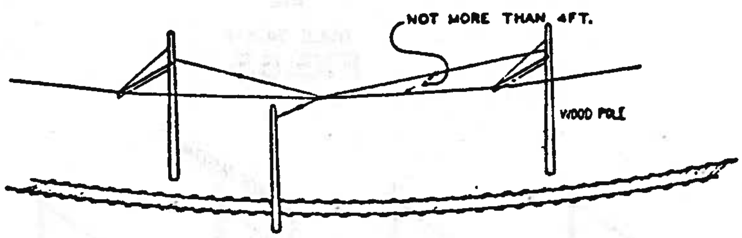
FIG. 67

SPAN WIRE INSULATORS FOR TROLLEY CONDUCTORS



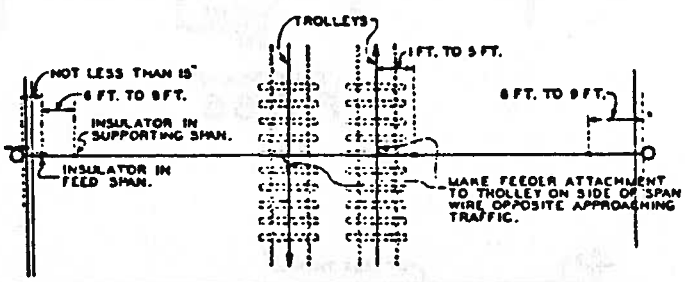
RULE 77.6-A1

FIG. 68



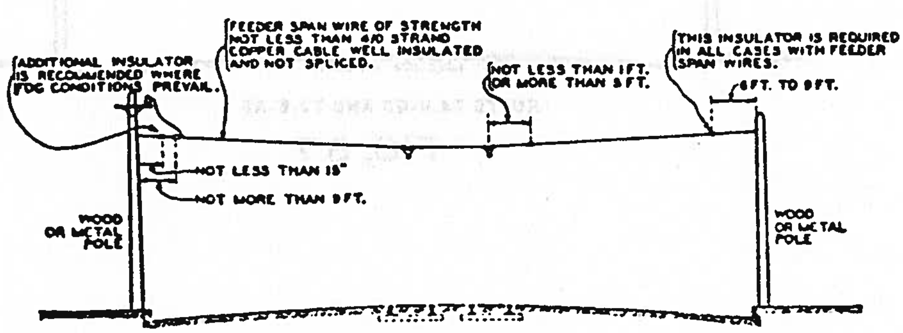
RULE 77.6-A1

FIG. 69



RULE 77.6-A5

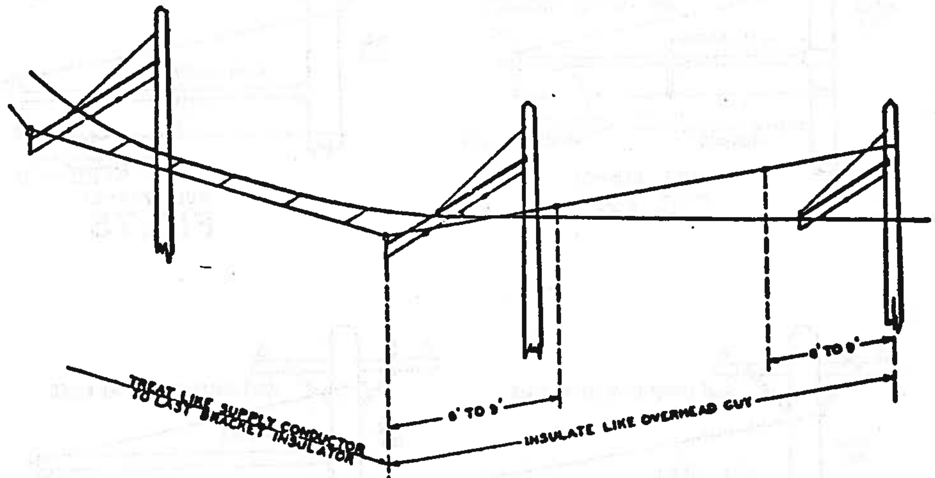
FIG. 70



RULE 77.6-A4

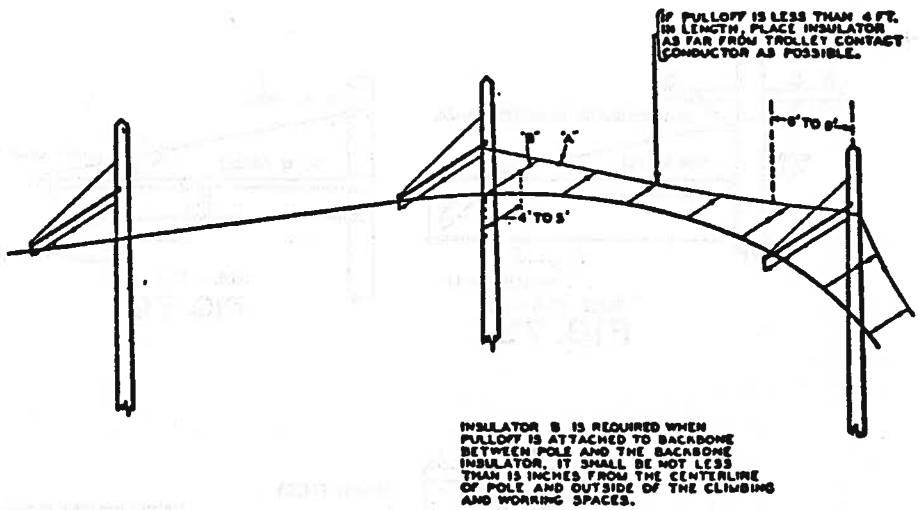
FIG. 71

INSULATION OF BACKBONES & PULLOFFS



RULE 77.6 - B1

