

Decision No. 34884

ORIGINAL

BEFORE THE RAILROAD COMMISSION OF THE STATE OF CALIFORNIA

In the Matter of the Investigation on  
the Commission's own motion into the  
Reasonableness of the Rules for Overhead  
Electric Line Construction prescribed by  
General Order No. 64-A and Supplements  
1 and 2 thereto.

Case No. 4324

J. J. Duell, for California Farm Bureau Federation.  
James C. Marshall, for The Pacific Telephone and Telegraph  
Company and Southern California Telephone Company.  
R. W. DuVal, for Pacific Gas and Electric Company,  
San Joaquin Light and Power Corporation, and Midland  
Counties Public Service Corporation.  
Randolph Karr, Julian Adams, Frank Karr and E. L. H. Bissinger,  
for Pacific Electric Railway Company.  
E. E. Bennett and L. T. Jackson, for Union Pacific Railroad.  
Ernest Irwin, for California Independent Telephone Association.  
I. R. Dains, S. L. Foster and Charles Wagner, for Market  
Street Railway.  
Paul Lebenbaum, for Southern Pacific Company, San Diego  
and Arizona Eastern Railroad, Northwestern Pacific  
Railroad, Petaluma and Santa Rosa Railroad, Stockton  
Electric Railway and Visalia Electric Railway Company.  
A. C. Putnam, for Nevada-California Electric Corporation.  
L. M. Perrin, for Public Utilities Commission of San Francisco,  
Municipal Railway of San Francisco and Hetch Hetchy Water  
Supply.  
C. E. Fletcher, for Sierra Pacific Power Company, Reno, Nevada.  
F. A. Gift, for Western Union Telegraph Company.  
G. E. Jenner, for San Diego Gas and Electric Company.  
G. C. Larkin and W. E. Row, for Southern California Edison Company,  
Ltd.  
M. O. Bolser and A. L. Williams, for Bureau of Power and  
Light, Los Angeles.  
A. A. Smith, for Postal Telegraph-Cable Company.  
M. A. deLew, for Tidewater Associated Oil Company and their  
Subsidiaries and also for Industrial and Manufacturers of  
California.  
H. F. Neill, for Sacramento Northern Railway.  
W. H. Evans, for Sacramento Northern Railway Company and  
Tidewater Southern Railroad Company and Central California  
Traction Company.  
W. E. Adams, for Western Pacific Railroad Company, Tidewater  
Southern Railway Company and Central California Traction  
Company.  
C. W. Carpenter, for Western Pacific Railroad Company.  
George E. Kimball, for Industrial Accident Commission of the  
State of California.

L. B. Yeager, for Los Angeles Railway Corporation.  
 Donohue, Richards and Hamlin, for Key System and  
 East Bay Transit Company.  
 C. H. Rohrer, F. W. Bartholomew, and J. C. Macdonald,  
 for International Brotherhood of Electrical Workers  
 and Electrical Workers State Association.  
 L. E. Anderson, for City of Palo Alto and California  
 Municipal Utilities Association.  
 A. W. Cartmell, for the City of Pasadena.  
 G. E. Bishop, for Coast Counties Gas and Electric Company.  
 James A. Graham, for Department of Electricity, San Francisco.  
 C. E. Plummer, for Modesto Irrigation District.  
 Elbert E. Dick, for City of Redding.  
 C. R. Austin, for California Water and Telephone Company.  
 Arthur G. James, for City of Palo Alto.

RILEY, COMMISSIONER:

### O P I N I O N

The present investigation, instituted by the Commission upon its own motion, is an inquiry into the reasonableness of the rules governing the construction of overhead electric supply and communication lines, as contained in General Order No. 64-A, effective March 1, 1929, and in two supplements to that General Order which were issued in 1932 and 1934.<sup>(1)</sup> Revision of the rules appears desirable as many changes have occurred since their adoption, improvements have been made in the art of constructing lines and in the equipment used; supplemental modifications of the rules have been made and much experience has been gained in their application.

(1) Statutes 1911, chapter 499, prescribed certain regulations for the erection, use and maintenance of electric poles, wires, cables and appliances. That statute provided that it should take effect six months from the date of its passage, in so far as it related to new work, and allowed five years in which to reconstruct all then existing work and construction so as to comply with its provisions. In 1915 the Commission was empowered to grant extensions of time within which to reconstruct existing lines. (Statutes 1915, chapter 600; L.A. G. & E. Corp., 11 C.R.C. 291; Re Compliance Investigation, 22 C.R.C. 651.) The 1915 amendment also empowered the Commission "to make such further additions and changes as said commission may deem necessary for the purpose of safety to employees and the general public."

General Order No. 64 was adopted in 1922 (21 C.R.C. 659). It embodied modifications of earlier General Order No. 26 and contained numerous requirements, including and additive to those contained in the statute. The present General Order No. 64-A was adopted in 1928 (32 C.R.C. 524).

At the initial hearing in this matter on June 7, 1938, a General Committee<sup>(2)</sup> representing the various interested parties was formed to discuss and study the changes to be made in the rules and to assist the members of the Commission's staff in the redrafting. During the succeeding period of three years, members of this General Committee participated in 32 meetings, in which representatives of all interested parties took part, with the result that all operators of electric supply and communication lines of the various classes were afforded the opportunity of proposing, discussing and aiding in the drafting of new and changed provisions for a revised order. Thereafter, members of the Commission's staff prepared revised rules, in the form of a suggested general order, which were the subject of an extended (four days) meeting of the General Committee. After making some changes, this suggested general order was presented in evidence by members of the Commission's staff, at public hearings held on June 23, 24 and 25, 1941. Some objections and new recommendations were made by interested parties, following which further changes were made and offered in evidence at a public hearing held on

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(2) General Committee:

S. S. Bloom, Chairman	California Railroad Commission
L. R. Knerr	California Railroad Commission
F. A. Gift	Western Union Telegraph Company
T. J. Fleming	California Independent Telephone Assn.
D. I. Cone	The Pacific Telephone & Telegraph Co. and Southern California Telephone Co.
S. J. Lisberger	Pacific Gas and Electric Company
D. D. Smalley	San Joaquin Light & Power Corp.* and Midland Counties Public Service Corp.*
W. E. Row	Southern California Edison Company Ltd.
A. C. Putnam	The Nevada-California Electric Corporation**
A. L. Williams	Bureau of Power and Light, Los Angeles
B. F. DeLanty	Municipal Utilities, Pasadena
J. J. Deuel	California Farm Bureau Federation
C. H. Rohrer***	International Brotherhood of Electrical Workers & Electrical Workers State Assn.
G. E. Kimball	Industrial Accident Commission
S. L. Foster	Market Street Railway
Julian Adams	Pacific Electric Railway
M. A. deLew	Industrials

\* Now Pacific Gas and Electric Company

\*\* Now California Electric Power Company

\*\*\* Succeeded by F. W. Bartholomew and J. C. Macdonald

September 17, 1941, at which time the matter was submitted for decision.

Rules of the character here before the Commission, for modification and revision, find a wide application in public utility operation and service. In these respects, the rules not only provide a standard of safety, both to the workman and to the public, but likewise materially contribute to the standard of service rendered and also afford a means of coordination between different types of lines, such as power and communication.

Under the terms of the new general order, existing facilities, lawfully erected in accordance with earlier general orders, are permitted to be maintained according to the rules effective when such facilities were constructed or reconstructed, except as to certain safety factor requirements specified in Rule 12.2; but any lines constructed or reconstructed after the new general order becomes effective, must comply with the rules therein contained. In other words, the new general order does not require a complete and immediate reconstruction of existing lines installed prior to its effective date. Such an order would be unreasonable to operators and to the public alike. The new order, like its predecessors, is a part of a long-range progressive program designed to eventually bring all lines up to the standards required in new construction. Completion of that program is not economically feasible within a short period and, in fact, the revision of the order at this time clearly indicates that no program may be considered complete and static. There is another phase to the adoption of rules such as these, in that the rules must not only be practical, from a physical point of view, but likewise they must be within reasonable economic limits; otherwise costs to serve and consumer rates may be adversely and unreasonably affected. Having in mind these considerations, Rule 12.3 in the new general order permits prior construction to remain in service and provides as follows:

"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."



For reasons hereinabove indicated, the Commission is of the opinion that Rule 12.3 of the new general order (there is a similar provision in General Order No. 64-A) is a reasonable and necessary provision and that it would be unreasonable to order wholesale and immediate reconstruction of all existing overhead lines, as is sometimes urged. However, Rule 12.4 provides that if "in its opinion, safety or public interest requires, the Commission may order reconstruction or alteration of existing lines."

The form of the new general order is similar to that of its predecessor, General Order No. 64-A. Sections I to IV, inclusive, are generally applicable to all classes of electric lines, as specified in the detailed provisions thereof. Section V embodies rules for supply lines (including trolley system lines); Section VI for tower lines; Section VII for trolley lines; Section VIII for communication lines; and Section IX provides special rules for all classes of lines on joint poles, while the rules of other sections provide the ordinary rules which apply to the several classes of lines when placed on joint poles. Furthermore, in addition to modifications of rules of General Order No. 64-A, the new rules contain some provisions which have not appeared in any previous orders. Broadly speaking, the changes to be incorporated in the new order will be both more and less restrictive, according to the conditions and situations obtaining.

The order instituting investigation states that one of the purposes of the investigation was to consider the procedure to be followed in obtaining authority to deviate from the rules and the conditions under which such authority may be granted. In this respect Rule 15 of the new order provides, in substance, that the Commission will consider applications which contain a full statement of existing conditions, together with the reasons why

authority to deviate is requested and is believed to be justifiable. That rule also provides that, unless otherwise ordered, authority to deviate will be limited to the particular case or the specific type of construction covered by the application. (3)

Three of the larger operators have requested that the new general order not be made effective until six months after promulgation, primarily because of the national defense situation. In view of the war development and the heavy demand being placed upon the utilities, it is my opinion that the request is reasonable and the order will provide an effective date of July 1, 1942. I recommend the following order.

C O R D E R

The Commission, on its own motion, having instituted an investigation into the reasonableness of rules governing overhead line construction, said investigation having been submitted following the taking of evidence at public hearings and, based upon the record and upon the findings contained in the foregoing opinion, it is hereby further found that the rules governing overhead line construction contained in the attached General Order No. 95 are reasonable and should be adopted, and

IT IS HEREBY ORDERED that said General Order No. 95, attached hereto, be and it is hereby adopted. Said General Order No. 95 shall supersede General Order No. 64-A, shall apply to all overhead electric supply and communication lines coming within the jurisdiction of this Commission, and shall become effective on July 1, 1942.

The foregoing opinion and order are hereby approved and filed as the opinion and order of the Railroad Commission of the State

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(3) Such applications, of course, should comply with the Commission's Rules of Procedure.

of California.

Dated, San Francisco, California, December 23, 1941.

W. L. Riley  
W. L. Riley  
James F. Cooney  
Francis J. Haver  
Richard Kach

Commissioners

*Original Copy*  
*H. H. Macdonald*

GENERAL ORDER No. 95

*sec*

RAILROAD COMMISSION  
Of The  
STATE OF CALIFORNIA

Rules For  
OVERHEAD ELECTRIC LINE  
CONSTRUCTION

Adopted December 23, 1941.

Effective July 1, 1942

Decision No. 34884, Case No. 4324

San Francisco, California

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## SECTION I

### GENERAL PROVISIONS

#### 11. PURPOSE OF RULES

The purpose of these rules is to formulate, for the State of California, 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 hereafter 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.

*Original Copy*  
*J. H. Matheson*

GENERAL ORDER No. 95 *see*

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Of The  
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### GENERAL PROVISIONS

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#### 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 hereafter 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.



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DEFINITIONS OF TERMS AS USED IN THE RULES  
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## SECTION II

DEFINITIONS OF TERMS AS USED IN THE RULES  
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- 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 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 5000 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. The provisions for the use of these various types of coverings are specified in certain of these rules.

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 (see Rules 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.

**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 and which generally is not a part of the conducting system, its primary function being to support wires or cables of the conducting system; sometimes called "suspension strand."

## **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.

**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 having the electrical insulating efficiency and mechanical strength of  $1\frac{1}{2}$  inches of redwood, or hardwood moulding (oak or rock elm) three-eighths of an inch in thickness or having a cross section as shown in Figure S1 of Appendix G, or as otherwise authorized by the Railroad Commission. Impregnated fiber conduit having a wall thickness of not less than one quarter of an inch and installed over metal conduit meets the requirements of



this definition when installed in a workmanlike manner as illustrated in Figure 82 of Appendix G.

**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 60° 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 60° 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.

**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.

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**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 II circuits shall not occupy both sides of thoroughfares except where special permission is obtained from the Railroad Commission.

#### **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.

#### **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 OF 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  $1\frac{1}{2}$  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, service drops are not supported on arms which support conductors of 7500-20,000 volts, and conductors on related buck arms are not less than 4 feet vertically from such bus timbers.
- (3) **0-750 VOLTS AND 750-7500 VOLTS:** Supply circuits of 0-750 volts and 750-7500 volts which are owned and operated by the same utility may be carried on opposite ends of 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 Rules 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 36 inches, provided proper ownership designation is maintained.
- (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 5000 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 nomi-

nal 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 poly-phase 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 750-5000 volts may be interconnected and grounded in accordance with the provisions of Rule 59; and

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

A ground connection 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-C are met. The clearance requirements of General Order 26-C, 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, 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.

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.

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 messenger	Communication conductors (including open wire, cables and service drops), supply service drops of 0-750 volts	Trolley contact, feeder and span wires, 0-3000 volts	Supply conductors of 0-750 volts, and supply cables treated as in Rule 87.2	Supply conductors and supply cables, 750-20,000 volts	Supply conductors and supply cables, more than 20,000 volts
1	Crossing above tracks of railroads which transport or propose to transport freight cars (max. height 15 ft. 4 in.) where not operated by overhead contact wires. (a) (b) (c) (d)	25 ft.	25 ft.	22 ft.	25 ft.	25 ft.	24 ft.
2	Crossing or paralleling above tracks of railroads operated by overhead trolleys. (b) (c) (d)	26 ft. (c)	26 ft. (c) (f) (g)	12 ft. (h) (i)	27 ft. (c) (d)	30 ft. (c)	24 ft. (c)
3	Crossing or along thoroughfares in urban districts or crossing thoroughfares in rural districts. (c) (d)	18 ft. (f) (h)	15 ft. (f) (f) (m)	19 ft.	20 ft.	25 ft. (a) (c)	20 ft. (c)
4	Above ground along thoroughfares in rural districts or across other areas capable of being traversed by vehicles or agricultural equipment.	15 ft. (h)	15 ft. (m) (a) (p)	19 ft.	16 ft.	25 ft. (a) (c)	20 ft. (c) (p)
5	Above ground in areas accessible to pedestrians only.	7 ft.	10 ft. (m) (q)	19 ft.	12 ft.	17 ft.	25 ft. (c)
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. (p)	8 ft. (p)	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. (a) (i)	-----	1 ft. (a)	2 ft.	2 ft. (a) (v)	4 ft. (v)	8 ft. (v)

Requirements for All Times



# Requirements for All Lines

	15 in. (3) (aa)	15 in. (aa) (bb)	15 in. (aa) (dd)	15 or 15 in. (dd) (cc)	11 in. (dd) (ee)
	3 in. (aa) (f)	3 in. (aa) (cc)	3 in. (aa) (dd)	3 in. (dd) (dd)	3 in. (dd) (dd)
Distance of conductors from center line of pole, whether attached or unattached. (a) (b) (c)					
Distance of conductors from surface of pole, crossarm or other overhead line structure upon which it is supported, providing it complies with Case 8 above. (a) (c)					

References to Rules Modifying Minimum Clearances in Table 1

	Rule	Page	Rule	Page
(a) Shall not be reduced more than 5% because of temperature or loading.	37.	35	(b) May be reduced along thoroughfares where not normally accessible by vehicles.	
1. Supply lines.	34-B1	35	1. Supply lines.	34-A1
2. Communication lines.	34-B1	35	2. Communication lines.	34-A1
(c) Shall be increased for supply conductors on suspension insulators under certain conditions.		120	(d) May be reduced where within 12 feet of curb line of public thoroughfare.	
(e) Special clearances not provided for traffic signal equipment.	37.	35	1. Supply service drops.	34-B1
(f) Special clearances not provided for street lighting equipment.	34-B1	35	2. Communication service drops.	34-B1
(g) Based on trolley pole throw of 35 feet. May be reduced where trolley protected.	34-B1	35	(e) May be reduced for trolley signal cables under special conditions.	34-A1
1. Supply lines.	34-B1	35	(f) May be reduced in rural districts.	
2. Supply cables and messenger.	34-B1	35	1. Supply conductors, 750-20,000 volts, crossing roads or drive-ways.	34-A2a
3. Communication lines.	34-B1	35	2. Supply conductors, 750-20,000 volts, above agricultural areas and along easements.	34-A2b
4. Communication cables and messenger.	34-B1	35	3. Communication conductors along roads.	34-A3
(h) May be reduced depending on height of trolley contact conductors.	34-B1	35	(g) May be reduced for transformer, regulator or capacitor leads.	
1. Supply service drops.	34-B1	35	1. Transformer leads.	34-B1a
2. Communication service drops.	34-B1	35	2. Regulator or capacitor leads.	34-B1b
(i) May be reduced and shall be increased depending on trolley throw.	34-B1	35	(h) May be reduced across arid or mountainous areas.	
1. Supply conductors (except service drops).	34-B1	35	1. Supply conductors of more than 20,000 volts.	34-B1c
2. Communication conductors (except service drops).	34-B1	35	2. Communication conductors.	34-B1d
(j) Shall be increased where freight cars are transported.	34-B1	35	(i) Shall be increased or may be reduced under special conditions.	
1. Trolley contact and feeder conductors.	34-B1	35	1. Increased for supply service drops on industrial or commercial premises.	34-B1e
2. Trolley area wire.	34-B1	35	2. Supply service drops on residential premises.	34-B1f
(k) May be reduced for trolley contact and span wire in subway, tunnel and under bridges.	34-B1	35	3. Increased for communication service drops on industrial or commercial premises.	34-B1g
1. Trolley contact conductors.	34-B1	35	4. Increased for communication service drops on residential premises.	34-B1h
2. Trolley span wire.	34-B1	35	5. Communication service drops on residential premises.	34-B1i
(l) May be reduced at crossings over private thoroughfares and entrances to private property and over private property.	34-B1	35		
1. Supply service drops.	34-B1	35		
2. Supply lines.	34-B1	35		
3. Communication service drops.	34-B1	35		
4. Communication lines.	34-B1	35		

(Continued on next page)

## References to Rules Modifying Minimum Clearances in Table 1—Continued

	Rule	Page
(r) May be reduced above roofs of buildings under special conditions.		
1. Supply overhead guys.....	54.4-G	134
2. Supply service drops.....	54.4-B4	119
3. Communication overhead guys.....	54.4-F	221
4. Communication conductors and cables.....	54.4-E	204
5. Communication service drops.....	54.4-C4	214
(s) Also applies at fire escapes, etc.		
1. Supply conductors.....	54.4-H1	106
2. Supply service drops on industrial or commercial premises.....	54.4-B4a	119
3. Supply service drops on residential premises.....	54.4-B4b	120
4. Communication conductors.....	54.4-E	204
(t) Special clearances where attached to buildings, bridges or other structures.		
1. Supply conductors of 750-20,000 volts.....	54.4-H3	106
2. Trolley contact conductors.....	74.4-E	174
3. Communication conductors.....	54.4-F	203
(u) Reduced clearances permitted under special conditions.		
1. Supply service drops on industrial or commercial premises.....	54.4-B4a	119
2. Supply cables grounded.....	57.4-O	141
3. Communication cables beside buildings, etc.....	54.4-E	204
4. Communication conductors under bridges, etc.....	54.4-F	203
5. Communication service drops.....	54.4-C4	214
(v) May be reduced under special conditions.		
1. Supply conductors of 750-7500 volts.....	54.4-H1	106
2. Supply transformer lead and bus wires, where guarded.....	58.4-B9	148
(w) May be reduced at angles in lines and transportation points.		
1. Supply conductors.....	54.4-D1	100
2. Communication conductors.....	54.4-D5	204
(x) May be reduced for suitably protected lateral or vertical runs.		
1. Supply bond wires.....	53.4	91
2. Supply ground wires.....	54.4-B	108
3. Supply lateral conductors.....	54.4-C	103
4. Supply vertical runs.....	54.4-D	102
5. Supply risers.....	54.4-E	109
6. Communication ground wires.....	54.4-B	206
7. Communication lateral conductors.....	54.4-C	206
8. Communication vertical runs.....	54.4-D	206
9. Communication risers.....	54.4-E	207

	Rule	Page
(y) Increased clearances required for certain conductors.		
1. Unattached conductors on collinear and crossing lines.....	53.3	90
2. Unattached supply conductors.....	54.4-D3	101
3. Supply service drops on clearance crossarms.....	54.4-C9	222
4. Supply service drops on pole top extensions.....	54.4-C8	223
5. Unattached supply service drops.....	54.4-D	123
6. Communication lines, collinear, conflicting or crossing.....	54.4-D3	203
7. Communication conductors passing supply poles and unattached thereto.....	54.4-D4	204
8. Communication service drops on clearance crossarms.....	54.4-D2	214
9. Communication service drops on pole top extensions.....	54.4-D3	216
10. Unattached communication service drops.....	54.4-E	217
(z) Special provisions for police and fire alarm conductors require increased clearances.....	51.3	211
(aa) May be reduced under special provisions.		
1. Supply conductors of 0-750 volts in rack configuration.....	54.4-D5	101
2. Supply service drops from racks.....	54.4-F	124
3. Supply cables and messengers attached to poles.....	57.4-F	140
4. Communication conductors on communication poles.....	54.4-D	201
5. Communication conductors on crossarms.....	54.4-D1	203
6. Communication conductors attached to poles.....	54.4-D2	203
7. Communication service drops attached to poles.....	54.4-B	213
8. Communication cables and messengers.....	57.4-D	129
9. Supply or communication cables and messengers on jointly used poles.....	51.1-B	235
10. Communication open wire on jointly used poles.....	51.1-C	239
(bb) May be reduced for Class T conductors of not more than 750 volts and of the same potential and polarity.....	74.4-D	175
(cc) Not applicable to trolley span wires.....	74.4-E	179
(dd) Special clearances for pole-top and dead-end construction.		
1. Conductors dead-ended in vertical configuration on poles.....	54.4-C4	99
2. Conductors dead-ended in horizontal configuration.....	54.4-D7	102
3. Conductors in pole-top construction.....	54.4-D5	103
(ee) Clearance requirements for certain voltage classifications.....	54.4-D3	101
(ff) Not applicable to communication conductors.....	54.4-D	201
(gg) Clearance from crossarms may be reduced for certain conductors.		
1. Suitably insulated leads to protected runs.....	54.4-E	103
2. Leads of 0-5000 volts to equipment.....	54.4-E	103
3. Leads of 0-5000 volts to entours or switches.....	54.4-C	154