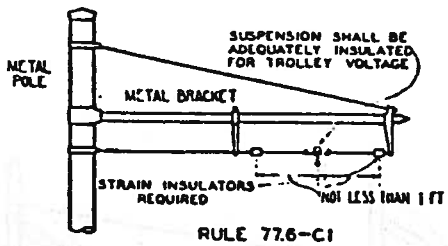
FIG.72



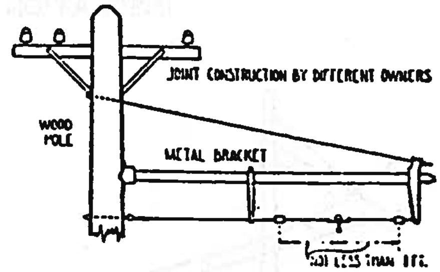
RULES 77.6-B2 AND 77.6-B3

FIG.73

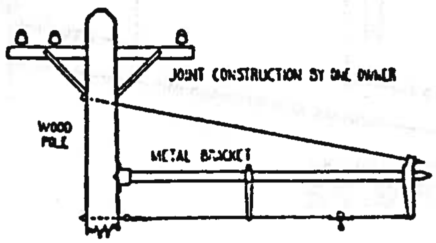
BRACKET WIRE INSULATORS FOR TROLLEY CONTACT LINES



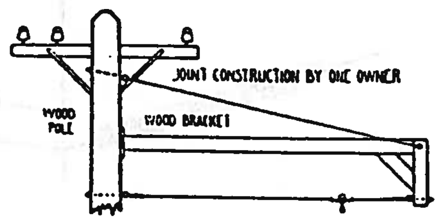
RULE 77.6-C1
FIG.74



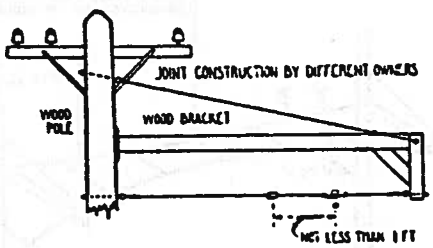
RULE 77.6-C1
FIG.75



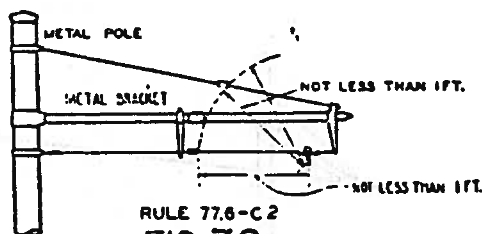
RULE 77.6-C2
FIG.76