### **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.

### Requirements for All Lines

**TABLE 2**  
Basic Minimum Allowable Clearance of Wires from Other Wires at Cornings and at Supports  
(Letter References Denote Modifications of Minimum Clearances as Referred to in Notes Following this Table)  
All Clearances Are in Inches

[illegible]

	3 (c)	10 1/2 (A, a)	10 1/2 (c)	10 1/2 (c)	34 (a)	34	43 (a)
15 Horizontal separation of conductors on same crossarm 1/16 spacing of longitudinal conductors, vertical con- ductors and service drops (a, w).							
16 Radial separation of conductors on same crossarm, pole or structure - incidental pole wiring	3 (c)	10 1/2 (A, a)	10 1/2 (c)	10 1/2 (c)	34 (a)	34	43 (a)
17 Conductors, taps, or lead wires of different circuits (a, x, y)	3 (c)	10 1/2 (A, a)	10 1/2 (c)	10 1/2 (c)	34 (a)	34	43 (a)
18 Conductors, taps, or lead wires of the same circuit (a, x, y)	3	3	6	6	12	12	24
19 Radial separation between guys and conductors Guys passing conductors supported on other poles, and guys systematically parallel to conductors supported on the same pole	3 (c, d)	12	15	15	30	30	36
Guys and span wires passing conductors supported on the same pole	3	3	6	6	12	12	34

References to Rules Modifying Minimum Clearances in Table 2

	Rule	Page		Rule	Page
(a) The clearances in column D are also applicable to supply cables of any voltage under certain conditions	57.4	133	(f) Increased clearance required over trolley contact conductors of 750-1000 volts	14.4-G1	117
(b) Clearances for guys and span wires apply vertically at crossings; see Case 15 for radial clearances from conductors			(g) Shall be increased for conductors of more than 50,000 volts		127
1. Supply guys and span wires from conductors	56.4-O	131	1. Conductors not supported on the same pole	51.4-C7a	130
2. Supply guys and span wires from guys and span wires	56.4-D1	132	2. Conductors supported on the same crossarm, pole or structure	51.4-C7b	130
3. Communication guys and span wires from conductors	56.4-O	133	(h) May be reduced for certain conductors of Class T elements of the same system	14.4-O	115
4. Communication guys and span wires from guys and span wires	56.4-D1	130	(i) May be reduced for service drops under special conditions		136
(c) Not applicable between messengers or span wires of the same system			1. Supply service drops and communication line conductors	51.4-C1a	127
1. Supply messengers	57.4-E	140	2. Supply service drops and communication service drops	51.4-C4	127
2. Trolley span wires	57.4-D	139	3. Communication service drops and supply line conductors	51.4-D1a	115
3. Communication messengers	57.4-O	139	4. Communication service drops and supply service drops	51.4-D1	115
(d) Protection required on guys, span wires, messengers, and cables where within trolley throw			(j) May be reduced or shall be increased for certain communication conductors or cables		127
1. Supply guys and span wires	56.4-B2	131	1. Open wire conductors attached to poles, within 3 feet of top-most conductor	51.4-C1a	201
2. Supply messengers and cables	57.4-B2	133	2. Line conductors of poles or fire-arm circuits and service drops from other communication circuits	51.4-D1b	115
3. Communication guys and span wires	56.4-B2	132	3. Cables and messengers attached to poles	57.4-C3	127
4. Communication messengers	57.4-B2	137			
(e) Not applicable to certain conductors supported on trolley span wires	14.4-O	117			
1. Trolley contact and feeder conductors	72.1	164			
2. Trolley feeder conductors	72.1	164			
3. Trolley system communication conductors	72.1	163			
4. Foreign conductors	72.1	163			

(Continued on next page)

## References in Rules Modifying Minimum Clearances in Table 2—Continued

Rule	Page	Rule	Page
(d) Special clearance for 0-750 volt conductors in rack configuration and messenger and cables attached to poles.	125	(c) Shall be increased where conductors of different classifications are supported on the same crossarm.	
1. Supply conductors of 0-750 volts in rack configuration.	54-B	1. Supply conductors of 0-750 volts and conductors of 7500-100,000 volts.	31-A, 31
2. Supply cables and messenger attached to poles.	54-B	2. Supply conductors of 0-750 volts and conductors of 750-1500 volts.	31-A, 31
3. Communication cables and messengers attached to poles.	54-C3	(c) Not applicable to certain kinds of conductors.	
4. On jointly used poles.	54-B	1. Supply conductors of same phase or polarity.	31-A, 31
(e) May be reduced for service drops, and poles or fire-alarm conductors, under special conditions.	125	2. Installed on poles or cross-arms in multiple-conductor cables.	31-A, 31
1. Supply service drops and communication line conductors.	54-B, 54-C1b	3. Communication installed conductors or multiple-conductor cables.	31-A, 31
2. Supply service drops on clearance arms.	54-B, 54-C3	(d) Shall apply to fully bonded conductors or conductors attached to crossarms.	
3. Supply service drops on pole-top attendances.	54-B, 54-C3	1. Supply conductors.	31-A, 31
4. Supply service drops and communication service drops.	54-B, 54-C4	2. Communication conductors.	31-A, 31
5. Communication service drops and poles, fire-alarm or supply line conductors.	54-B, 54-D1b	(e) Shall be handled between conductors of different classification supported on the same crossarm.	
6. Communication service drops on pole-top attendances.	54-B, 54-D3	1. Supply conductors of different voltage classifications.	31-A, 31
7. Communication service drops and supply service drops.	54-B, 54-D4	2. Supply conductors of 0-750 volts and communication circuits.	31-A, 31
8. Poles or fire-alarm conductors.	54-B	3. Supply circuits and private communication circuits.	31-A, 31
(f) May be reduced for lead wires.	88	(f) Special clearance for unprotected supply conductors from one level to another level.	
1. Supply lead wires above supply conductors.	54-B, 54-C4	1. Supply conductors.	31-A, 31
2. Supply drop drops above communication conductors.	54-B, 54-F3	2. Communication conductors.	31-A, 31
(g) May be reduced for supply conductors and private communication conductors of the same ownership.	240	(g) Not applicable to the following:	
1. Supply conductors.	54-B, 54-C4	1. Clearances between conductors at different levels specified in Cases 1 to 11 inclusive.	
2. Supply drop drops above communication conductors.	54-B, 54-F3	2. Supply conductors, mainly protected.	31-A, 31
(h) May be reduced or shall be increased for triangular or vertical configuration or for pole-top construction.	233	3. Supply circuits, mainly protected.	31-A, 31
1. Triangular or vertical configuration on crossarms.	54-B, 54-C4	4. Communication conductors.	31-A, 31
2. Dressed to pole in vertical configuration.	54-B, 54-C4	(h) Not applicable between cables and their supporting messengers.	
3. Conductors of 0-750 volts in triangular configuration at top of pole.	54-B, 54-D3b	1. Supply conductors.	31-A, 31
4. Conductors of more than 7500 volts at top of pole.	54-B, 54-D3b	2. Communication conductors.	31-A, 31
(i) May be reduced for supply service drops of 0-750 volts.	103	(i) May be reduced for communication guys and communication conductors supported on the same poles.	
(j) Shall be increased between circuits where conductors of more than 7500 volts are at pole top.	104	(j) Clearances required between guys.	
(k) May be reduced under special conditions.	104	1. Supply guys crossing.	31-A, 31
1. Supply conductors of 7500-100,000 volts.	54-B, 54-C1a	2. Supply guys approximately parallel.	31-A, 31
2. Supply conductors of 7500-100,000 volts.	54-B, 54-C1b	3. Communication guys or messengers.	31-A, 31
(l) Does not apply where conductors do not cross.	87	4. Communication guys approximately parallel.	31-A, 31
1. Supply conductors of different phase or polarity.	54-B, 54-C1a	(k) Shall be increased where within 6 feet of a pole.	
2. Communication conductors.	54-B, 54-C1b		
(m) Shall not be applied consecutively both above and below the same supply conductors.	200		
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## SECTION IV

## STRENGTH REQUIREMENTS FOR ALL CLASSES OF LINES

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## 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 B
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.....	"C"
C.....	Under all conditions not required to be Grade "A," "B," or "C".....	"C"

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

## 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 the Railroad 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 California where the elevation exceeds 3000 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 California where the elevation above sea level is 3000 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:

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	3	2	2	2
Noninterlocking	3	2	3	
Guy, except in light loading rural districts	2	2	3	$1\frac{1}{2}$
Guy, in light loading rural districts	2	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$
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	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	
Foundations against uplift	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	
Foundations against depression	3	3	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 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	
	Sawn rectangular poles, crossarms, etc. (a)	Round poles
Cedar, western red.....	4,700 lbs. per sq. in.	5,600 lbs. per sq. in.
Douglas fir, dense.....	5,300 lbs. per sq. in.	6,800 (b) lbs. per sq. in.
Douglas fir, not dense.....	5,000 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.....	5,300 lbs. per sq. in.	6,800 (b) lbs. per sq. in.
Pine, southern yellow, not dense.....	5,000 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, C5.6-1941 for Douglas Fir Poles (creosoted) and C5.4-1941 for Southern Pine Poles (creosoted), this value may be increased to not more than 7,400 lbs. per square inch.

##### 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 durability 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, Q5.2-1941, Q5.4-1941 or Q5.6-1941, 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)

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, double crossarms shall be used to permit conductor fastenings at two insulators and thus retard slipping.

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 Rules 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  $1\frac{1}{2}$  inches.
- (2) METAL PINS: The minimum diameter of the shank shall not be less than  $\frac{1}{2}$  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 composition 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 1½ by 9 inch locust pin will usually provide cantilever strength up to 1000 pounds tension in the conductor with the conductor 3½ 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, double pins and insulators shall be used and each line conductor shall be tied or fastened to both insulators so as to prevent slipping of the conductor under the maximum working tension with a safety factor of 2 under the temperature and 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 2  
Minimum Conductor Sizes (150-foot spans or less)

Loading condition and grade of construction	Material or type of conductor					Galvanized iron or galvanized steel
	Soft or annealed copper	Hard-drawn or medium-hard-drawn copper	Stranded aluminum	Aluminum cable, steel-reinforced	Copper-coated steel wire or composites	
<b>HEAVY LOADING</b>						
Grade "A".....	4	6	1	4	6	1/2-in. diam. strand
Grade "B" (a) (h).....	4	6	1	6	8	9 BWG
Grade "C" (h).....	4	6	1	6	8	9 BWG
<b>LIGHT LOADING</b>						
Grade "A".....	4	6	1	4	8	1/2-in. diam. strand (b)
Grade "B" (a) (e) (h).....	6	6	1	6	8	9 BWG
Grade "C" (e) (h).....	6	8	1	6	10	9 BWG
<b>HEAVY AND LIGHT LOADING</b>						
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 the Railroad 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 32.3-F and 32.3-C.  
 (e) No. 12 AWG or No. 14 NBK.  
 (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-C5.

## 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) **SPICES:** 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. Supply service drops of 0-750 volts shall, in all cases, have a weather-resistant covering equivalent to standard double braid weatherproofing.

- b) *Communication*: Communication service drops of No. 16 AWG paired copper wire may be used, provided they do not cross over supply lines, trolley contact or feeder conductors, or railways.
- Paired wire communication service drops of No. 18 AWG high strength bronze or high strength copper-covered steel may be used provided the breaking strength of the pair is not less than 340 pounds.
- (8) *COMMUNICATION LINE CONDUCTORS*: Paired wire of No. 18 AWG high strength bronze or high strength copper-covered steel may be used as communication line conductors provided the breaking strength of the pair is not less than 340 pounds.

**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 Medium-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
Brass.....	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.

### 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.

### 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.

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**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  $2\frac{1}{2}$  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 of corrosion-resisting metal 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 corrosion-resisting metal 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 support-

ing conductors of constant current 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  $1\frac{1}{2}$  inches from lead wires, ground wires, and bond wires (except as provided in Rule 53.4), metal pins and other insulator hardware, switch and cutout 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  $1\frac{1}{2}$  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  $1\frac{1}{2}$  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  $1\frac{1}{2}$  inches from metal pins and dead-end hardware. Guys and space bolts shall have a clearance of not less than  $1\frac{1}{2}$  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.

#### 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



top circuit position of the pole may be installed on the face, back or under side 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 under side 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  $1\frac{1}{2}$  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.

(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 (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  $1\frac{1}{2}$  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

## 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 the Railroad 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 Rules 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.

## **B. ABOVE RAILWAYS AND TROLLEY LINES**

- (1) **WHICH TRANSPORT FREIGHT CARS:** The clearances specified in Table 1, Case 1, Columns C, D, E, and F are based upon the maximum height of standard freight cars, 15 feet 1 inch from top of rail to top of running board. These clearances 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 crossarm 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.

is maintained as great as practicable and in no case less than the following:

<i>Voltage of lead wires</i>	<i>Minimum distance above other conductor level</i>
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  $\frac{1}{2}$  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  $\frac{1}{2}$  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 clearances 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 $\frac{1}{2}$ -inch per kv in excess of 46 kv.

- (3) CONDUCTORS PASSING AND UNATTACHED: The center-line clearance between poles and conductors which pass unattached shall be not less than  $1\frac{1}{2}$  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 cross-arms 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  $2\frac{1}{2}$  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.



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 30 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 24 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 36 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:

<i>Highest voltage classification of conductors concerned</i>	<i>Minimum radial distance between conductors</i>
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 56.2-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  $1\frac{1}{2}$  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.

## C. LATERAL CONDUCTORS

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.

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 crossarms, as specified in Table 1, Cases 8 and 9, provided such conductors are suitably insulated and are protected by impregnated fiber conduit attached to the bottom surface of crossarm. The wood moulding or fiber conduit required for protection in accordance with this Rule 54.6-C shall extend 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.

The radial clearances between conductors, specified in Table 2, Cases 16 and 17, are not required between 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 suitable protective covering.) 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. Such runs shall be located outside of the climbing and working spaces and shall not pass between conductors of different ownership except between the pole pair and at a clearance therefrom of not less than 6 inches.

Vertical runs, where encased in grounded metal conduit, 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 enclosed in securely grounded metal casing or covering and shall be 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 grounded iron or steel pipe (or other metal 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).

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 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 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 the terminal leads are connected except as follows:

Where the line conductors are dead-ended on the opposite side of the arms 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 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.

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  $1\frac{1}{2}$  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  $1\frac{1}{2}$  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  $1\frac{1}{2}$  inches.

#### H. ATTACHMENT OF PROTECTIVE COVERING

Protective covering shall be attached to poles, crossarms, 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.

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

- (1) DIMENSIONS WHERE CROSSARMS ARE NOT INVOLVED: Climbing space through the levels of conductors dead-ended on poles in vertical configuration shall be a square of the horizontal dimensions tabulated below; and one side of such 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):

<i>Voltage of conductors</i>	<i>Dimensions of square</i>
750-7500 volts.....	30 inches
7500-46,000 volts.....	36 inches
More than 46,000 volts.....	36 inches plus $\frac{1}{2}$ inch per kv in excess of 46 kv.

For climbing space dimensions for low voltage rack construction see Rule 54.9-F.

- (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.

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.)

- c) *For Combination Arm Construction with Line Arm and Line Buck Arm or Service Buck Arms:* (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, Figs. 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:** Cross-arms 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.

Modifications of these requirements for rack construction are specified in Rule 54.9-F.

## 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 54.3-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.

**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

### Requirements for Supply Lines

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 10 feet. If the building served does not permit an attachment which will afford at least 10 feet clearance 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 10 feet but shall be maintained as great as possible and shall be not less than 8 feet 6 inches. If the building served would require the installation of an attachment structure to provide height sufficient to afford a vertical clearance of at least 8 feet 6 inches, the full clearance of 10 feet shall be maintained.

(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 buildings and structures. 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. Where attached to the surface of buildings



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 conduit or under wood protective covering.

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 and 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 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:

<i>Length of span (feet)</i>	<i>Minimum vertical separation (inches)</i>
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.

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

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

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.

#### 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  $\frac{3}{4}$ -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 outer 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.

shall not be grounded if the crossarms 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 App. G, Fig. 52) shall not be sectionalized and shall have their lower ends securely grounded (by means of ground wires, anchor guys, or attachment to securely grounded metal poles or structures). Excepted from the above requirements are:

Guys 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

**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**

<i>Nominal voltage of circuits nearest point of attachment</i>	<i>Dry flashover voltage of insulators</i>
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, 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  $1\frac{1}{2}$  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.

**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

**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

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:

<i>Conveyance using thoroughfare</i>	<i>Minimum clearance of signal above thoroughfare</i>
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  $8\frac{1}{2}$  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  $8\frac{1}{2}$  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  $8\frac{1}{2}$  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

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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  $7\frac{1}{2}$  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.

**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  $22\frac{1}{2}$  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  $22\frac{1}{2}$  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 10 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 10 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 10 Inches Below Cases:* Where a transformer case is unusually long, a cross-arm supporting line conductors of 0-750 volts may be used as a heel arm or such conductors on an arm may be less than 10 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 10 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  $1\frac{1}{2}$  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  $1\frac{1}{2}$ -inch creepage distance.

(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  $1\frac{1}{2}$  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  $1\frac{1}{2}$  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 mid-point 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.

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 cross-arm 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.

### **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-B1a.

- (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  $1\frac{1}{2}$  inches; except that such cases shall clear crossarm braces by not less than 1-inch air-gap distance and  $1\frac{1}{2}$ -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  $1\frac{1}{2}$  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  $1\frac{1}{2}$  inches.

#### 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 5,000 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.

Related phase and neutral line conductors shall be of the same material, except that the neutral conductor may be of copper.

#### 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 two or more separate and continuous metallic return conductors to the source of supply.

If two return conductors only are used, each 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 two return conductors are used, the current-carrying capacity of the return system shall be such that a break in any one path shall leave two or more return paths which, combined, 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, thus providing adequate current-carrying capacity for full load current. (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.
- (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.

#### F. DESIGNATION OF COMMON NEUTRAL

In common neutral systems, where the common neutral line conductor is installed in a primary pin position, it shall be designated by an approved noncorrosive metal tag having a minimum diameter of not less than 1 inch upon which shall be permanently imprinted the letters "CN" not less than 5/16 inch in height. Said tag shall be attached securely to and maintained on the common neutral conductor at each pin position of line arm and buck arm at a distance not more than 12 inches from the face of the crossarm on the climbing side of each pole and so installed as to be clearly visible at all times.

### 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. 1 AWG medium-hard-drawn stranded copper. From the No. 1 AWG or larger conductor to the common neutral line conductor, 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)  $\frac{1}{2}$  inch in diameter by 8 feet in length and driven to a minimum depth of 8 feet below the surface of the ground.

The driven ground rod, pipe or equivalent shall be located not less than 2 feet from the surface of the pole. Where two or more such rods are installed, they shall be located at not less than 6-foot centers and the separation required from the surface of the pole shall not be held to apply to the connection between rods.

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  $3\frac{1}{2}$  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  $3\frac{1}{2}$  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  $3\frac{1}{2}$  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  $3\frac{1}{2}$  ohms, to the common neutral line conductor either at the transformer pole or at an adjacent pole.

## SECTION VI

ADDITIONAL CONSTRUCTION REQUIREMENTS FOR  
TOWER LINES

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## 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,  $\frac{3}{8}$  inch; other members,  $\frac{1}{2}$  inch.

Painted steel: Main corner members,  $\frac{1}{2}$  inch; other members,  $\frac{3}{8}$  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  $\frac{1}{4}$  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  $\frac{1}{4}$  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 VII

DETAILED CONSTRUCTION REQUIREMENTS FOR TROLLEY  
CONTACT AND FEEDER CONDUCTORS AND THEIR  
SUPPORTING MESSENGERS, SPAN WIRES, ETC.

(Class T Circuits)

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**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

**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.)

(2.5) 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 19 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 22 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 pantograph 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~~ <sup>a vertical</sup> 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

**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 19 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 22 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 in accordance with the provisions of Rule 77.6-A1. For this purpose each pair of positive and negative contact conductors shall be treated as a single conductor, the measurement being made to the nearest contact conductor of the pair.

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 flashover insulating value of 6000 volts or more.

Where contact conductors are more than 18 feet apart an insulator shall be placed in the section of the span wire between such contact conductors at a point between 4 feet and 5 feet from each contact conductor hanger or support.

(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

## 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 the Railroad 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  $\frac{3}{8}$ -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 reconstruction 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 VIII

## DETAILED CONSTRUCTION REQUIREMENTS FOR COMMUNICATION LINES

(Class C Circuits)

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**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, 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 above ground accessible to pedestrians only less than as specified in Table 1, Case 5, Column B (10 feet) but not less than 8 feet.
- (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.

#### **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 less than 25 feet. 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).

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 and a clearance of not less than 15 inches from center line of pole shall be obtained when appreciable reconstruction of such lines is undertaken;

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, the clearance of not less than 9 inches shall apply only to conductors supported on a crossarm in the pole top position and no conductors are supported below such crossarms except supply service drops on clearance crossarms. This provision for lines in rural districts is intended to permit the use of a related buck arm, in which the climbing space shall conform to the requirements of Rule 84.7-B;

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 provided, for climbing space purposes, such cables are placed on one side of pole only and any conductor (supported by a crossarm and on the opposite side of pole) which is within 36 inches vertically from the level of the cable or messenger is not less than 24 inches (if an exchange conductor) or 18 inches (if a toll conductor) horizontally from the vertical plane of such cable or messenger. (See App. G, Fig. 84.)

(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 intersected 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 TIMBERS:** 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.

- (5) **CENTER LINE CLEARANCE AT ANGLES IN LINES AND AT TRANSPOSITIONS:** The clearance of 15 inches from center line of pole specified in Table 1, Case 8, Column B (and the reduced clearance of 9 inches permitted by Rules 84.4-D1 and 84.4-D3a) may be reduced at angles in lines and at transposition supports: provided that at angles in lines the reductions of the 30 inch and 18 inch widths of climbing spaces shall not exceed the reduction specified in Rule 84.7-A1, and further provided that the 30 and 18 inch widths of climbing space shall not be reduced at transposition supports (see App. G, Fig. 34).

#### 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  $\frac{1}{2}$  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-pin 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 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. LATERAL CONDUCTORS

Lateral runs of suitably insulated communication conductors on poles which support supply conductors may cross the pole or run laterally from the pole at a clearance less than the 15 inches from center line specified in Table 1, Case 8, provided those portions of such runs less than 15 inches from center line of pole and located less than 6 feet below the level of unprotected supply conductors are supported by and underneath the bottom surface of cross-arm or guard arm, or are supported on the side of such crossarm or guard arm not less than 2 inches below the top surface thereof.

### D. VERTICAL RUNS

Vertical runs of communication wires or cables supported on the surface of wood poles or structures, shall be covered by a suitable protective covering (see Rule 22.2) where within a vertical distance of 3 feet above or 6 feet below unprotected supply conductors supported on the

same pole or structure. Vertical runs of communication wires or cables on the surface of a wood pole shall be covered by a suitable protective covering where within a 6-foot radius of any other pole supporting supply conductors except that those portions of such runs which are more than 3 feet above or 6 feet below the level of unprotected supply conductors need not be covered. Cable and drop wire runs to or from terminal boxes are excepted from these requirements for covering, under the following conditions:

Where guard arms are installed above messengers or longitudinal cables which are less than 6 feet below but not less than 4 feet below unprotected supply conductors of 0-750 volts, or where cables are supported on crossarms at not less than 15 inches from center line of pole, in which cases any portion of metal sheathed cable runs on the surface of pole below the guard arm and in the same quadrant as the longitudinal cable (see App. G, Fig. 86), or below and on the same side of the pole with a crossarm which supports a longitudinal cable, need not be covered.

Runs of bridled conductors, attached to surface of pole, need not be covered provided such runs are below the guard arm and in the same quadrant as the longitudinal cable, or where such runs are below and on the same side of pole with a cable arm and are not in the climbing space, or are connected to service drops which are placed in accordance with the provisions of Rule 84.8-B2b.

Where bridled runs are not required to be covered by these rules, they shall be supported by bridle hooks or rings spaced at intervals of not more than 24 inches.

Vertical runs shall be treated as risers (see Rule 84.6-E) where within a distance of 8 feet from the ground line.

#### **E. RISERS**

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.

Vertical risers shall be covered by suitable protective covering where within a vertical distance of 3 feet above or 6 feet below the level of unprotected supply conductors supported on the same wood pole or structure.

Vertical 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.

#### F. 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 midway on the side of the climbing space parallel to the crossarm. 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 inches may be reduced to not less than 16½ and 27½ inches respectively provided the horizontal separation of pole pin conductors measured parallel to the crossarm shall be not less than 18 and 30 inches respectively.

- (1) ON POLES WHICH SUPPORT COMMUNICATION CONDUCTORS ONLY: The climbing space for toll, trunk and other conductors not used for local distribution shall be not less than 18 inches in width and not less than 30 inches in depth.

The climbing space for exchange or local distribution conductors shall be not less than 30 inches in depth and not less than 30 inches in width, except that for conductors of 160 volts or less, which are used for exchange or local distribution service but which were originally used and placed as toll conductors of like voltage, the climbing space shall be not less than 18 inches wide.

In rural districts, the climbing space for exchange or local distribution circuits of 160 volts or less which are supported on crossarms at the top positions of poles which support no other crossarms shall be not less than 18 inches wide and not less than 30 inches deep.

- (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 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  $26\frac{1}{2}$  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  $26\frac{1}{2}$  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 (measured from center line of pole) shall be maintained through all conductor levels of such conductors except those levels of similarly supported conductors within 3 feet of the topmost conductor on the pole (see App. G, Fig. 38).

### D. THROUGH SERVICE DROPS NOT ON CROSS-ARMS

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 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 weather-proofing.

**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.



(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 10 feet. If the building served does not permit an attachment which will provide this 10-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 8 feet 6 inches.
- 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  $\frac{1}{2}$  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).

#### 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 supports 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 Communication  
Service Drops and Line Conductors

Radial distance of crossing from supporting pole (feet)	Minimum radial clearance (inches)	
	From police and fire alarm line conductors	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

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, provided they clear the top of rails a vertical distance of 25 feet where the railway crossed transports standard freight cars or 23 feet where the railway does not transport freight cars. 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.

*CORRECTION*

# CORRECTION

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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).

#### 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 supports 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 Communication Service Drops and Line Conductors

Radial distance of crossing from supporting pole (feet)	Minimum radial clearance (inches)	
	From police and fire alarm line conductors	From supply line conductors
5 or less	6	12
5 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

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84.8-D2

- (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 conduit or under wood protective covering. 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.

- (3) 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, provided they clear the top of rails a vertical distance of 26 feet where the railway crossed transports standard freight cars or 23 feet where the railway does not transport freight cars. 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.

**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  $\frac{3}{4}$ -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  $\frac{1}{2}$  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 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).

#### 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 44c).

#### 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

<i>Nominal voltage of circuits nearest point of attachment</i>	<i>Dry flashover voltage of insulation</i>
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, 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  $1\frac{1}{4}$  inches or greater in diameter, has an over-all 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



vided 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, provided such messengers or cables are placed on one side of pole only and any conductor on the opposite side of the pole, less than 36 inches vertically from such messenger and cable, shall be not less than 24 inches (if an exchange conductor) or not less than 18 inches (if a toll conductor) horizontally from such messenger or cable (see App. G, Fig. 84).

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 provided such attachments are not less than 2 feet below the lowest level of communication conductors supported on a crossarm and provided that the vertical separation between such messengers or cables and open wire conductors in the same configuration shall be not less than 12 inches.

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.

**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 when 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 IX

## JOINT POLES OR POLES JOINTLY USED

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**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.

**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**

All jointly used poles which support supply conductors shall be provided with pole steps if vertical runs or risers of supply or communication conductors are attached to the surface of such poles; except that those jointly used

poles which carry circuits operated only by one party are not required to be stepped provided any vertical runs or risers on the surface of such poles are covered by a suitable protective covering of wood throughout their length above a point 8 feet from the ground line. 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 pole not exceeding 36 inches, at least to the height of the upper end of the top-most run or riser attached to the surface of pole. 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 1½ 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

## 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.

**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 open-wire communication conductors are used they shall be placed on one side of pole only.

**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.

- (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 54.7 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 X

SUPPLY AND COMMUNICATION LINES IN LINE CROSSINGS  
OR CONFLICTS

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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 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 the Railroad 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.

### **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 XI

SUPPLY LINES OR COMMUNICATION LINES CROSSING OVER  
RAILWAYS

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**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-C. (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.

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 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.

**115. SCREENS AND CRADLES**

The use of screens or cradles for crossing protection is not approved under these rules.

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## APPENDICES

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# APPENDICES

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## 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 Com-  
posite
- 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 4 lbs. per sq. ft. on conductor	Resultant load	Vertical load, conductor with $\frac{1}{8}$ inch of ice	Horizontal load, wind of 4 lbs. per sq. ft. on conductor with $\frac{1}{8}$ 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	.0514	.0893	.105	.4186	.5670	.723
	10	.128	.01287	820	662	.0496	.0853	.099	.4101	.5610	.715
9		.114	.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	.5101	.661
	14	.080	.00503	330	265	.0194	.0533	.057	.3800	.5100	.660

\* Minimum ultimate strengths of ASTM Specification, B 1-39.

\*\* Minimum ultimate strengths of ASTM Specification, B 2-39, plus  $\frac{1}{8}$  the difference between minimum and maximum.

**TABLE 18**  
**COPPER WIRE—BARE—STRANDED AND SOLID—CHARACTERISTICS AND LOADING**

Characteristics of conductor						Loading per linear foot of conductor, pounds						
Size of cable or wire, circular mils or AWG	Component wires (strands)		Diameter, inch	Area, square inch	Ultimate tensile strength, pounds		Light loading district			Heavy loading district		
	Number	Diameter, inch			Hard drawn*	Medium hard drawn**	Vertical load, conductor only	Horizontal load, wind of 6 lbs. per sq. ft. on conductor	Resultant load	Vertical load, conductor with 1/4 inch of ice	Horizontal load, wind of 6 lbs. per sq. ft. on conductor with 1/4 inch of ice	Resultant load
500,000	37	0.1162	0.813	0.3927	22,510	18,726	1.544	0.5420	1.636	2.3601	0.9065	2.528
350,000	19	.1357	.679	.2749	15,590	13,024	1.081	.4523	1.172	1.8141	.8395	1.993
250,000	19	.1147	.574	.1961	11,365	9,366	0.7710	.3827	0.862	1.4397	.7870	1.641
0000	7	.1739	.527	.1662	9,151	7,772	.6533	.3514	.742	1.2919	.7635	1.500
000	7	.1518	.461	.1318	7,366	6,204	.5181	.3093	.601	1.1175	.7320	1.334
00	7	.1379	.414	.1015	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	.6810	1.103
1	7	.1093	.328	.0657	3,802	3,151	.2581	.2187	.338	.7733	.6010	1.019
2	7	.0974	.292	.0521	3,012	2,517	.2019	.1917	.283	.6974	.6160	0.950
2	3	.1487	.320	.0521	2,913	2,453	.2029	.2133	.291	.7123	.6600	.971
4	7	.0772	.232	.0328	1,910	1,604	.1289	.1547	.201	.5811	.6160	.819
4	3	.1180	.254	.0328	1,879	1,564	.1276	.1693	.212	.5964	.6270	.865
4	1		.2013	.03278	1,970	1,612	.1264	.1360	.185	.5611	.6020	.825
6	3	.0935	.201	.0206	1,201	995	.0825	.1340	.157	.5181	.6005	.793
6	1		.1620	.02062	1,280	1,016	.0795	.1080	.131	.4911	.5810	.759
8	1		.1285	.01297	826	667	.0500	.0853	.099	.4106	.5610	.716

\* Minimum ultimate strengths of ASTM Specifications, B 1-39.

\*\* For stranded conductors, 90% minimum ultimate strengths of ASTM Specifications, B 2-39, plus  $\frac{1}{4}$  of the difference between maximum and 90% of minimum ASTM values; for solid conductors, minimum ultimate strengths of ASTM Specifications, B 2-39, plus  $\frac{1}{4}$  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					
Size of cable or wire, circular mils or A.W.G.	Component wires (strands)		Diameter with covering, inches**	Area without covering, square inch	Ultimate tensile strength, pounds		Light loading district			Heavy loading district		
	Number	Diameter, inch			Hard drawn*	Medium hard drawn**	Vertical load, conductor only	Horizontal load, wind of 4 lbs. per sq. ft. on conductor	Resultant load	Vertical load, conductor with $\frac{1}{8}$ inch of ice	Horizontal load, wind of 4 lbs. per sq. ft. on conductor with $\frac{1}{8}$ inch of ice	Resultant load
1,000,000	61	0.1250	1.430	0.7851	45,030	37,210	3.456	0.9531	3.585	4.6561	1.2150	4.812
750,000	61	.1109	1.195	.5890	31,090	28,272	2.635	.7967	2.753	3.6890	1.0975	3.849
500,000	37	.1162	1.081	.3927	22,510	18,720	1.765	.7207	1.906	2.7481	1.0105	2.938
350,000	19	.1357	0.867	.2749	15,590	13,021	1.218	.5780	1.375	2.0980	0.9335	2.296
250,000	19	.1147	.710	.1961	11,365	9,366	0.9070	.4931	1.032	1.6780	.8700	1.890
0000	7	.1739	.685	.1662	9,151	7,772	.7450	.4567	0.874	1.4818	.8425	1.701
000	7	.1518	.610	.1318	7,360	6,204	0.6010	.4267	0.740	1.3128	.8200	1.618
00	7	.1379	.560	.1015	5,925	4,952	0.4820	.3731	0.610	1.1111	.7800	1.382
0	7	.1228	.516	.0829	4,753	3,953	0.3880	.3610	.532	1.0381	.7730	1.294
1	7	.1093	.445	.1657	3,802	3,151	.3030	.2967	.421	0.8906	.7225	1.147
2	7	.0974	.415	.0521	3,012	2,517	.2160	.2767	.370	.8149	.7075	1.079
4	7	.0772	.314	.0328	1,910	1,604	.1550	.2293	.277	.6798	.6720	0.956
4	1		.337	.03278	1,970	1,612	.1535	.2247	.272	.6739	.6685	.949
6	1		.290	.0206	1,280	1,016	.1030	.1933	.219	.5942	.6150	.877
8	1		.246	.01297	826	667	.0680	.1610	.178	.5319	.6230	.819

\* Minimum ultimate strength of ASTM Specifications, B 1-39.

\*\* For stranded conductors, 90% minimum ultimate strength of ASTM Specifications, B 2-39, plus  $\frac{1}{4}$  of the difference between maximum and 90% of minimum ASTM values; for solid conductors, minimum ultimate strength of ASTM Specifications, B 2-39, plus  $\frac{1}{4}$  of the difference between minimum and maximum.

\*\*\* Average outside diameter obtained commercially.

LYBTE 18

TABLE 20

## COPPER WIRE—STRANDED AND SOLID—TRIPLE BRAID WEATHERPROOF—CHARACTERISTICS AND LOADING

Size of cable or wire, in. or A.W.G.	Characteristics of conductor				Loading per linear foot of conductor, pounds							
	Component wires (strands)		Diameter with covering, inches**	Area without covering, square inch	Ultimate tensile strength, pounds		Light loading district			Heavy loading district		
	No.	Diameter, in.			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 1/2 inch of ice	Horizontal load, wind of 8 lbs. per sq. ft. on conductor with 1/2 inch of ice	Resultant load
1,000,000	61	0.1280	1.656	0.7851	45,030	37,210	3.761	1.1011	3.836	5.0146	1.3280	5.188
750,000	61	.1109	1.380	.5890	31,090	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	1.891	.8334	2.069	2.9822	1.1250	3.187
350,000	19	.1357	1.000	.2749	15,590	13,024	1.315	.6667	1.501	2.2777	1.0000	2.488
250,000	19	.1147	0.850	.1961	11,365	9,366	0.9850	.5667	1.136	1.8211	0.9250	2.015
0000	7	.1739	.805	.1662	9,151	7,772	.8000	.5367	0.963	1.6114	.9025	1.817
000	7	.1518	.710	.1318	7,366	6,201	.6530	.4731	.807	1.4051	.8550	1.615
00	7	.1379	.660	.1015	5,925	4,952	.5220	.4100	.683	1.2133	.8300	1.495
0	7	.1228	.610	.0829	4,753	3,953	.4210	.4067	.588	1.1142	.8050	1.375
1	7	.1093	.509	.0657	3,802	3,154	.3280	.3391	.472	0.9551	.7515	1.217
2	7	.0974	.488	.0521	3,012	2,517	.2700	.3253	.423	.8843	.7410	1.156
4	7	.0772	.390	.0328	1,910	1,604	.1700	.2600	.311	.7231	.6950	1.003
4	1	.387	.387	.03278	1,970	1,612	.1665	.2580	.307	.7180	.6935	0.998
6	1	.317	.317	.0206	1,280	1,016	.1136	.2313	.258	.6103	.6735	.929
8	1	.291	.291	.01297	826	667	.0760	.1960	.210	.5697	.6170	.862

\* Minimum ultimate strengths of ASTM Specifications, B 1-39.

\*\* For stranded conductors, 90% minimum ultimate strengths of ASTM Specifications, B 2-39, plus 1/4 of the difference between maximum and 90% of minimum ASTM values; for solid conductors, minimum ultimate strengths of ASTM Specifications, B 2-39, plus 1/4 of the difference between minimum and maximum.

\*\*\* Average outside diameter obtained commercially.

TABLE 21

## GALVANIZED STEEL AND IRON WIRE—BARE—SOLID—CHARACTERISTICS AND LOADING

Characteristics of conductor						Loading per linear foot of conductor, pounds					
Size of wire, B&O	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 3/4 inch of ice	Horizontal load, wind of 8 lbs. per sq. ft. on conductor with 3/4 inch of ice	Resultant load
4	0.238	0.0115	2,028	2,270	2,433	.1530	0.1587	0.220	0.6119	0.6190	0.870
6	.203	.0321	1,475	1,650	1,770	.1120	.1353	.176	.5191	.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	.131	.0141	615	720	774	.0490	.08934	.102	.4132	.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	.0051	247	275	297	.0190	.05533	.058	.3815	.5115	.662

\* All ultimate tensile strengths are from ASTM Specification A 111-33.

**TABLE 23**  
**COPPER COVERED STEEL—STRAND, SOLID AND COMPOSITE—CHARACTERISTICS AND LOADING**

COPPER COVERED STEEL—STRAND, SOLID AND COMPOSITE										Loading per linear foot of conductor, pounds				
Characteristics of conductor					Ultimate tensile strength, pounds			Light loading district			Heavy loading district			
Nominal diameter, inch	Strands		Actual diameter, inch	Area of conductor, square inch	High strength		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 1/4 inch of ice	Horizontal load, wind of 8 lbs. per sq. ft. on conductor with 1/4 inch of ice	Resultant load	
	No.	Size AWG			40% Cond.	30% Cond.								
1/2	7	6	0.486	0.1113	15,330	16,890	20,400	0.5150	0.3240	0.608	1.1281	0.7430	1.351	
7/16	7	7	.433	.1115	12,670	13,910	16,890	.4081	.2887	.500	.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	.2010	.288	.7019	.6530	0.961	
	3	6	.319	.0618	6,201	6,835	8,281	.2203	.2327	.320	.7482	.6745	1.007	
	3	8	.277	.0389	4,232	4,629	5,621	.1385	.1817	.231	.6216	.6385	0.891	
	3	9	.217	.0303	3,488	3,802	4,565	.1099	.1617	.198	.5711	.6235	.818	
	3	10	.220	.0215	2,882	3,140	3,722	.08713	.1167	.171	.5318	.6100	.811	
	1	6	.1620	.0206	2,433	2,680	3,217	.07285	.1080	.130	.4811	.5810	.756	
	1	8	.1285	.0130	1,660	1,815	2,201	.01581	.08567	.097	.4366	.5612	.713	
	1	9	.1141	.0103	1,368	1,491		.03633	.07627	.081	.4153	.5572	.697	
	1	10	.1019	.00816	1,130	1,231		.02881	.06791	.074	.4031	.5510	.683	
	1	12	.08081	.00513	711	800		.01812	.03388	.057	.3792	.5401	.660	
	3	*	.366	.0680			5,876	.2568	.2410	.351	.7953	.6830	1.048	
	3	**	.290	.0128			3,938	.1615	.1933	.252	.6527	.6150	0.918	
	3	***	.230	.0269			2,585	.1016	.1533	.181	.5555	.6150	.820	

1 foot of copper covered steel and 1 hard drawn copper wire.  
No. 4 AWG.

Notes—Items marked with asterisks are composite conductors of 1 copper covered steel and 2 hard drawn copper wires.  
 Copper conductance equivalents: \* = No. 1 AWO, \*\* = No. 4 AWO, \*\*\* = No. 6 AWO.



TABLE 23

## ALUMINUM CABLE STEEL REINFORCED—BARE—CHARACTERISTICS AND LOADING

Characteristics of Conductor						Loading per linear foot of conductor, pounds						
A.C.S.R. size, cir mils or A.W.G.	Copper equivalent conductivity size, cir mils or A.W.G.	Number of strands		Diameter, inches	Area, square inch	Ultimate tensile strength, pounds	Light loading district			Heavy loading district		
		Alumi- num	Steel				Vertical load, conductor only	Horizontal load, wind of 18 lbs. per sq. ft. on conductor	Resultant load	Vertical load, conductor with 1/2 inch of ice	Horizontal load, wind of 18 lbs. per sq. ft. on conductor with 1/2 inch of ice	Resultant load
795,000	500,000	30	19	1.140	0.7668	38,400	1.231	0.7600	1.449	2.2338	1.0700	2.495
795,000	500,000	26	7	1.108	.7261	31,200	1.093	.7387	1.319	2.0928	1.0510	2.343
795,000	500,000	51	7	1.093	.7053	28,500	1.023	.7287	1.256	2.0135	1.0165	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	.5161	.5220	.750	1.3142	.8915	1.613
266,800	000	26	7	.612	.2136	11,250	.3668	.4280	.504	1.0760	.8210	1.351
0000	00	6	1	.563	.1939	8,420	.2921	.3751	.476	0.9531	.7815	1.232
000	0	6	1	.502	.1538	6,675	.2316	.3317	.407	.8516	.7510	1.138
00	1	6	1	.447	.1219	5,315	.1837	.2980	.350	.7725	.7235	1.058
0	2	6	1	.398	.0967	4,280	.1456	.2653	.303	.7010	.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	.181	.5381	.6285	.827
4	6	6	1	.250	.0383	1,830	.0576	.1667	.176	.5210	.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 271 to 276, 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 274, 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 277, 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 274, 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 277, 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,

$$20 \times 0.024 = 0.48 \text{ feet}$$

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.