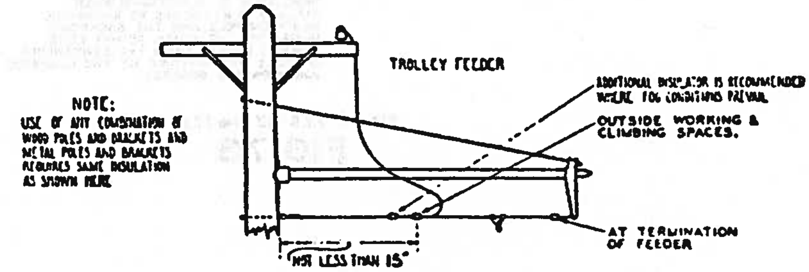
RULE 77.6-C2
FIG.77



RULE 77.6-C2
FIG.78



RULE 77.6-C2
FIG.79



RULE 77.6-C3
FIG.80

HARDWOOD GROUND MOULDING
RULE 22.2

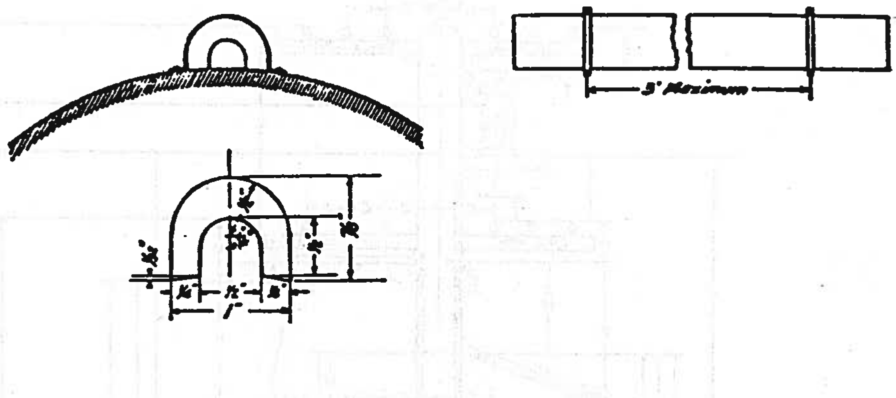


FIG. 81

PIPE OR CABLE COVERING
RULE 22.2

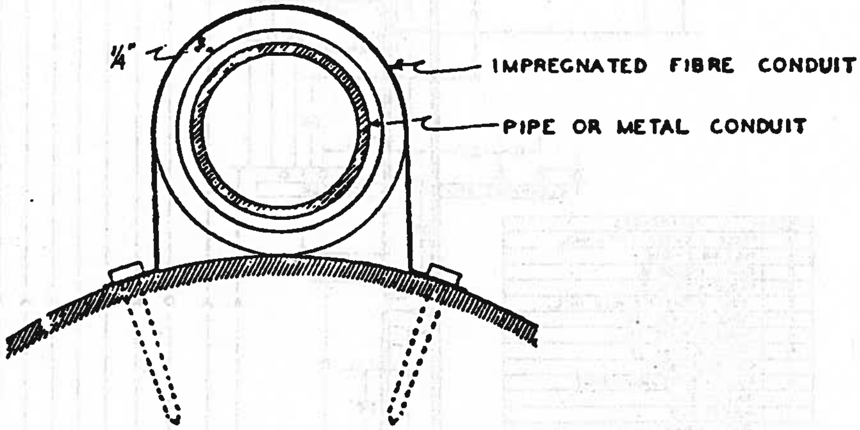
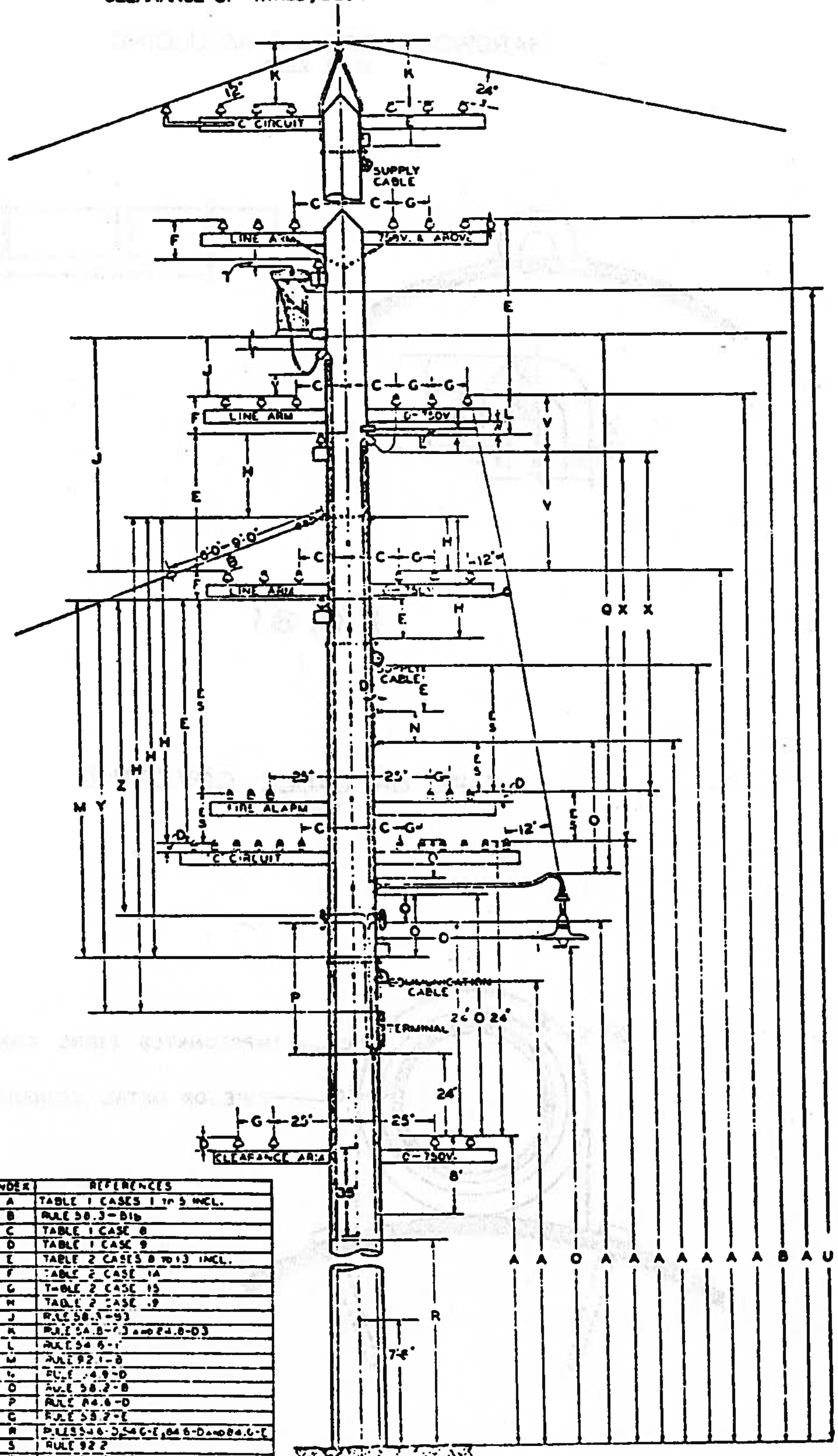


FIG. 82

CLEARANCE OF WIRES, EQUIPMENT ETC. ON POLES



INDEX	REFERENCES
A	TABLE 1 CASES 1 TO 5 INCL.
B	RULE 58.3-B1b
C	TABLE 1 CASE 8
D	TABLE 1 CASE 9
E	TABLE 2 CASES 8 TO 13 INCL.
F	TABLE 2 CASE 14
G	TABLE 2 CASE 15
H	TABLE 2 CASE 19
J	RULE 58.3-B3
K	RULE 54.8-C3 AND 84.8-D3
L	RULE 54.6-F
M	RULE 92.1-B
N	RULE 54.9-D
O	RULE 58.2-B
P	RULE 84.6-D
Q	RULE 58.2-E
R	RULES 54.6-D, 54.6-E, 84.6-D AND 84.6-E
S	RULE 92.2
T	RULE 58.3-B3d
U	RULE 58.3-B1b
V	RULE 54.4-C6
W	RULE 54.8-F
X	RULE 92.1-F3
Y	RULE 92.1-F
Z	RULE 84.8-B2b