#### (c) Sags for Supports at Different Elevations

The sag curves have been based on the supports being at the same elevation. The curve on page 278 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 274, 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 278. The multiplier C for this ratio is 0.58. Therefore the sag below the lower point of support is,

$$0.58 \times 5.30 = 3.07 \text{ feet}$$

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 271 to 276, 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 279 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 279, the value of the sag at this point is 91 per cent of the center sag. The sag at this point, therefore, equals  $5.30 \times 0.91 = 4.82$  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).

$$25 \text{ feet} + 6 \text{ feet} + 4.82 \text{ feet} = 35.82 \text{ feet}$$

### (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.	Description	Page
1.	Conductor Sags, Light Loading, Bare Copper, Hard Drawn and Medium Hard Drawn.....	271
2.	Conductor Sags, Light Loading, Weatherproof Copper Hard Drawn and Medium Hard Drawn.....	272
3.	Conductor Sags, Heavy Loading, Bare Copper, Hard Drawn .....	273
4.	Conductor Sags, Heavy Loading, Bare Copper, Medium Hard Drawn.....	274
5.	Conductor Sags, Heavy Loading, Weatherproof Copper, Hard Drawn.....	275
6.	Conductor Sags, Heavy Loading, Weatherproof Copper, Medium Hard Drawn.....	276
7.	Copper, Sag Adjustment for Temperature.....	277
8.	Sag Adjustment Factor—Supports at Different Elevations .....	278
9.	Catenary Curve Ordinates.....	279

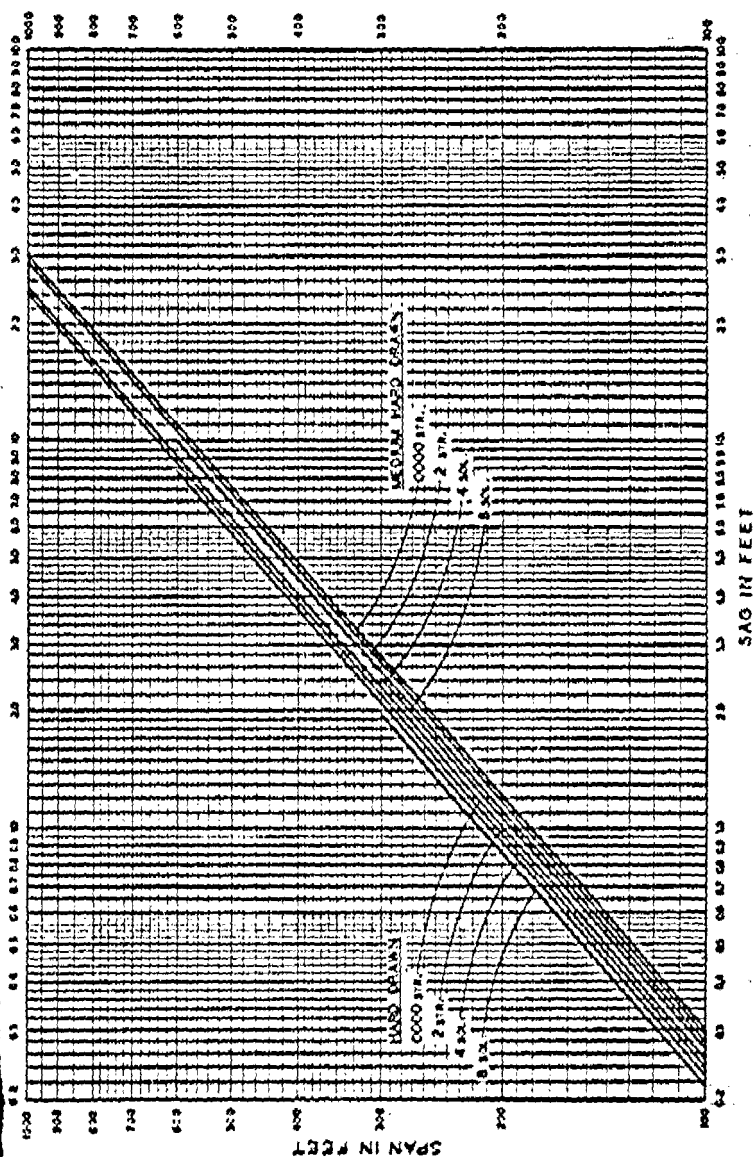
### Table No.

25.	Suggested Sags for Communication Conductors in Grade "F" Construction.....	280
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## CHART NO. 1. LIGHT LOADING

Sags at 60° F and No Wind

Bare Copper—Hard Drawn and Medium Hard Drawn

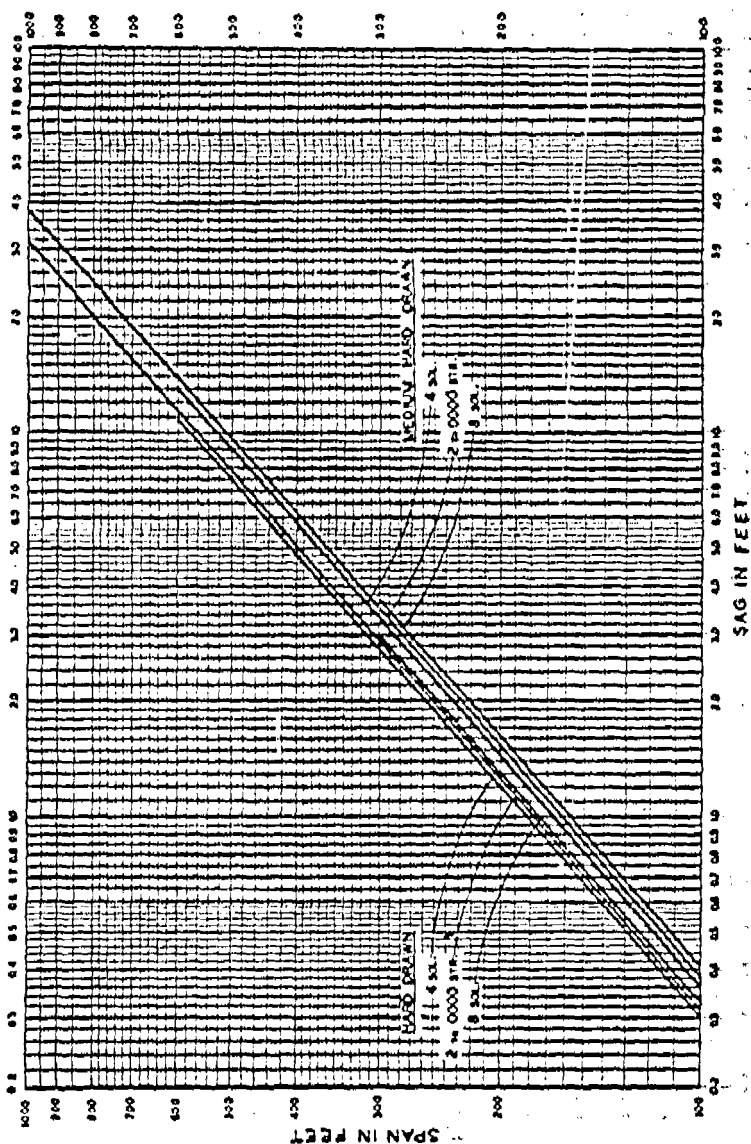




## CHART NO. 2. LIGHT LOADING

Sags at 60° F and No Wind

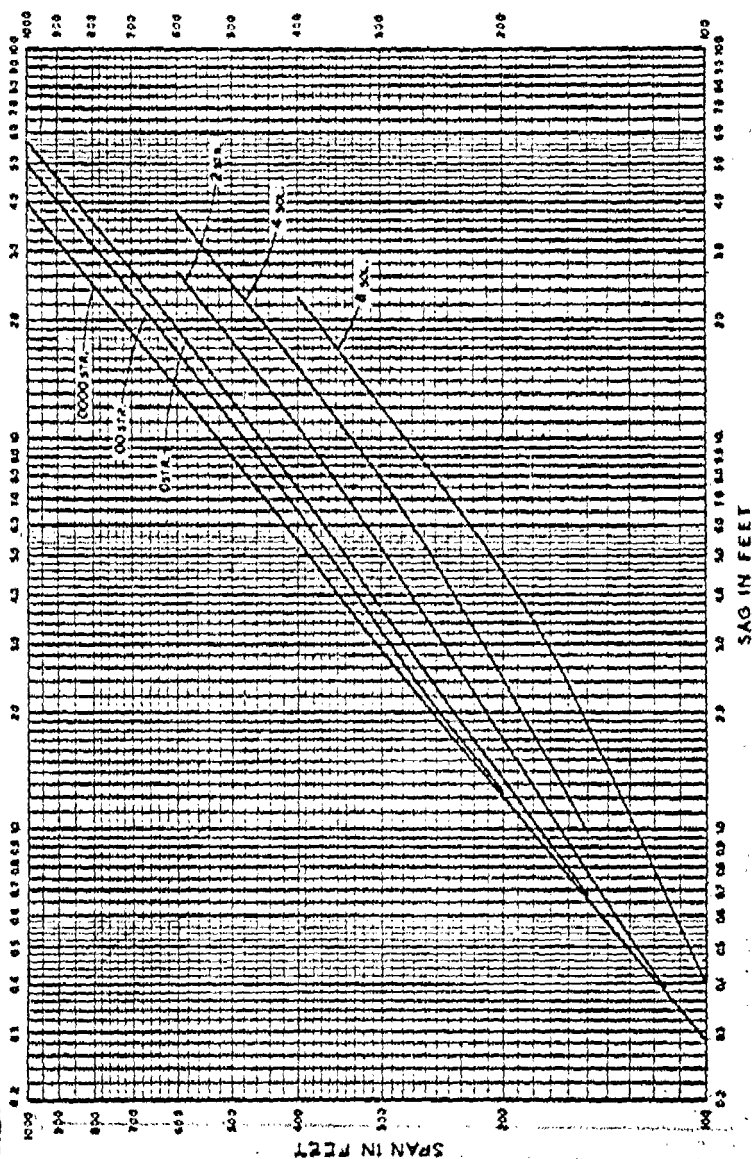
Weatherproof Copper—Hard Drawn and Medium Hard Drawn



## CHART NO. 3. HEAVY LOADING

Sags at 60° F and No Wind

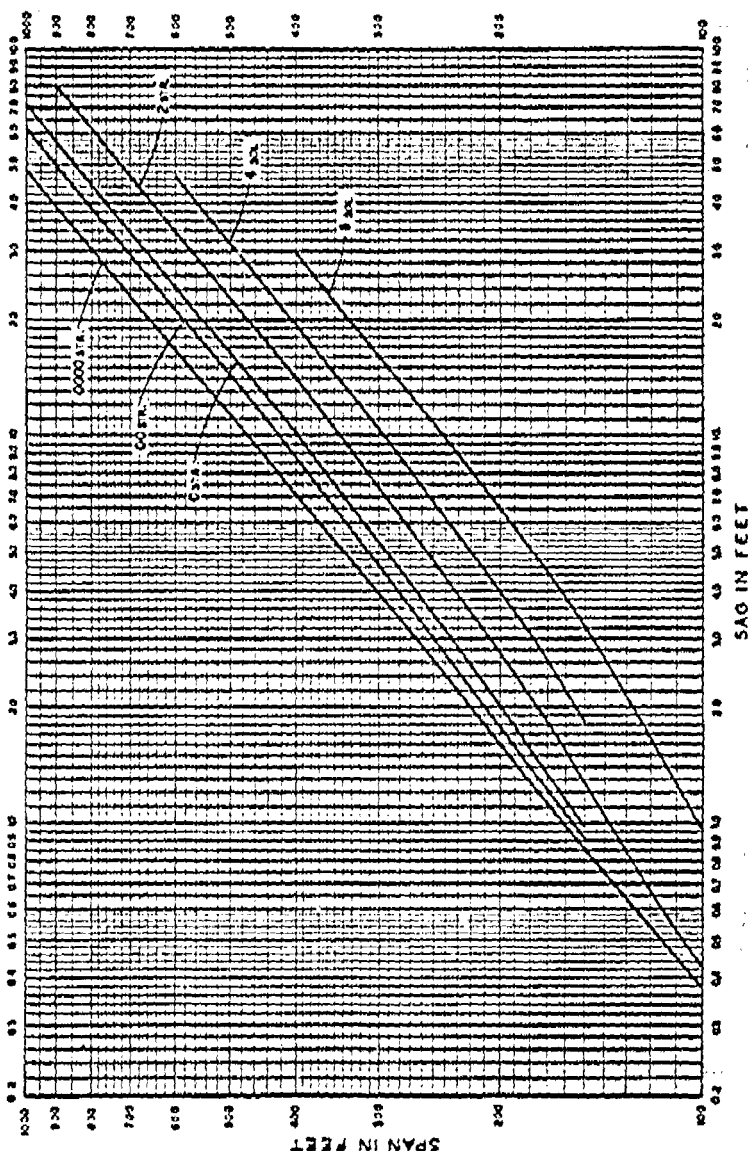
Bare Copper—Hard Drawn



## CHART NO. 4. HEAVY LOADING

Sags at 60° F and No Wind

Bare Copper—Medium Hard Drawn



## CHART NO. 5. HEAVY LOADINGS

Sags at 60° F and No Wind  
Weatherproof Copper—Hard Drawn

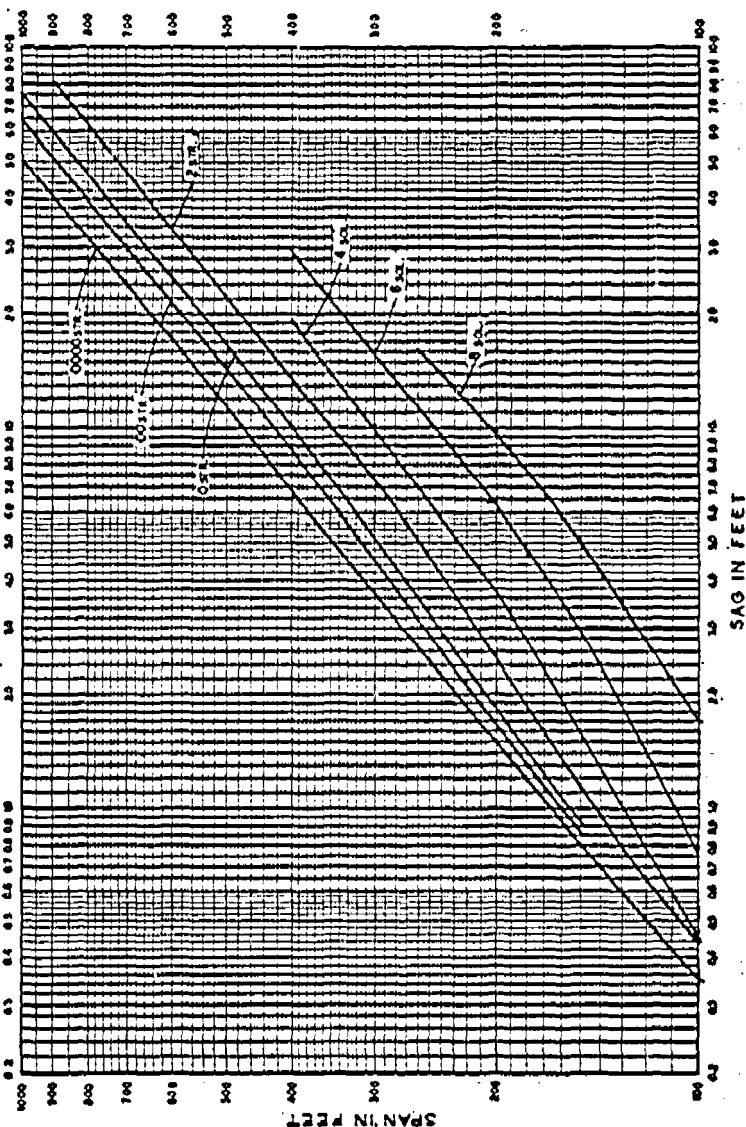






CHART NO. 9

CATENARY CURVE ORDINATES

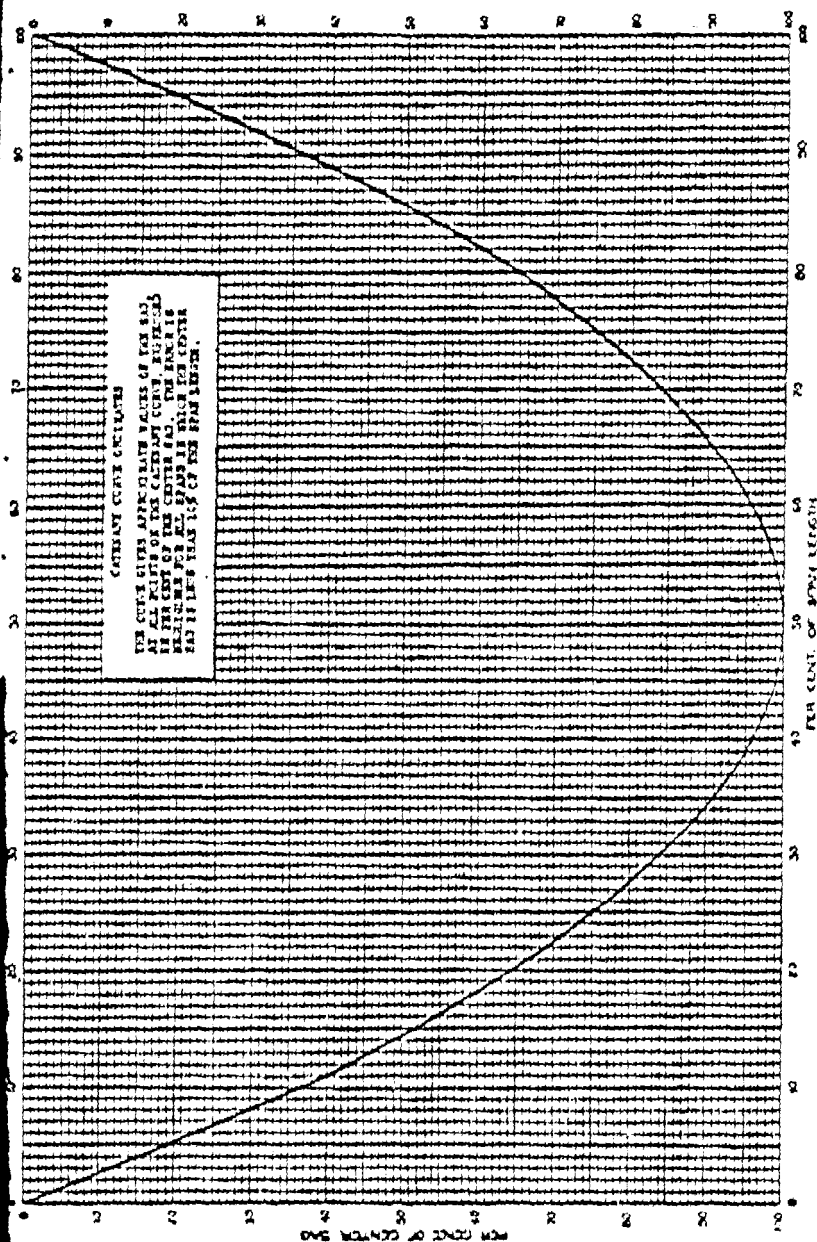


TABLE 25

## 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	20.5	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 190 feet.  
 Galvanized iron, EBB, No. 9 BWG in spans greater than 170 feet.  
 Galvanized iron, EBB, No. 10 BWG in spans greater than 160 feet.  
 Galvanized iron, EBB, No. 11 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**

3 $\frac{1}{2}$ "x4 $\frac{1}{2}$ "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  $\frac{1}{2}$ -inch bolts and  $\frac{1}{2}$ -inch drive screw at the pole.

**PINS**

1 $\frac{1}{2}$ "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. ( $\frac{1}{2}$ " 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 5000 pounds per square inch, and the maximum number of wires (.101 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	11	23	11	21
	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 5,000 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 clearance from the face of a pole, tower or structure to the railroad track shall be as follows:

Class of track	Between center line of track and face of pole		Between side of widest car and face of pole	
	Standard gauge		Narrow gauge	
	Poles supporting trolley contact conductors in bracket construction, single and double tracks	All other poles	Poles supporting trolley contact conductors in bracket construction, single and double tracks	All other poles
Main tracks -----	8' 0"	8' 6"	32"	38"
All other tracks --	8' 0"	8' 6"	38"	38"

The above clearances are based on tracks that transport standard gauge freight cars of a maximum overall width of 10 feet 8 inches. The clearances tabulated above and other clearances specified for railroads and street railways not transporting standard freight cars are found in this Commission's General Order No. 26C.

All minimum side clearances prescribed in this section are for tangent track. In general, all structures adjacent to curved track shall have a minimum side clearance one foot greater than the equivalent minimum side clearance required for tangent track. Where space is limited, the minimum side clearance for structures adjacent to tracks of not over 12 degrees curvature shall be the same as for tangent track but if over 12 degrees curvature,  $\frac{1}{2}$ -inch shall be added to the equivalent minimum side clearance required for tangent track for each degree of the curve. Where track contains super elevation, minimum side clearance shall be increased as necessary to give the equivalent clearances based on tangent track.

## 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 300 and 301. 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. 00 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),  $1\frac{1}{2} \times 18\frac{1}{2}$ ", to comply with Rules 49.3-B and 49.3-C. Assumed bonded in accordance with the requirements of Rule 53.4.

Communication circuit— $1\frac{1}{2} \times 9$ " locust.

**Crossarms**

Power circuits—Douglas fir (dense),  $4\frac{1}{2} \times 5\frac{1}{2} \times 12$ , 1.9" pin holes,  $\frac{11}{16}$ " hole for through bolt.

Communication circuit—Douglas fir (dense),  $3\frac{1}{2} \times 4\frac{1}{2} \times 42$ ",  $1\frac{1}{2}$ " pin holes,  $\frac{11}{16}$ " 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 271, 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

$$\text{Sag} = \frac{.0795 \times (200)^2}{8 \times 448} = 0.89 \text{ feet}$$

#### 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  $\frac{1}{4}$  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  $18\frac{1}{2}$  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 300 and 301, 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:

$$28' 4" - (7" + 24") = 3' 9" \text{ clearance.}$$

The minimum required clearance as given in Table 2, Case 3, Column C is 2 feet.



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"

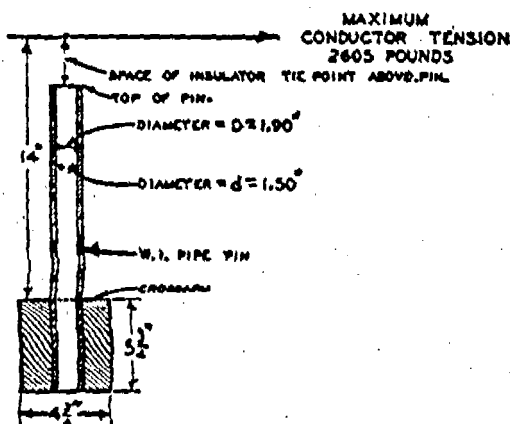
## 6. Insulators

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

$$\text{Section modulus } E = \frac{11 (D^4 - d^4)}{32 D} = 0.0982$$

$$\frac{(1.90^4 - 1.50^4)}{1.90} = 0.412 \text{ inches}^3$$

$$\text{Fiber stress } S = \frac{M}{E} = \frac{36,470}{0.412} = 88,500 \text{ pounds per sq. in.}$$

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

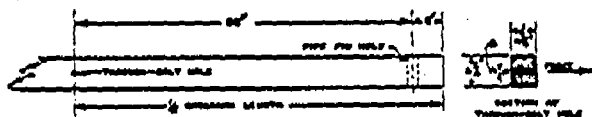
tension of 2605 pounds in the conductor at maximum loading. Since a safety factor of unity (Rule 47.5) is required, two pins are necessary and therefore double crossarms, pins and insulators are used on the poles supporting the crossing span.

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  $4\frac{1}{2}" \times 5\frac{1}{2}" \times 12'$ , 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

$$b = 5.75" - 0.69 = 5.06"$$

$$d = 4.75"$$

$$s = \frac{1}{8}" = 0.69"$$

$$\text{Section modulus} = \frac{5.06 \times (4.75)^2}{6} = 19.0 \text{ inches}^3$$

Fiber stress = Bending moment

$$\text{Section modulus} = \frac{171,930}{19.0} = 9050 \text{ lbs. per sq. in.}$$

*Maximum loading*

Bending moment  $= 570 \times 18 = 10,260$  pound-inches

Section modulus  $= 6.26$  inches<sup>3</sup> (as per calculations above)

Fiber stress  $= \frac{10,260}{6.26} = 1640$  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.

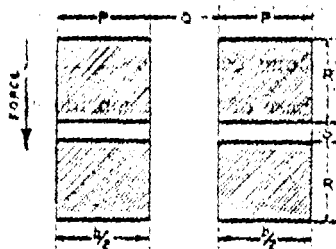
$w$  = weight of conductor in pounds per foot.

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

$$334 \times 66 = 22,040 \text{ pound-inches}$$



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:

$$M_c = L_n P_h \left( \frac{S_1 + S_2}{2} \right) \text{ pound-feet}$$

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

$$\begin{aligned} M_p &= \text{Moment due to wind pressure on pole;} \\ P &= \text{Pressure in lbs. per sq. ft. on projected area of pole (8 lbs./sq. ft.)} \\ H &= \text{Height of pole above ground in feet (48')} \\ D_1 &= \text{Diameter of pole at ground in inches (15.6")} \\ D_2 &= \text{Diameter of pole at top in inches (8.9")} \\ M_p &= \frac{8 (48)^2 \times (15.6 + 2 \times (8.9))}{72} = 8550 \text{ lb.-ft.} \end{aligned}$$

$$\text{Total moment} = 13,510 + 8,550 = 22,060 \text{ lb.-ft.}$$

$$\text{Moment of resistance of pole} = M = \frac{FI}{c}$$

Where

$$\begin{aligned} F &= \text{Fiber stress in pounds per sq. in.} \\ I &= \text{Moment of inertia of section} = \frac{\pi D_1^4}{64 \times 12} \\ c &= \text{Distance from neutral axis to outer fiber} = \frac{D_1}{2} \end{aligned}$$

$$M = \frac{\pi F D_1^3}{384} = \frac{F D_1^3}{122}$$

$$F = \frac{122 M}{D_1^3} = \frac{122 \times 22,060}{(15.6)^3} = 710 \text{ lbs. per sq. in.}$$

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

$$\frac{(D_1 + D_2)}{24} \text{ HP}$$

$$\frac{(15.6 + 8.91) 48 \times 8}{24} = 392.2 \text{ pounds}$$

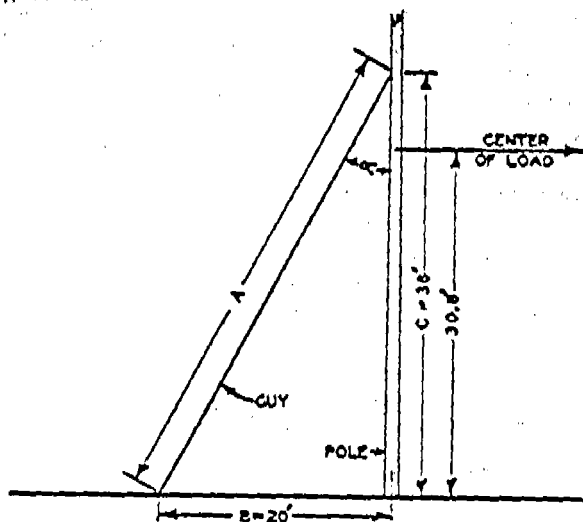
$$\text{Total Wind Pressure} = 716.4 \text{ pounds}$$

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

$$T = \frac{M_t}{C \sin \alpha} \propto$$

$$\sin \alpha = \frac{B}{A} \text{ where}$$

$$A = \sqrt{B^2 + C^2}$$

$$\sin \alpha = \frac{20}{\sqrt{20^2 + 36^2}} = .485$$

$$T = \frac{22,060}{36 \times .485} = 1260 \text{ pounds}$$

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  $\frac{1}{2}$ -inch Siemens-Martin or a  $\frac{1}{8}$ -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.

$$\text{Number of conductors involved} = \frac{8}{3} = 2\frac{2}{3}; \text{ use } 3$$

Location of conductors resulting in maximum load—two on top arm and one on next arm below

Bending moment:

$$2 \times 2605 \times 48.75 = 254,000 \text{ pound-feet}$$

$$1 \times 2605 \times 43.25 = 112,600 \text{ pound-feet}$$

$$\text{Total moment} = 366,600$$

$$\text{Fiber stress} = \frac{122 M}{D^2_1} = 122 \times \frac{366,600}{15.6^2} = 11,780 \text{ pounds per sq. in.}$$

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  $\frac{1}{8}$ -inch common,  $\frac{1}{8}$ -inch Siemens-Martin, or  $\frac{3}{4}$ -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:

$$8,520 \times 8 = 68,160 \text{ pound-feet}$$

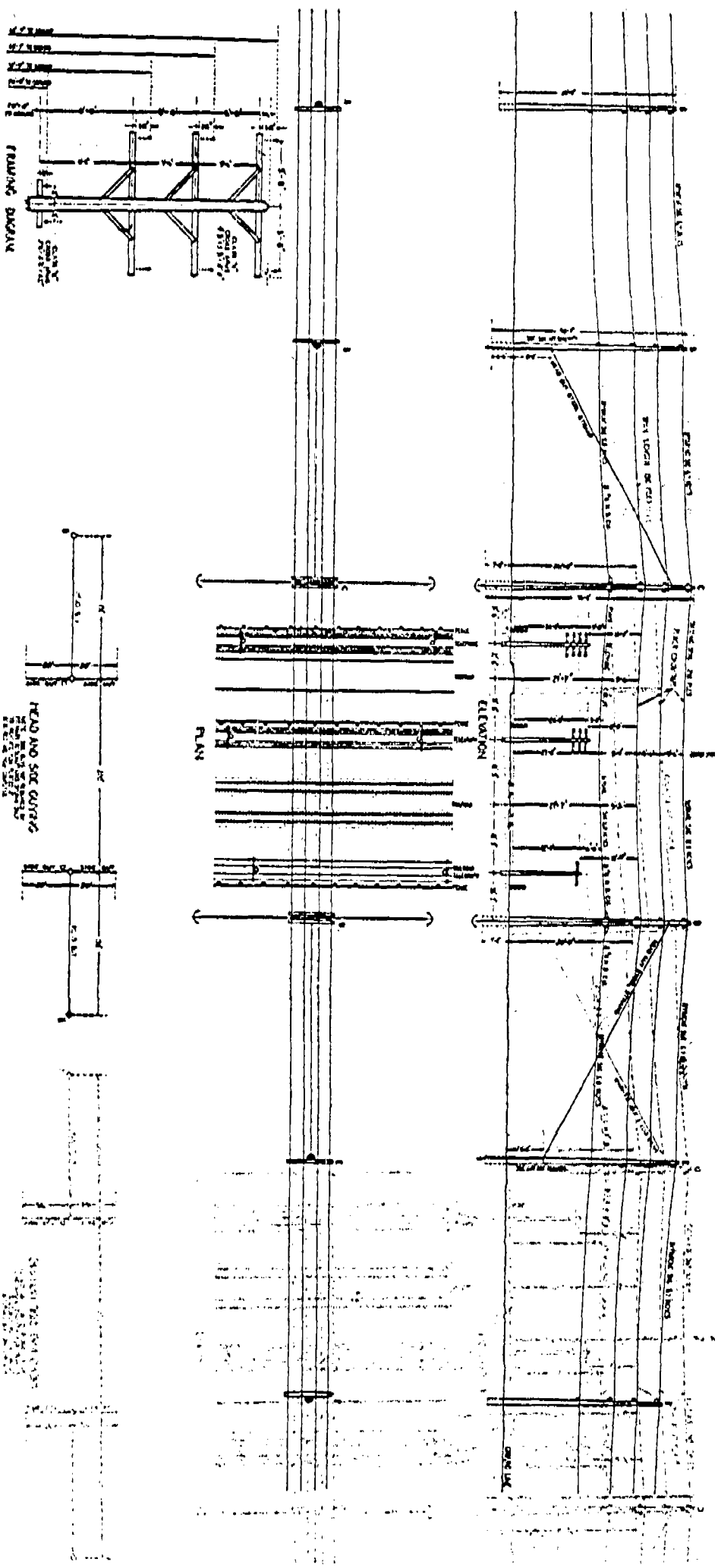
and the fiber stress developed in pole B or E by the tension of 9,070 pounds in the head guy would be:

$$F = \frac{122M}{D^3} = \frac{122 \times 68,160}{(15.0)^3} = 2,460 \text{ pounds per square inch.}$$

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 TRANSMISSION LINES OF CANADIAN POWER GRID AND VARIOUS



715—Tip in Facing page 200

## 2. Crossarms

Spacings assumed are shown on the pole framing diagram on page 304. 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.  $\left(\frac{6300 \times 0.55}{2} = 1732\right)$  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 304)

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:

$$\begin{aligned}
 3 \times 2125 \times 47.3 &= 301,500 \text{ pound-feet} \\
 4 \times 1360 \times 38.3 &= 208,400 \text{ pound-feet} \\
 3 \times 890 \times 30.3 &= 80,900 \text{ pound feet} \\
 3 \times 1360 \times 25.3 &= 103,200 \text{ pound feet}
 \end{aligned}$$

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$$\text{Total moments} = 694,000 \text{ pound-feet}$$

The total dead-end stress, using the tension values for maximum loading given above, will be:

$$3 \times 2125 = 6,380 \text{ pounds}$$

$$4 \times 1360 = 5,440 \text{ pounds}$$

$$3 \times 890 = 2,670 \text{ pounds}$$

$$3 \times 1360 = 4,080 \text{ pounds}$$

$$\text{Total} = 18,570 \text{ pounds}$$

$$\text{Center of load} = \frac{694,000}{18,570} = 37.4 \text{ feet above ground}$$

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:

$$\text{Bending moment } 3 \times 2125 \times 118.8 = 757,400 \text{ pound-inches}$$

$$4 \times 1360 \times 10.8 = 58,800 \text{ pound-inches}$$

$$\text{Total moment} = 816,200 \text{ pound-inches}$$

The section modulus of a solid circular section is

$$E = \frac{11 d^3}{32} = 0.0982 d^3$$

The diameter of the pole at the center of load is

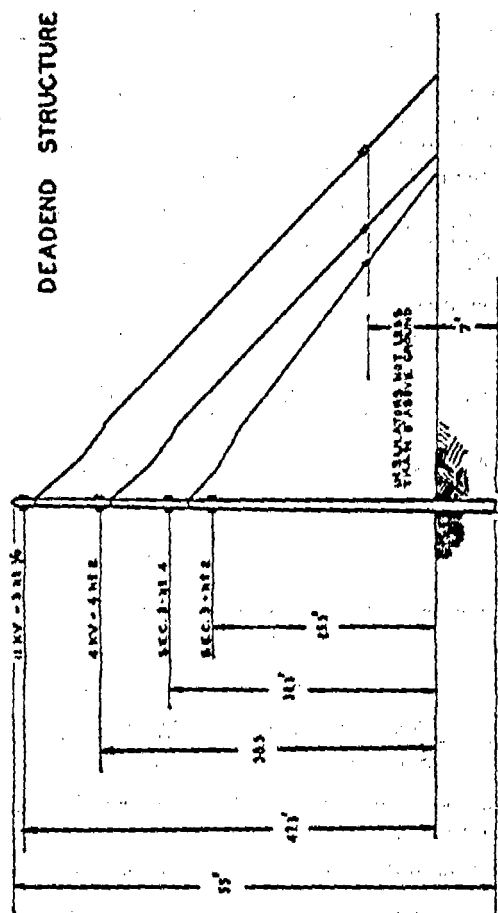
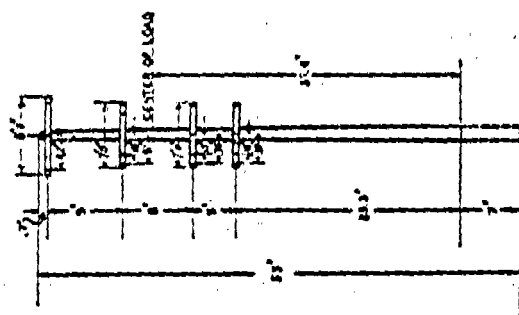
$$d = 9.7 \text{ inches}$$

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 304.



## PART 3

# METHODS OF PROVIDING PROPER STRENGTH FOR UNBALANCED CONDUCTOR LOADS AT ANGLE POLES

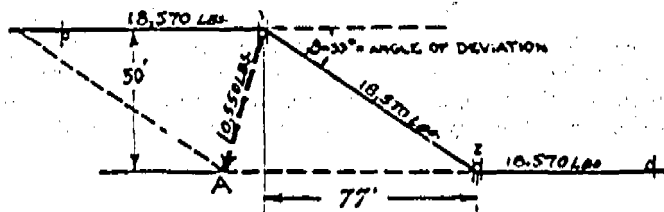
To maintain poles in proper position at angles and corners, it is generally necessary to use guys or some other form of pole bracing. Unless the line is dead-ended, the pull of the conductors is taken as being the same throughout the line.

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 ( $\beta$ ) is 33 degrees. (See sketch.) This would result in an unbalanced force being exerted in the direction of A of

$$18,570 \times 2 \sin \frac{\beta}{2} = 18,570 \times 2 \times .2840 = 10,550 \text{ pounds}$$

## 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:

$$\text{Bending moment, } M = 27.4 \times 10,550 = 394,400 \text{ pound-feet}$$

$$\text{Fiber stress} = \frac{122 M}{d^3}$$

where circumference = 50 inches  
and  $d = 15.9$  inches

$$\text{Fiber stress} = \frac{122 \times 394,400}{(15.9)^3} = 11,970 \text{ lbs. per sq. in.}$$

As a safety factor of 4 is required, the allowable working stress is  $\frac{5600}{4}$  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

$$\text{Top arm: } 3 \times 2125 \times 118.8 \times 2 \sin \frac{\beta}{2} = 430,200 \text{ pound-inches}$$

$$\text{Second arm: } 4 \times 1370 \times 10.8 \times 2 \sin \frac{\beta}{2} = 33,400 \text{ pound-inches}$$

$$\text{Total moment} = 463,600 \text{ pound-inches}$$

Section modulus,  $E$

The section modulus ( $E$ ) at 27.4 ft. above ground is 89.6 inches cubed, which is the value computed in Problem 2

Fiber stress

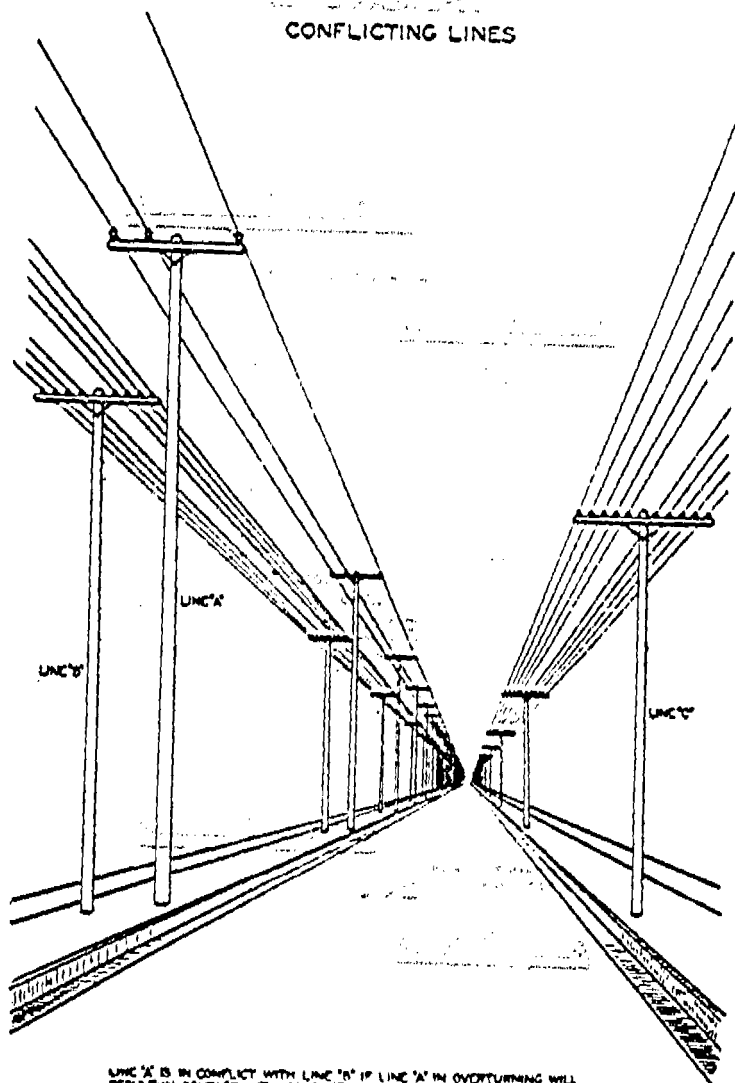
The fiber stress is

$$F = \frac{M}{E} = \frac{463,600}{89.6} = 5,170 \text{ pounds per sq. in.}$$

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 304.

Figure No.	Subject	Page
53-54	Location of Supply Cables	345
55	Traffic Signal Installations	346
56	Street Light Installation	347
57-58-59	Grounding of Transformer Windings	348
60	Rack Conductor Clearance from Pole	349
61	Riser Covering and Terminal Clearance	350
62	Trolley Spans of 100 Feet or Less	351
63	Trolley Spans Exceeding 100 Feet	351
64	Trolley Lines Under Bridges	351
65	Broken Trolley Suspension	352
66	Broken Trolley Fastening	352
67	Feeder Span Wire Insulation	352
68-69	Span Wire Insulation	353
70-71	Feeder Span Wire Insulation	353
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81	Hardwood Ground Moulding	356
82	Pipe or Cable Covering	356
83	Clearance of Wires and Equipment	357
84	Pole Clearance—Communication Wires	358
85	Guying Terms	359
86	Quadrant or Side of Pole for Uncovered Runs or Risers	360

# 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 'B' PROVIDED THAT LINE 'A' 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.

3.3.17



## CO-LINEAR LINES

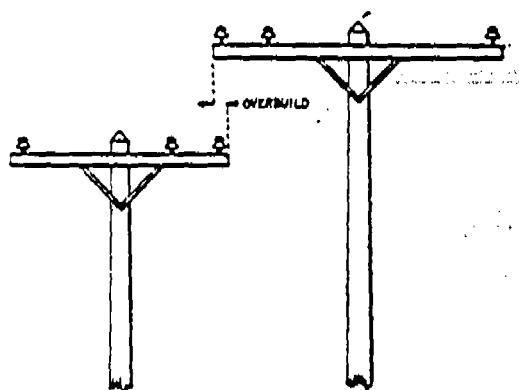
SEE DEFINITION  
21.7-B

FIG. 2'

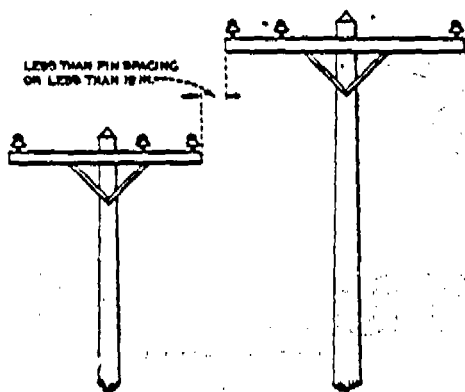
SEE DEFINITION  
21.7-B

FIG. 3

CLEARANCE OF WIRES ABOVE RAILROAD TRACKS, HIGHWAYS ETC.  
RULE 37, TABLE 1, CASES 1 TO 5.

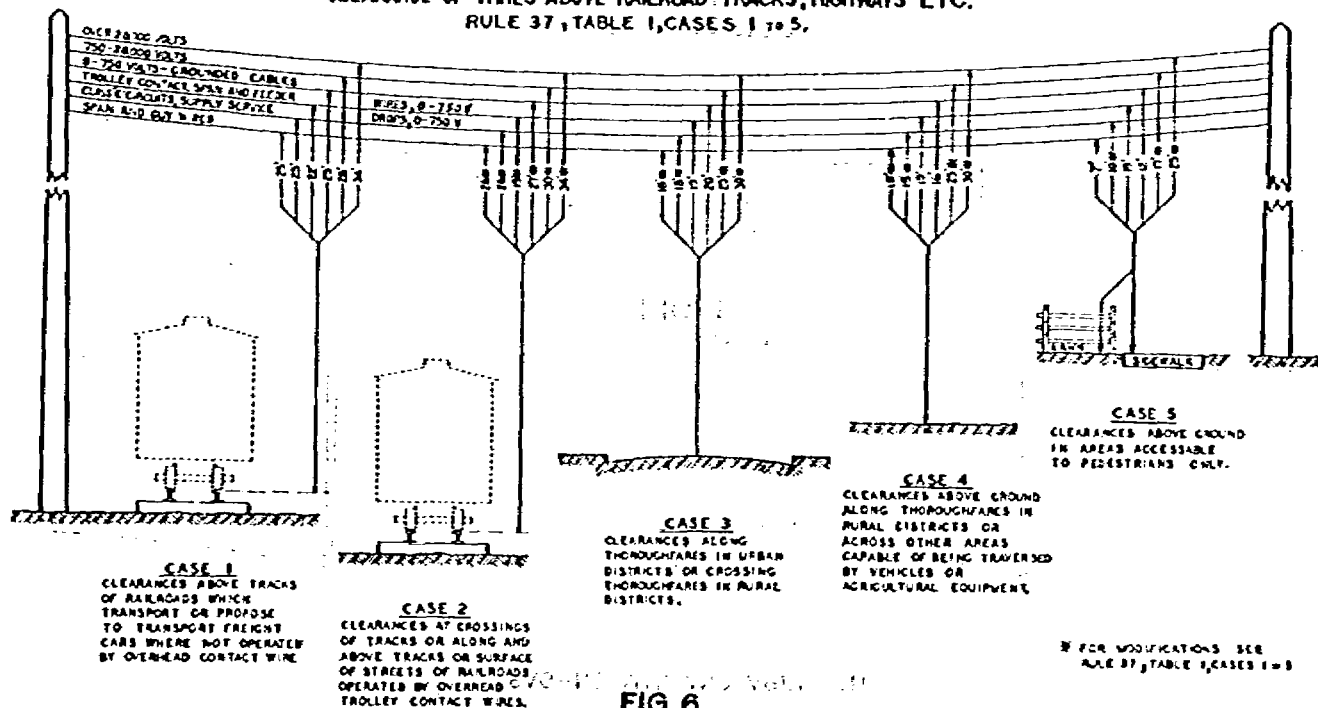


FIG. 6



VERTICAL SEPARATION OF WIRES ON  
DIFFERENT CROSSARMS OF THE SAME POLE.  
RULE 38, TABLE 2, CASES 8 TO 13.