FIG. 83

CLEARANCES OF COMMUNICATION
WIRES AND CABLES

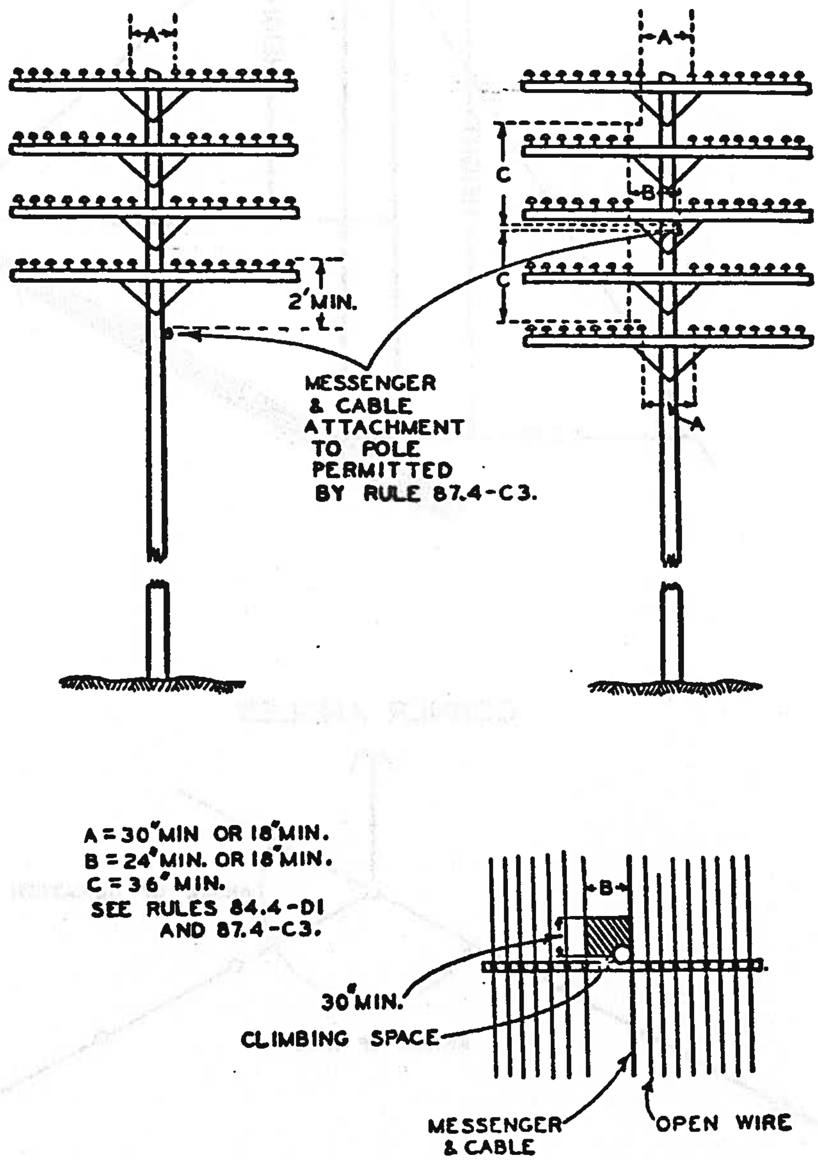
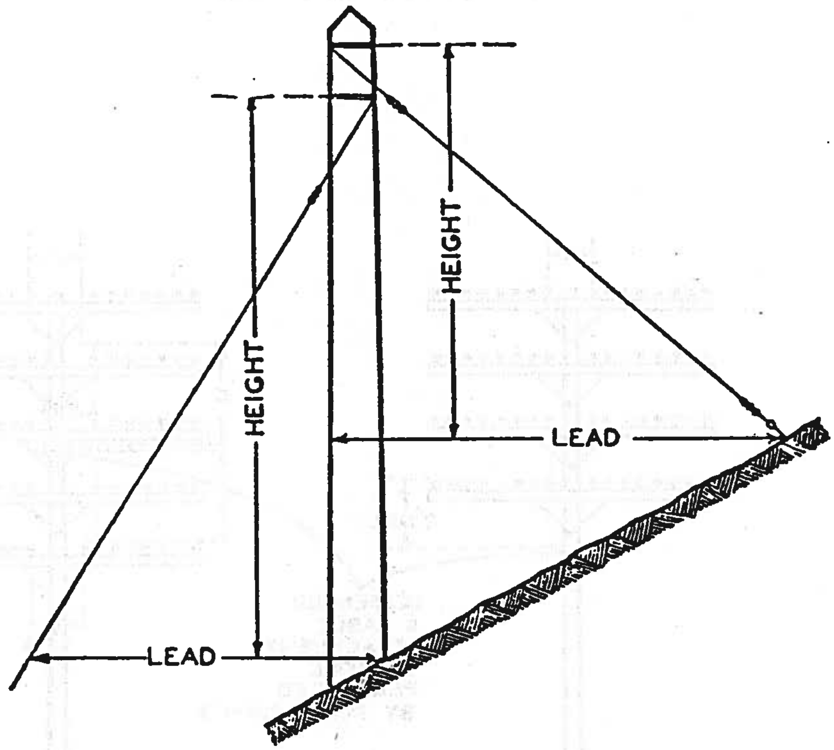