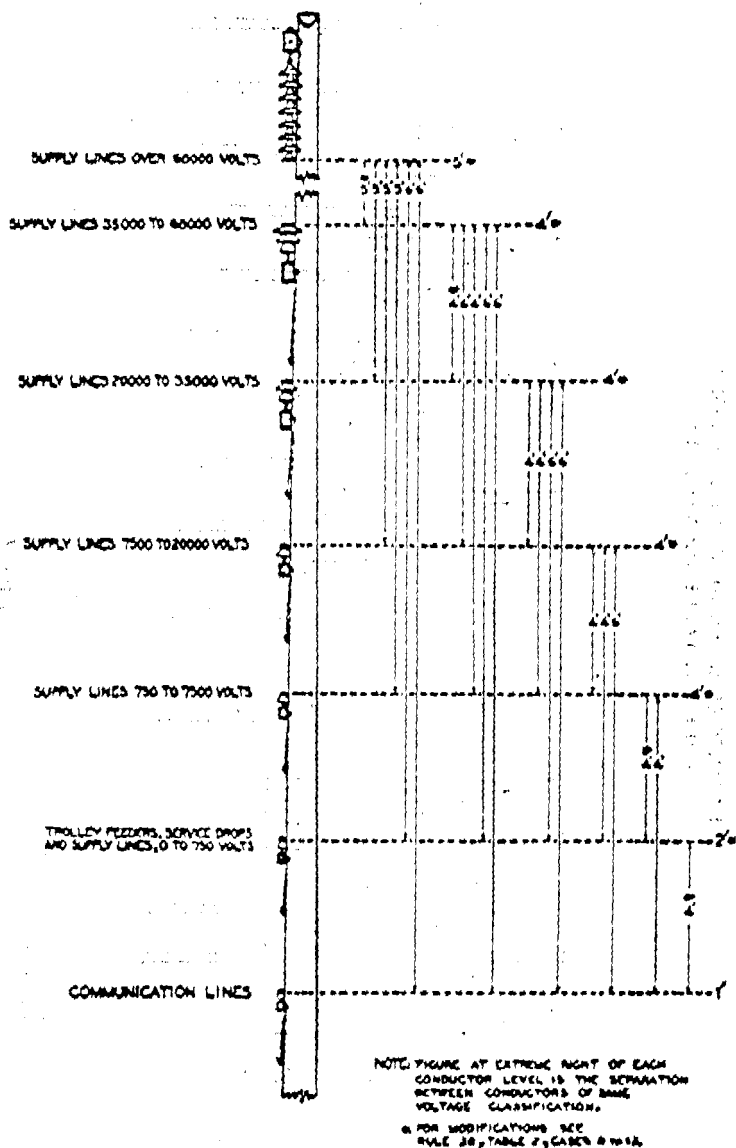


FIG. 8

MINIMUM VERTICAL SEPARATION  
BETWEEN CABLES, LOW VOLTAGE RACK CONDUCTORS AND OTHER CONDUCTORS  
ON JOINTLY USED POLES  
ILLUSTRATING RULE 92.1-A & 92.1-B

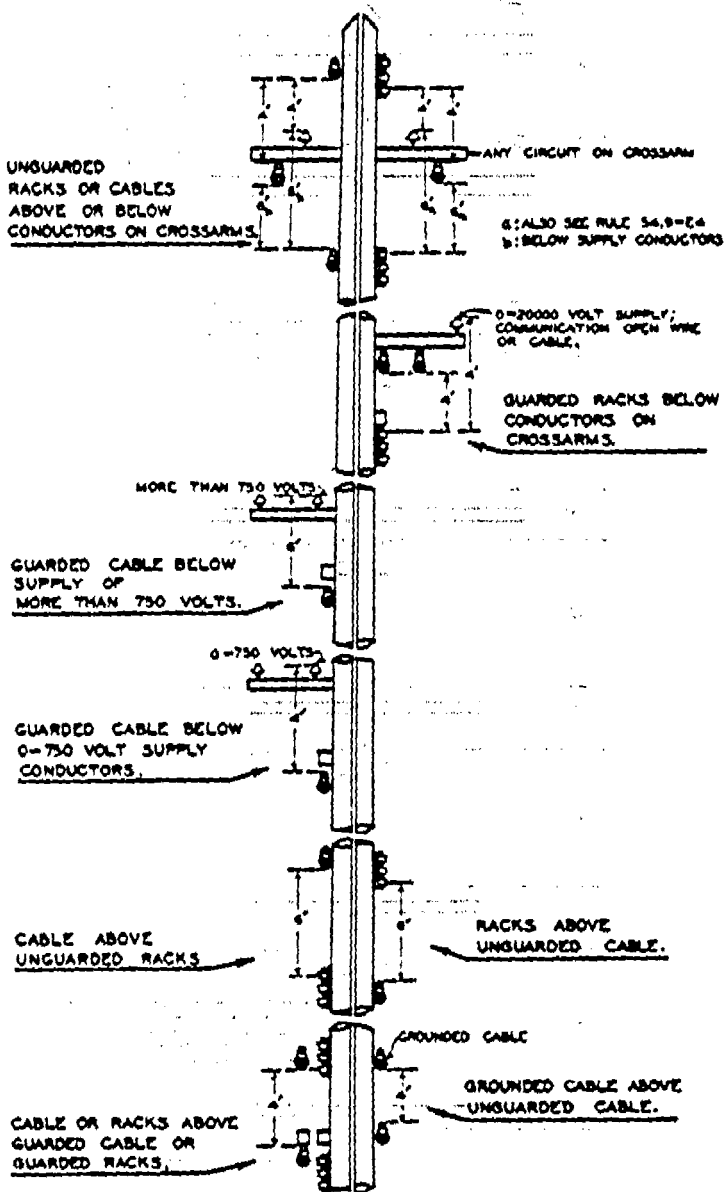


FIG. 9



MINIMUM VERTICAL CLEARANCES  
IN COMBINATION LINEARM AND  
COMBINATION BUCKARM CONSTRUCTION  
RULE 38, TABLE 2, CASES 8 TO 14.

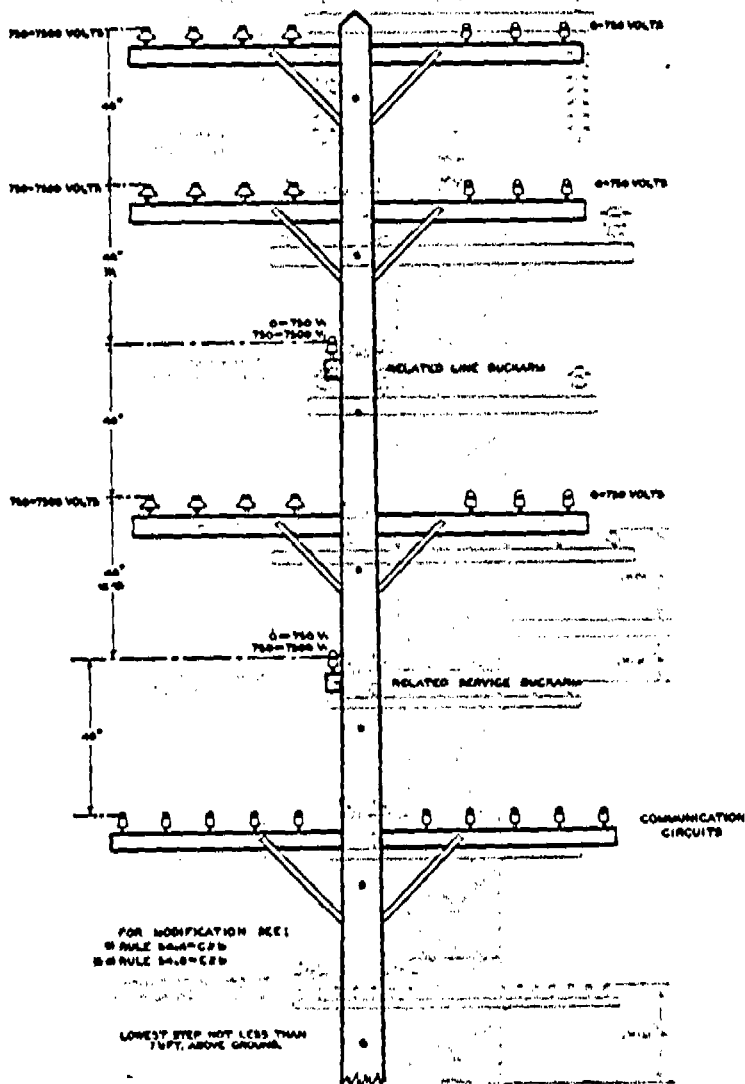


FIG. 11

S. 1017

MINIMUM  
HORIZONTAL CONDUCTOR SPACING  
TABLE 1, CASE 8 AND TABLE 2, CASE 15

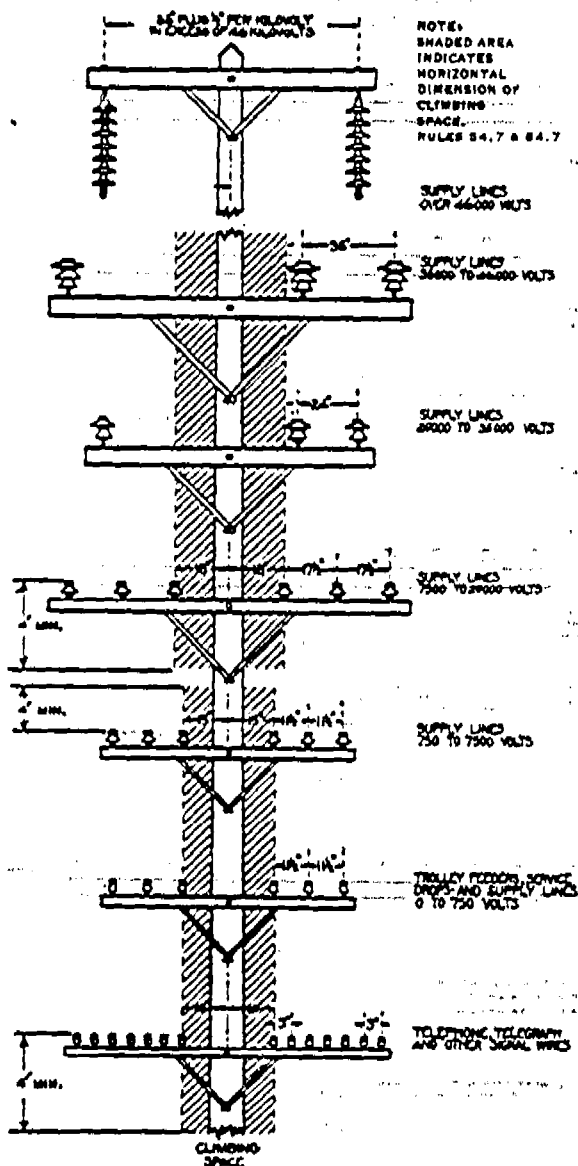


FIG. 12



SUPPLY CONDUCTORS  
DEAD ENDED IN HORIZONTAL CONFIGURATION  
0-7500 VOLTS

RULE 54.4-D7a.

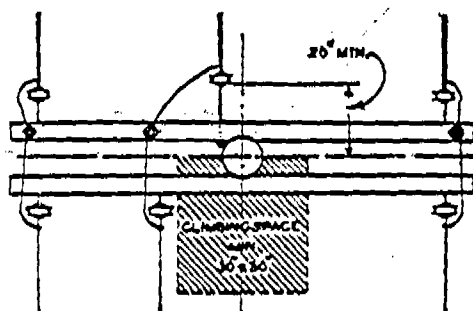
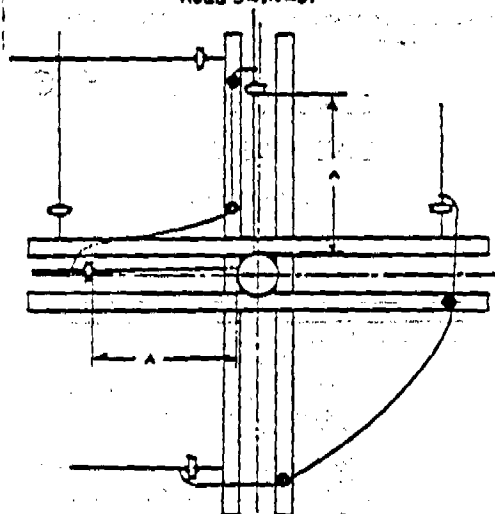


FIG. 13

SUPPLY CONDUCTORS  
DEAD ENDED IN HORIZONTAL CONFIGURATION

RULE 54.4-D7

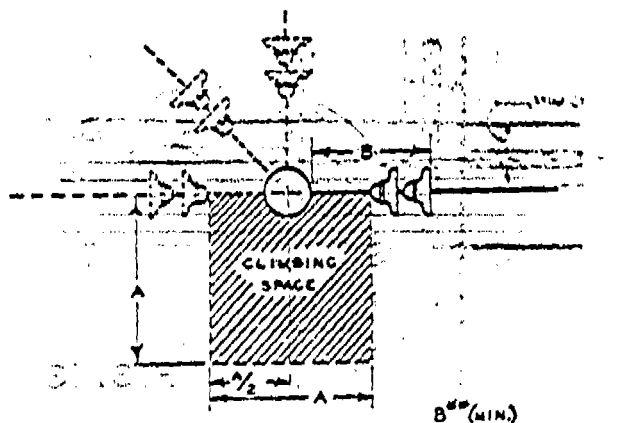


NOTE A = 30° FOR 0-7500 VOLTS  
= 36° FOR MORE THAN 7500 VOLTS

FIG. 14

# CLIMBING SPACE FOR DEAD ENDING IN VERTICAL CONFIGURATION

RULE 54.7-A1



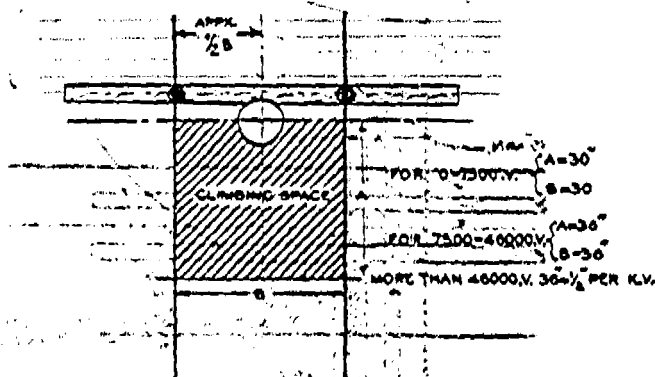
VOLTAGE OF CIRCUIT	A (MIN)	TOP CIRCUIT	BELOW TOP CIRCUIT
750-7500 VOLTS	30"	15"	24"
7500-40000 VOLTS	36"	18"	34"
MORE THAN 40000 VOLTS	36" PLUS 1/2" PER KV OVER 48 KVM	18"	36"

\* UNOBSTRUCTED BY DEADEND INSULATORS ETC. (RULE 54.7-A2)  
 \* SEE RULE 54.4-D2B

## CLIMBING SPACE LINE ARMS ONLY

FIG. 15

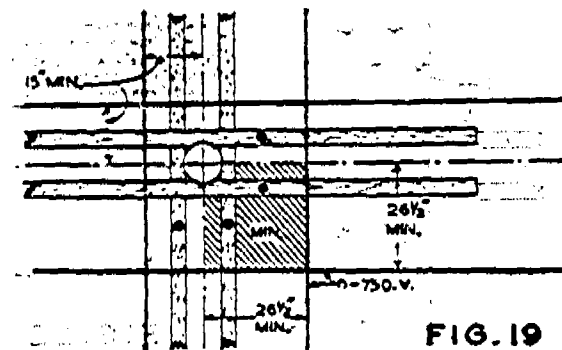
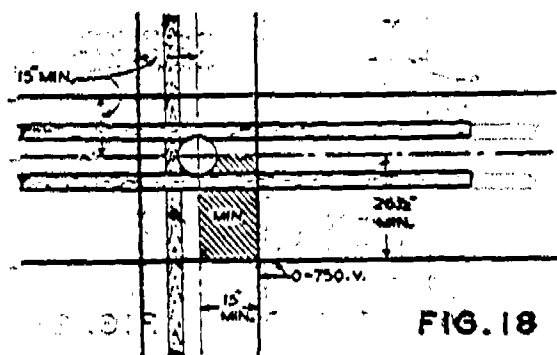
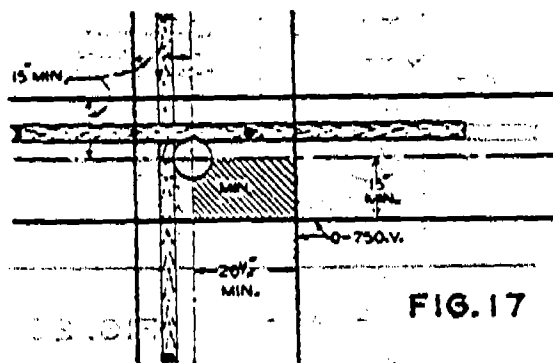
RULE 54.7-A2



FOR 750-7500V. A=30"  
 B=30"  
 FOR 7500-40000V. A=36"  
 B=36"  
 MORE THAN 40000V. 36" + 1/2" PER KV.

FIG. 16

CLIMBING SPACE  
LINEARM AND RELATED BUCKARM  
0-750-VOLT CONDUCTORS  
RULE 54.7-A3a

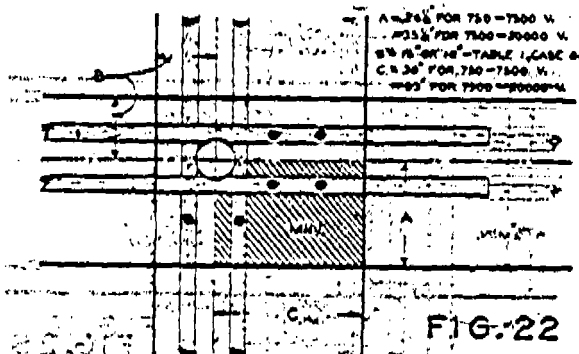
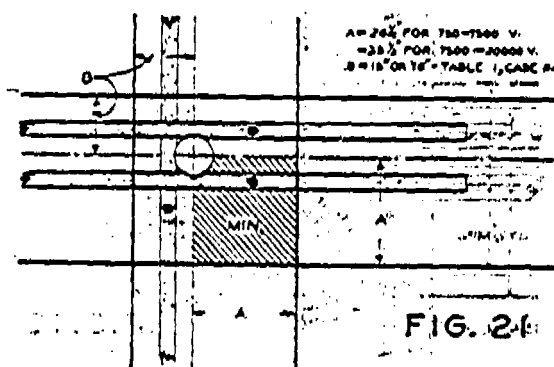
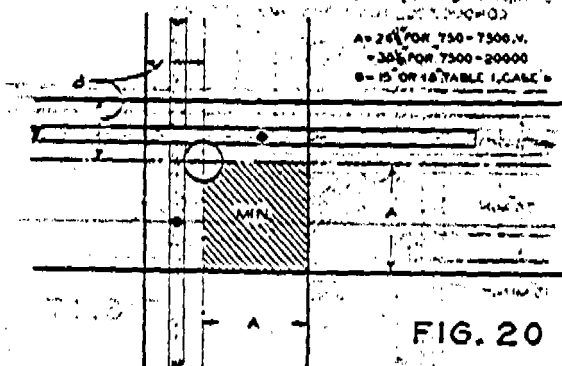


## CLIMBING SPACE

## LINEAR AND RELATED BUCKARM

## 750 TO 20000 VOLT CONDUCTORS

RULE 54.7-A3b



CLIMBING SPACE  
FOR COMBINATION ARM CONSTRUCTION  
RULE 54.7-A34

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.

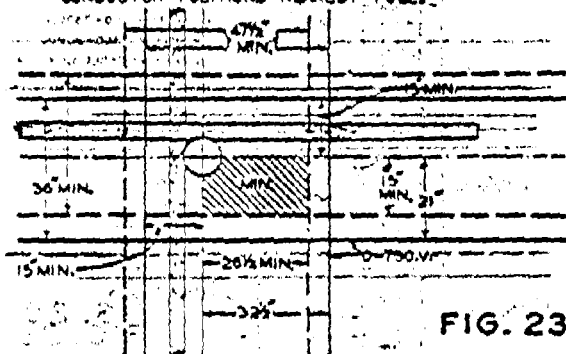


FIG. 23

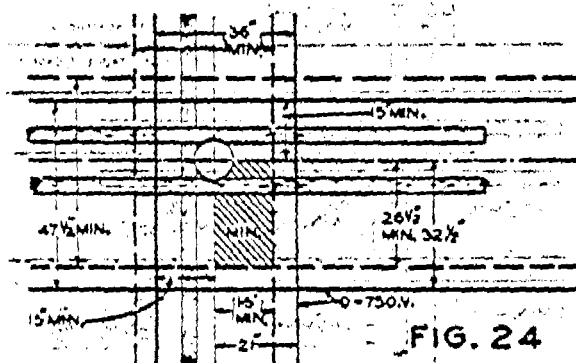


FIG. 24

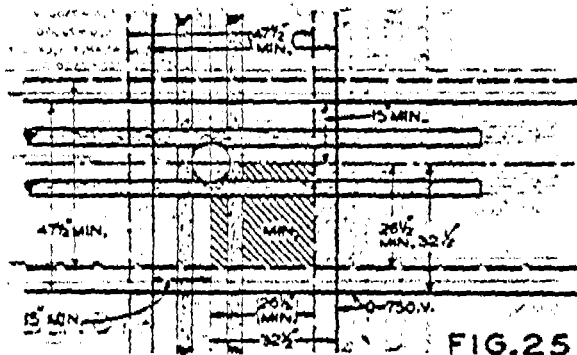


FIG. 25

## CLIMBING SPACE

## FOR COMBINATION ARM CONSTRUCTION

RULE 54.7-A36

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.

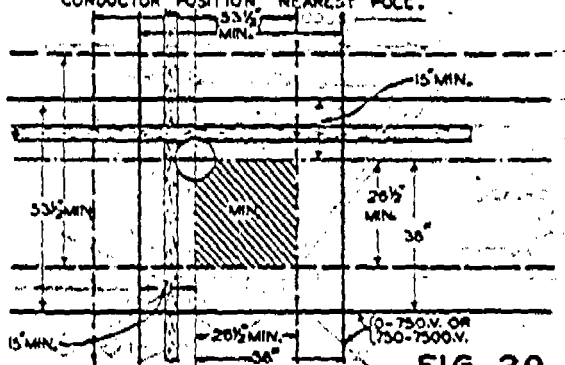


FIG. 29

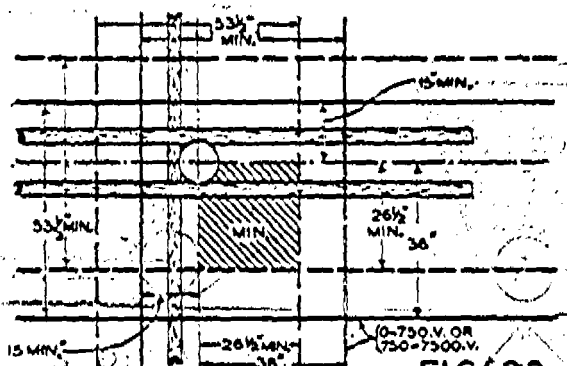


FIG. 30

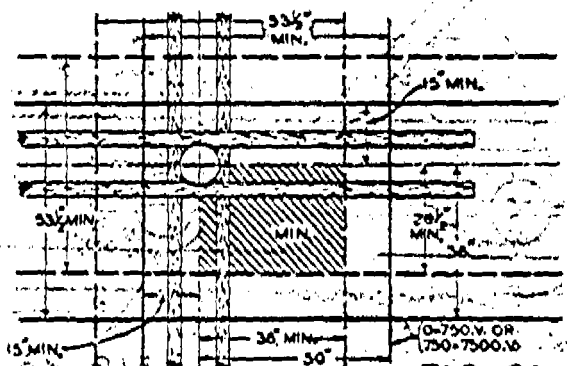


FIG. 31

# LOW VOLTAGE RACKS CONDUCTOR CLEARANCE BELOW TRANSFORMERS

RULE 5439-E3

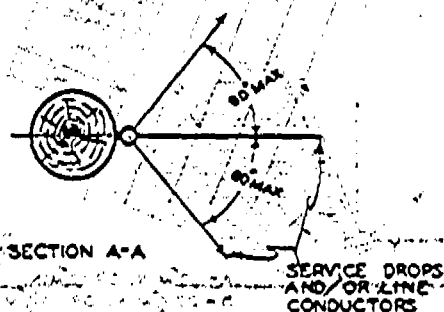
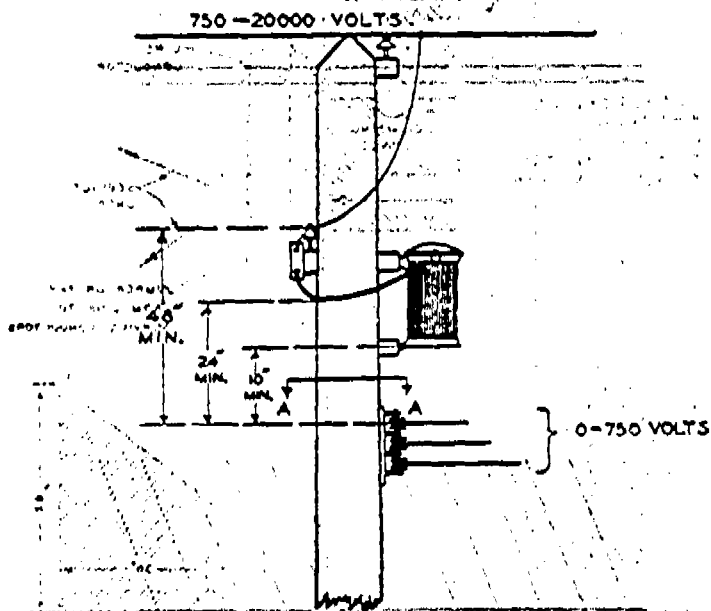
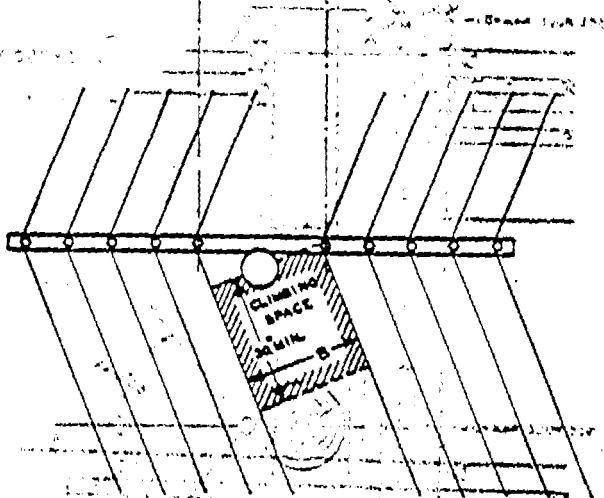
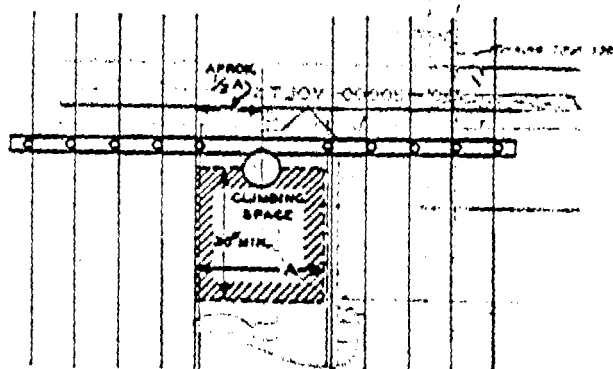


FIG. 33

## CLIMBING SPACE

COMMUNICATION CONDUCTORS ON LINEARMS

RULES 84.4-DS AND 84.7-A



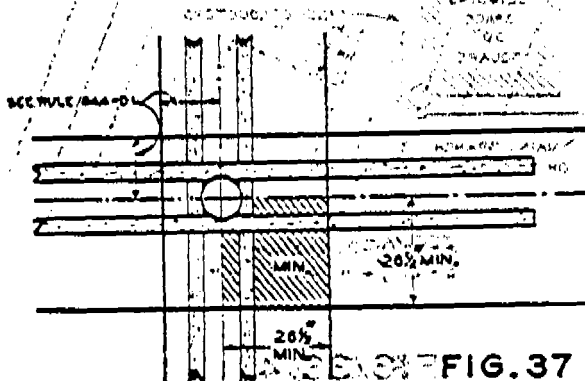
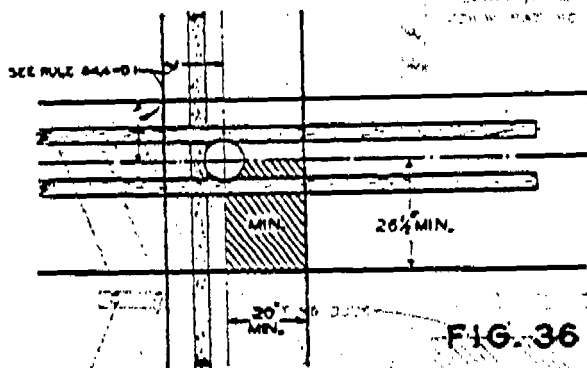
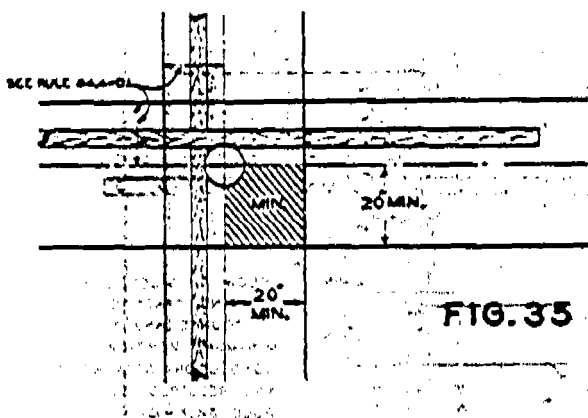
A = 30 MIN. OR 18 MIN.  
 B = 27 1/2 MIN. OR 16 1/2 MIN.

FIG. 34



MINIMUM CLEARING SPACE  
COMMUNICATION CONDUCTORS ON  
LINEARM AND RELATED BUCKARM

SEE RULE 84.7-B



## COMMUNICATIONS CONDUCTORS

NOT ON CROSSARMS

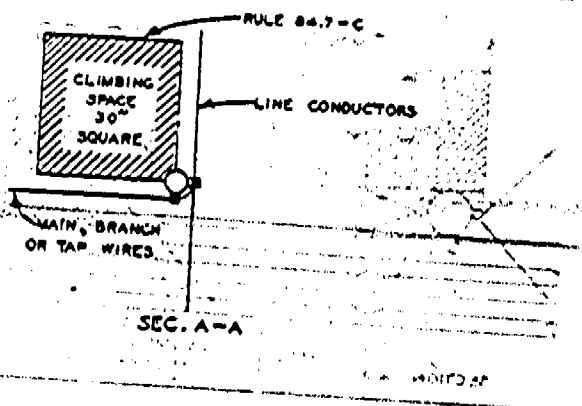
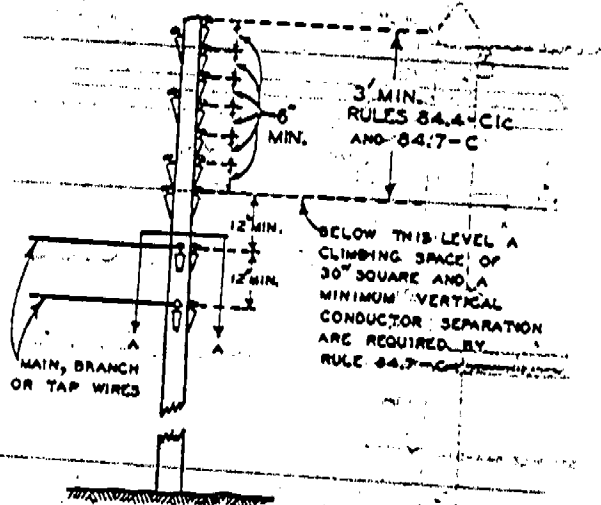
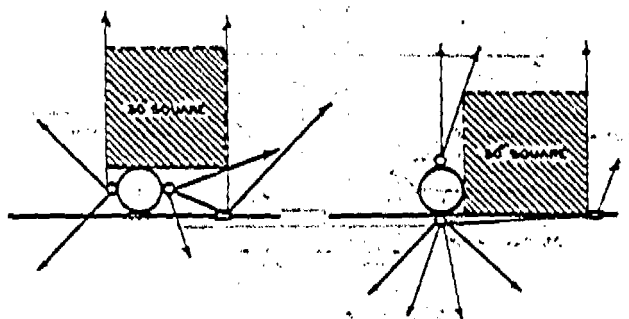
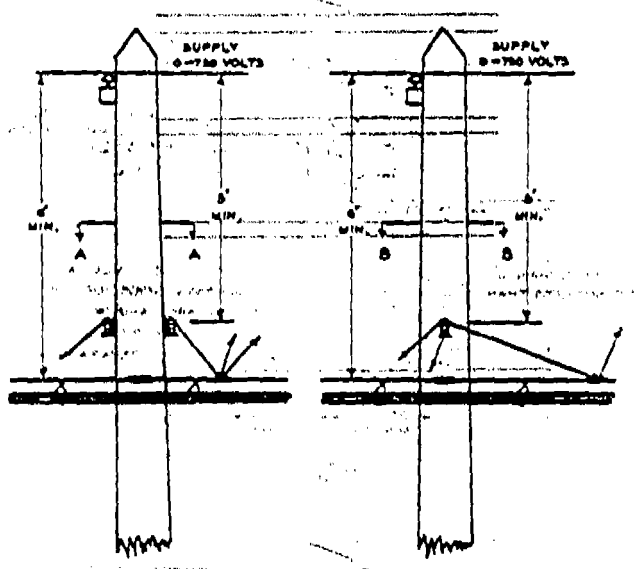


FIG. 38

28070. CLOMBING SPACE  
COMMUNICATION SERVICE DROPS NOT ON CROSSARMS

RULE 84.7-0



SECTION A-A

SECTION B-B

F16.39

## CLEARANCE ATTACHMENTS

0-750 VOLT SERVICE DROPS

RULE 34.8-C2

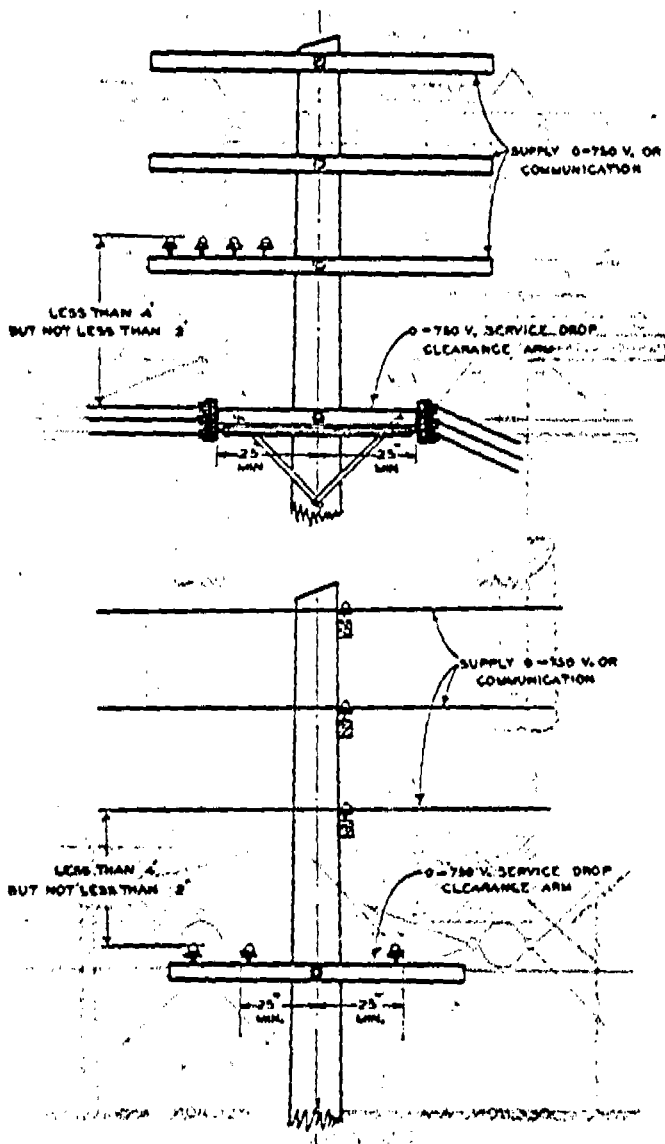
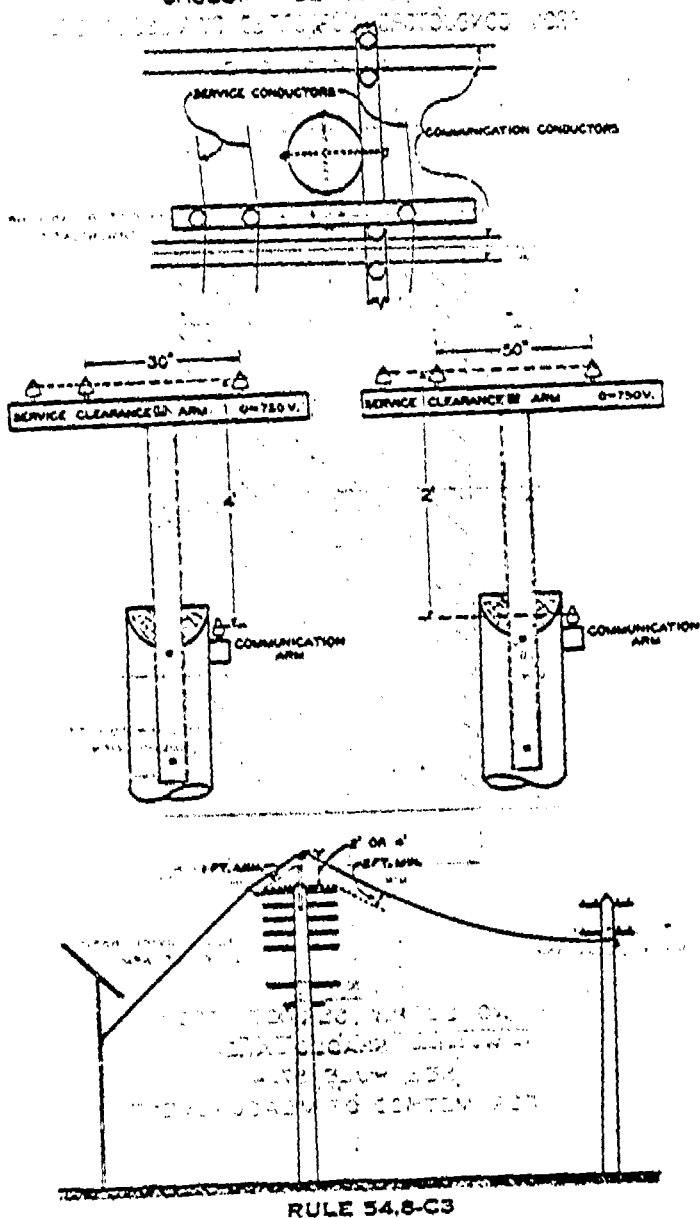