FIG. 84

GUYING TERMS

LEAD AND HEIGHT



CORNER ANGLES

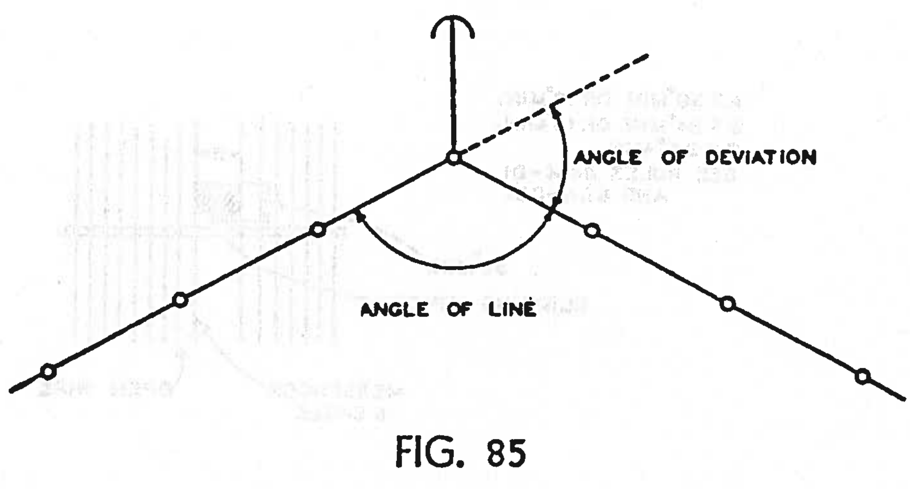
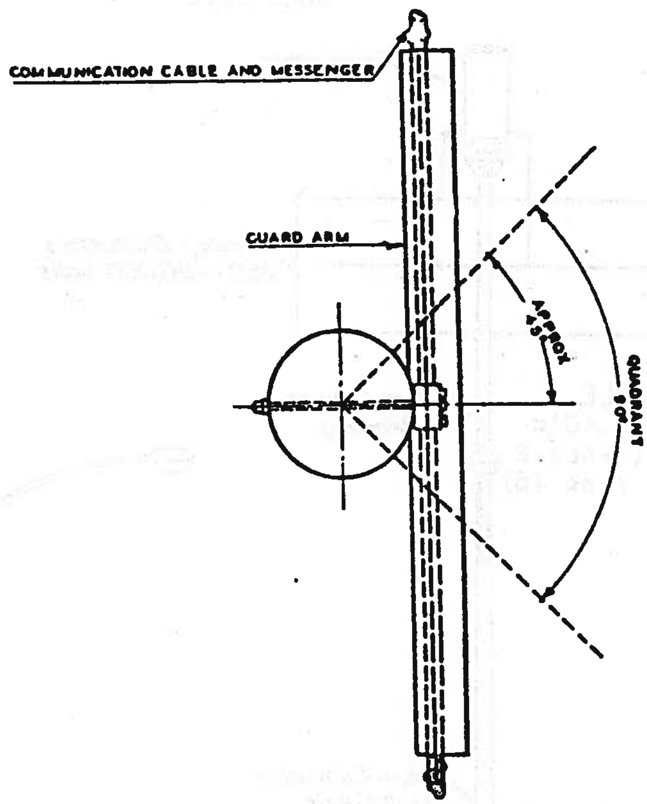


FIG. 85

QUADRANT OR SIDE OF POLE
FOR UNCOVERED RUNS OR RISERS
RULE 84.6-D



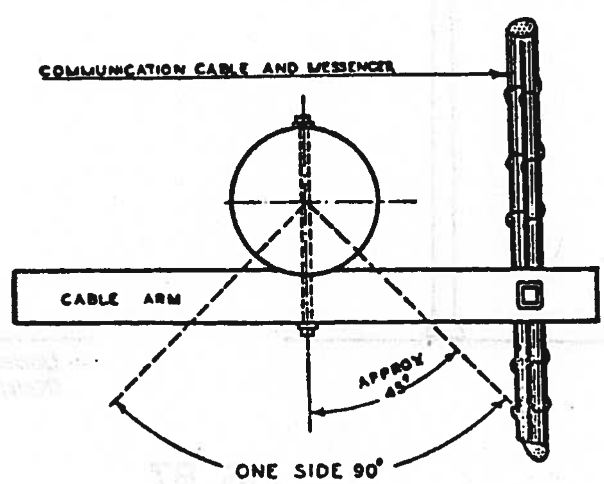


FIG. 86

APPENDIX G

PARTIAL UNDERGROUND

RULE 21.10

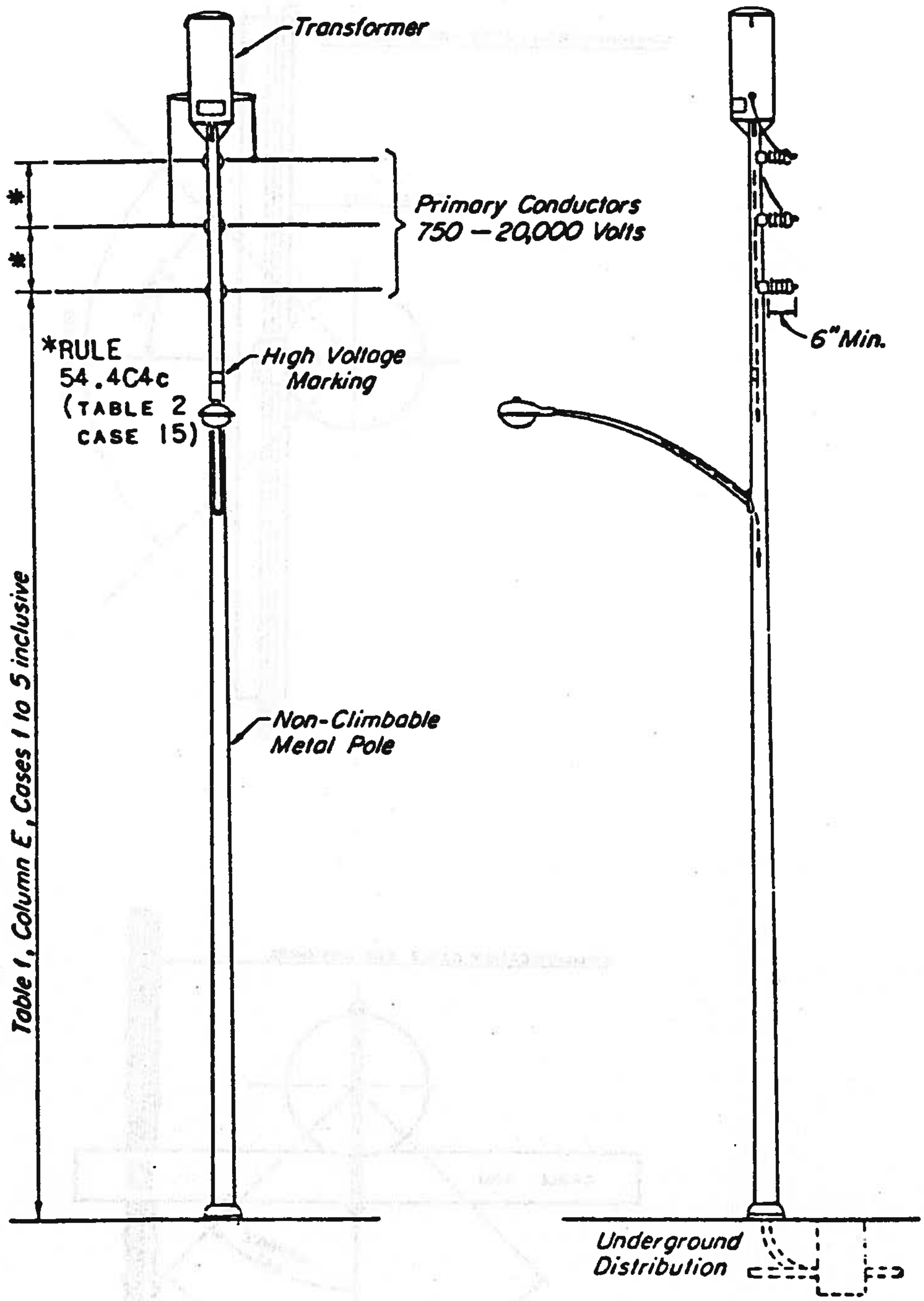
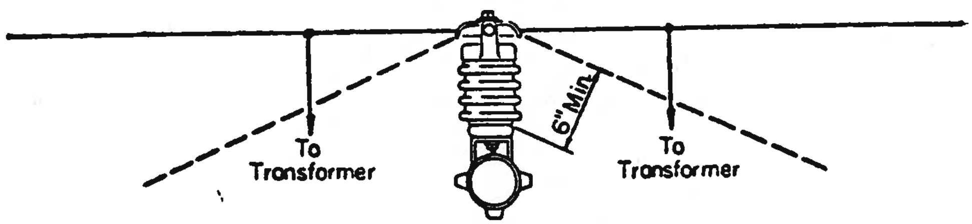
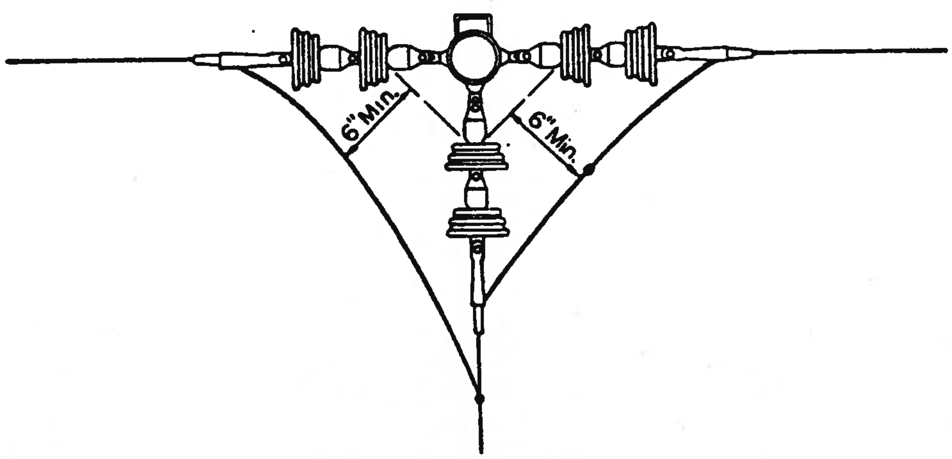


FIG. 87

CONDUCTOR CLEARANCE AND ARRANGEMENT
PARTIAL UNDERGROUND
RULE 54.4-D2



TANGENT CONSTRUCTION



DEADEND CONSTRUCTION

FIG. 88