FIG. 40

SUPPLY SERVICE DROPS 0-750 VOLTS  
CROSSING CLASS 'C' LINE

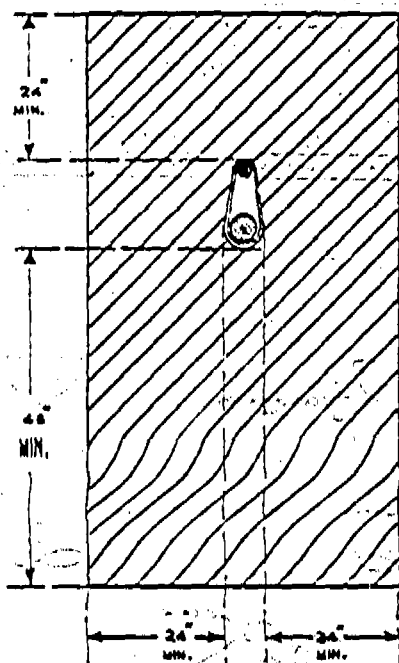


RULE 54.8-C3

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

2000 SUPPLY SERVICE DROPS  
FROM GUARDED RACK CONDUCTORS  
UNDER SECTION RULE 5A-1-E-F

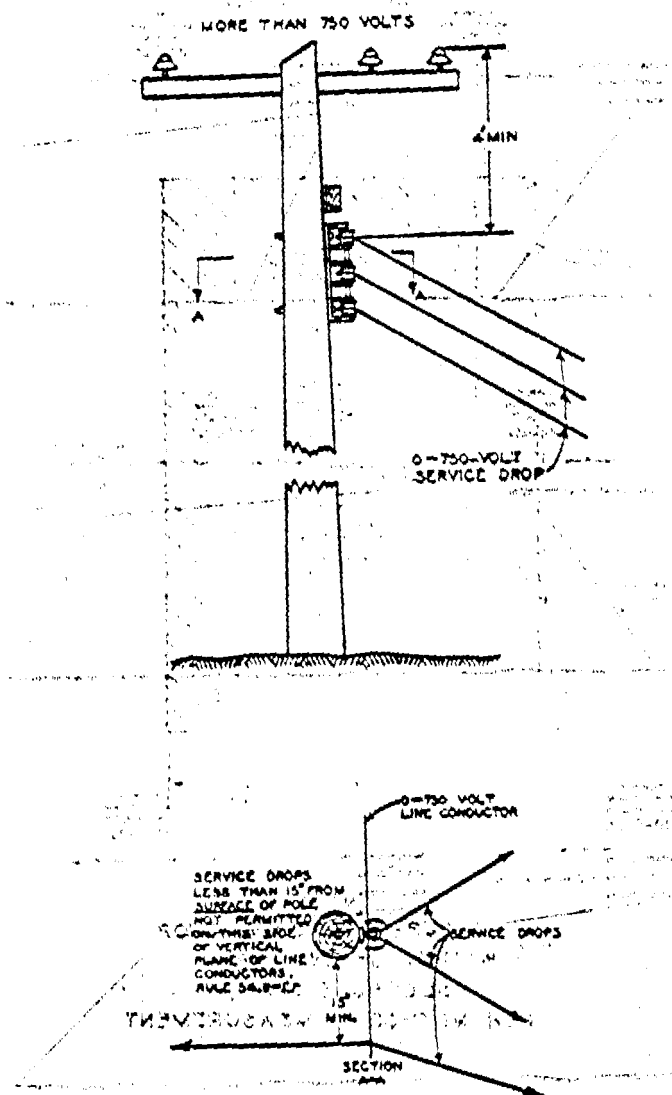


FIG. 43  
SECTION 5A-1-E-F

EXPOSED COMMUNICATION GUYS  
 NOT IN PROXIMITY TO SUPPLY CONDUCTORS ON WOOD POLES  
 RULES 21.3-C AND 68.6

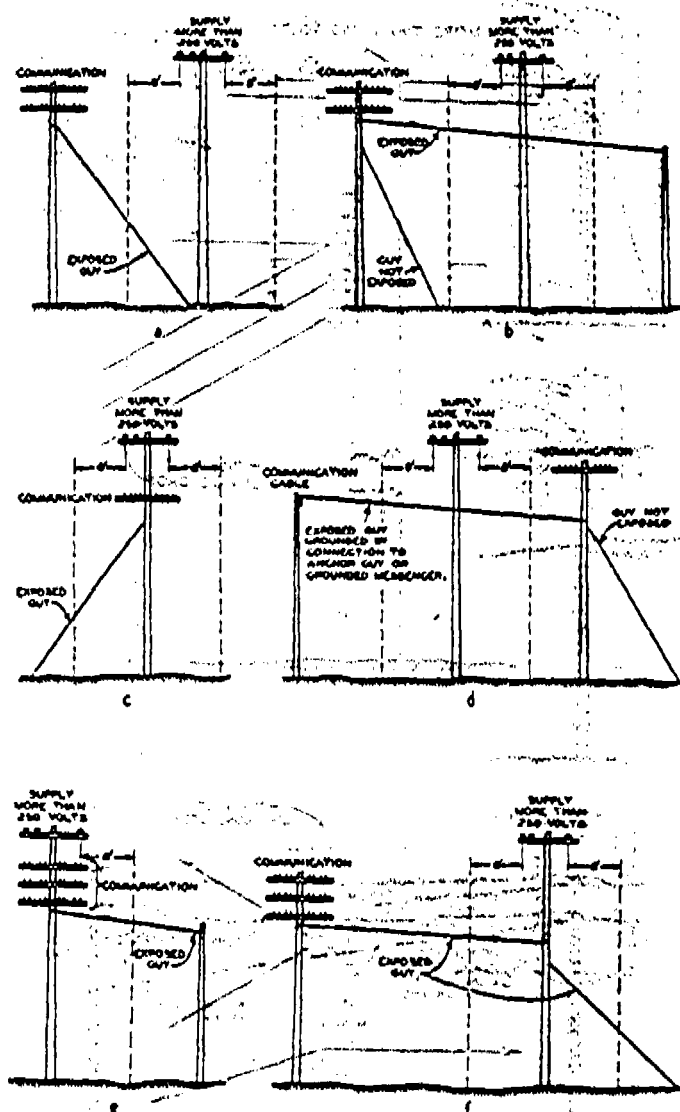


FIG. 4.4



SECTIONALIZATION OF OVERHEAD GUYS  
ON SUPPLY LINES  
RULE 56.7-A

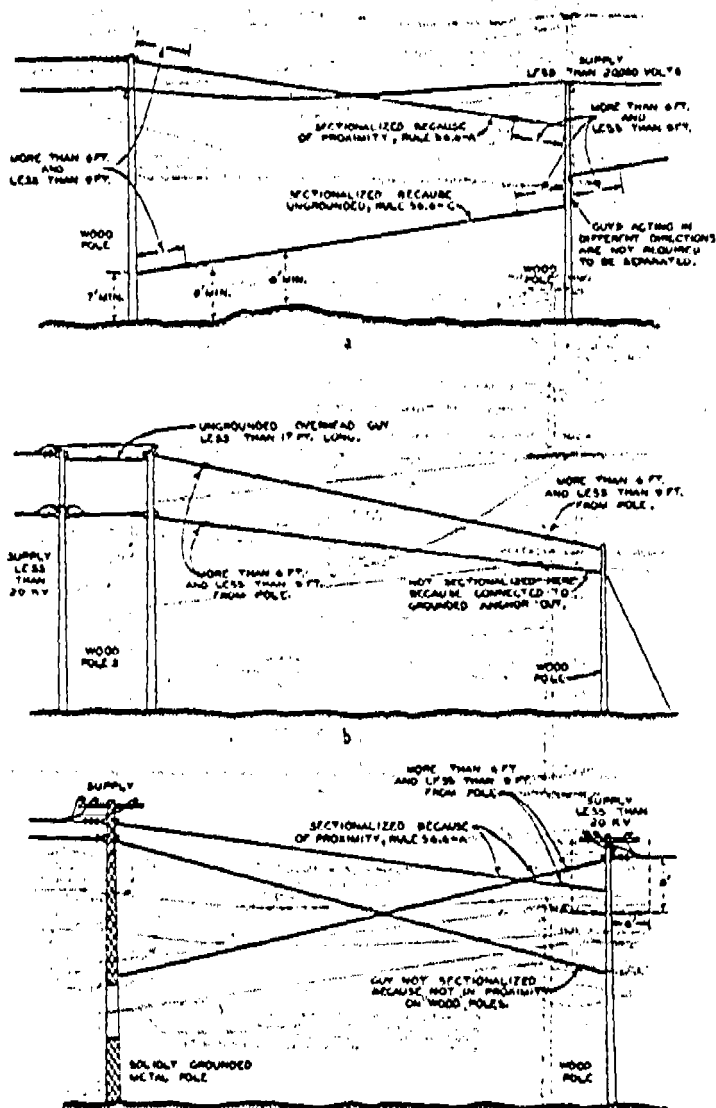


FIG. 46

SECTIONALIZATION OF OVERHEAD GUYS  
ON COMMUNICATION LINES  
RULE 86.7-A

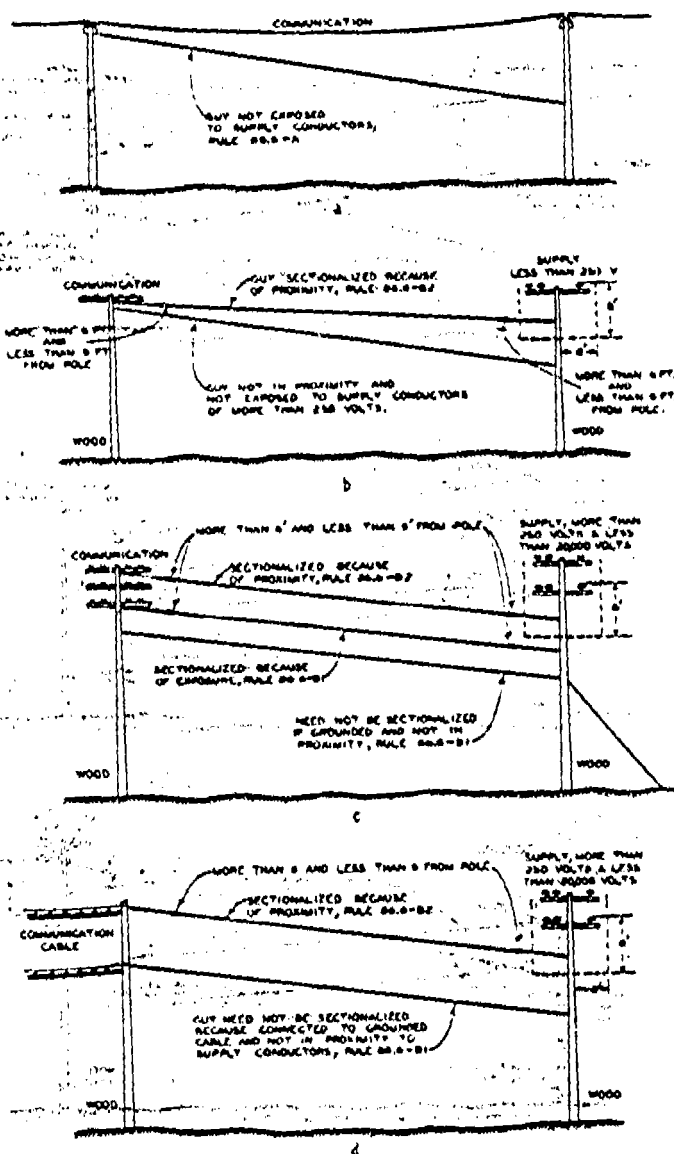


FIG. 47

SECTIONALIZATION OF OVERHEAD GUYS  
ON JOINTLY USED POLES  
RULES 86.7-A AND 86.7-A

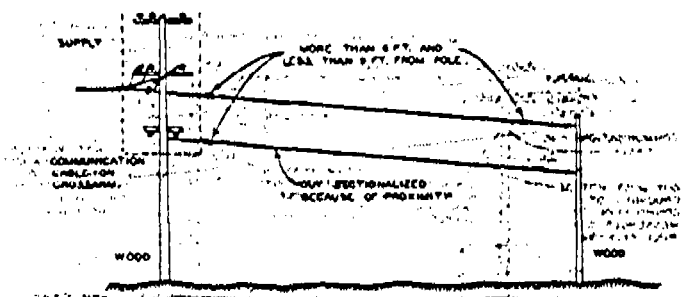
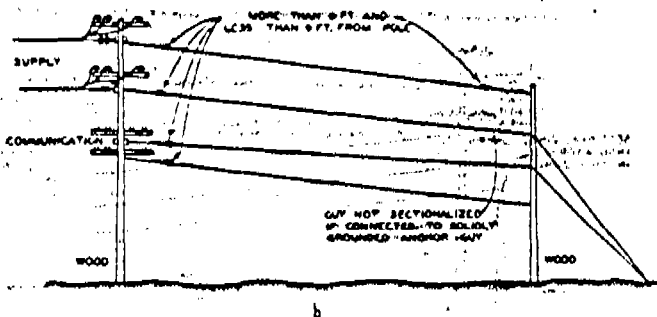
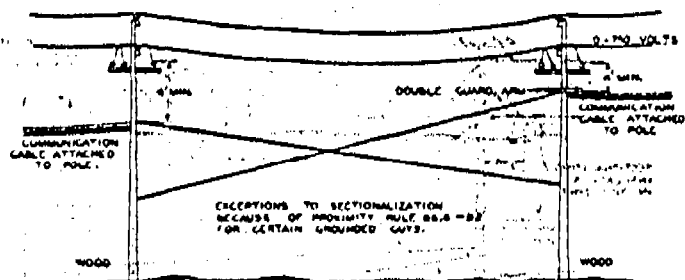


FIG. 48

## SECTIONALIZATION OF ANCHOR GUYS

RULES 56.7-B &amp; 56.7-B.1

FIG. 49

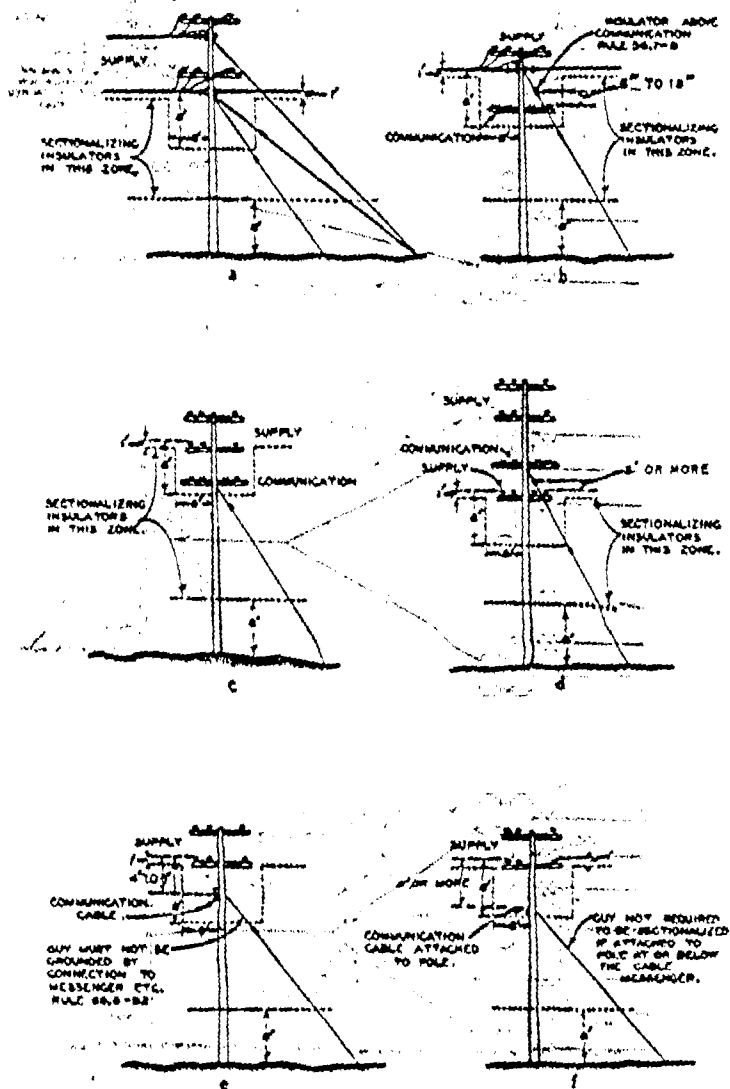


FIG. 49

SECTIONALIZATION OF  
ARM GUYS AND BRANCHED GUYS.

RULE 56.7-A

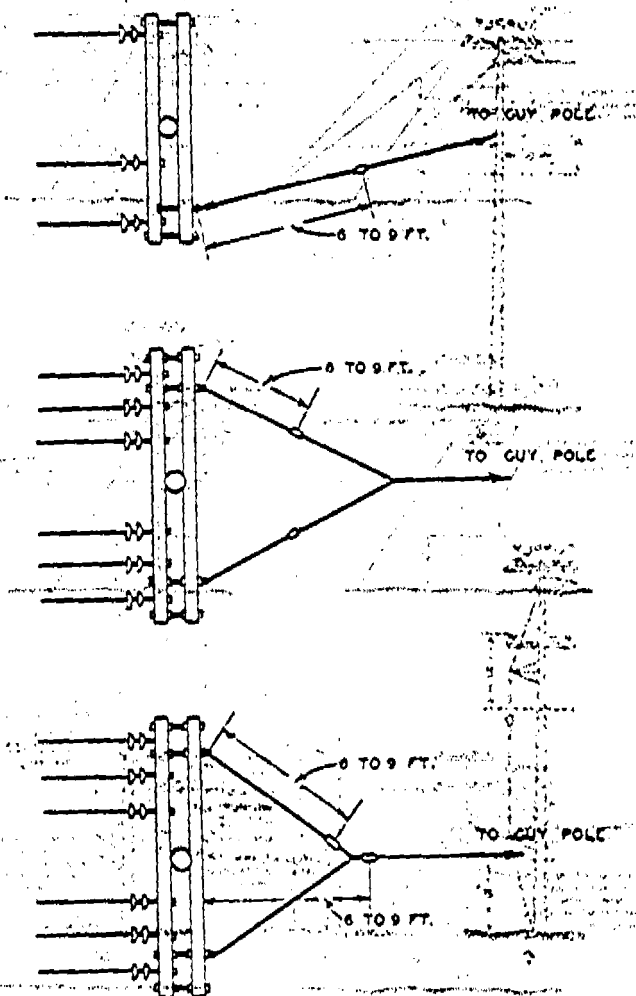
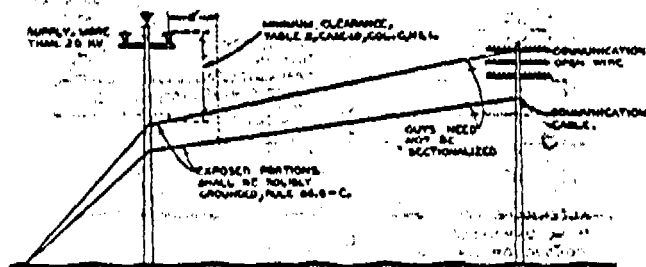
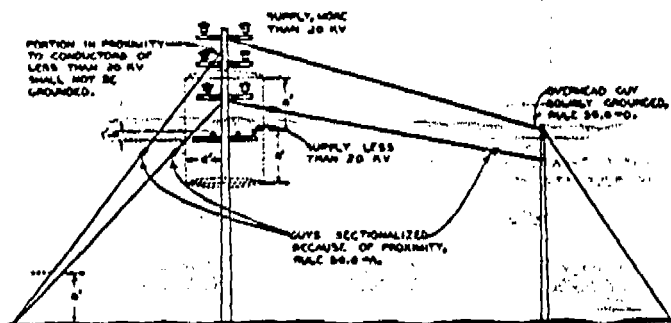
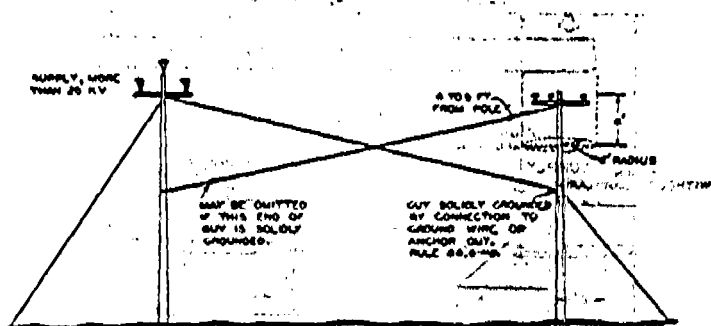


FIG. 50

GUYS EXPOSED TO SUPPLY CONDUCTORS  
OF MORE THAN 20,000 VOLTS  
RULES 56.6-D & 56.6-C



SUPPLY CABLES  
RULE 37.4-F

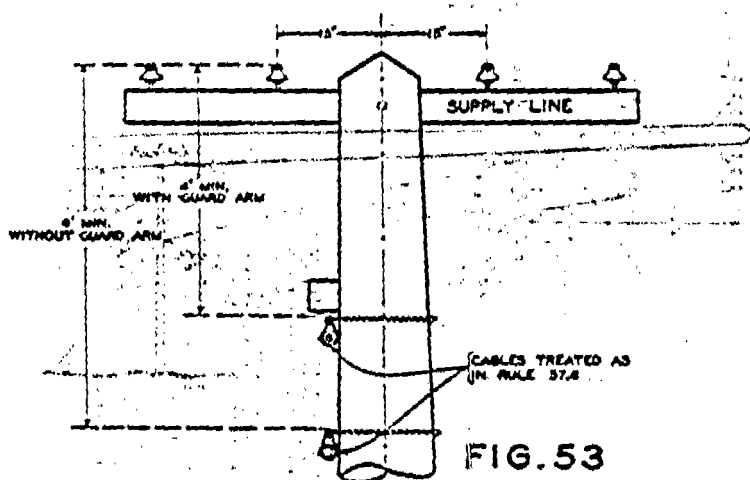


FIG. 53

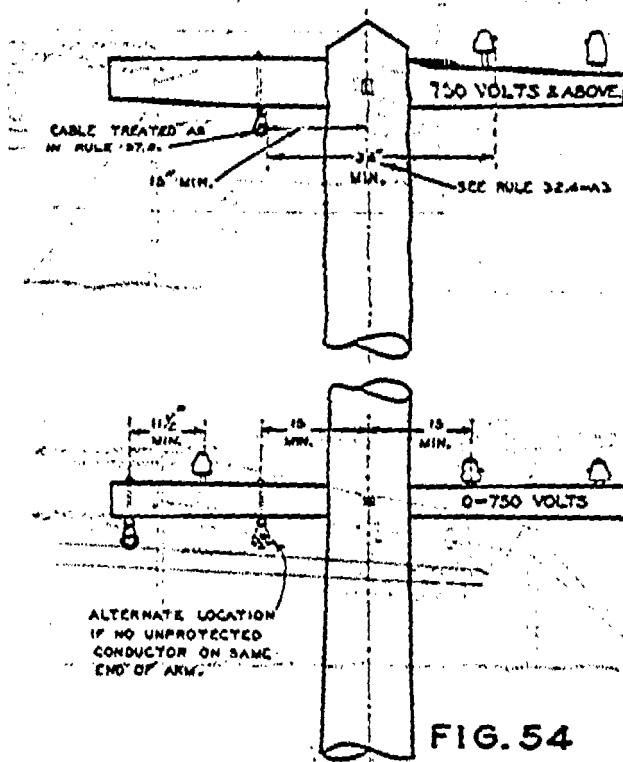
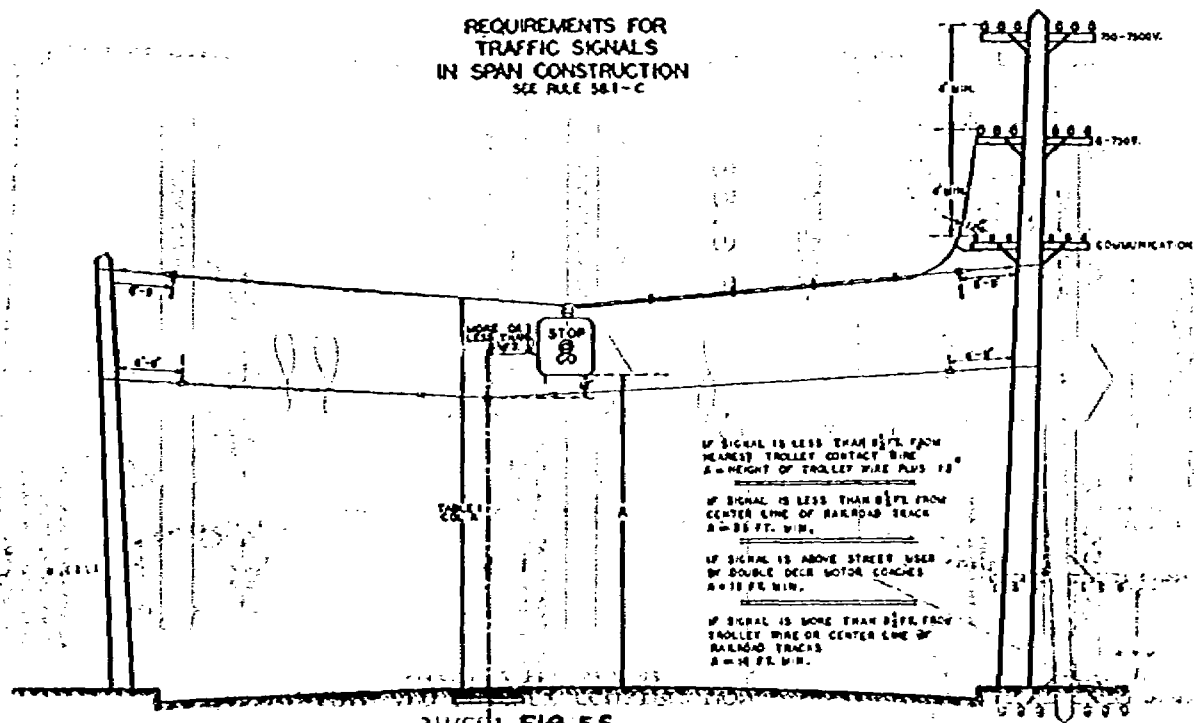


FIG. 54

REQUIREMENTS FOR  
TRAFFIC SIGNALS  
IN SPAN CONSTRUCTION  
SEE RULE 54.1-C



STREET FIG. 55  
REQUIREMENTS FOR



REQUIREMENTS FOR  
STREET LAMPES  
IN SPAN AND BRACKET CONSTRUCTION  
RULES 58.2-81 AND 58.2-82.

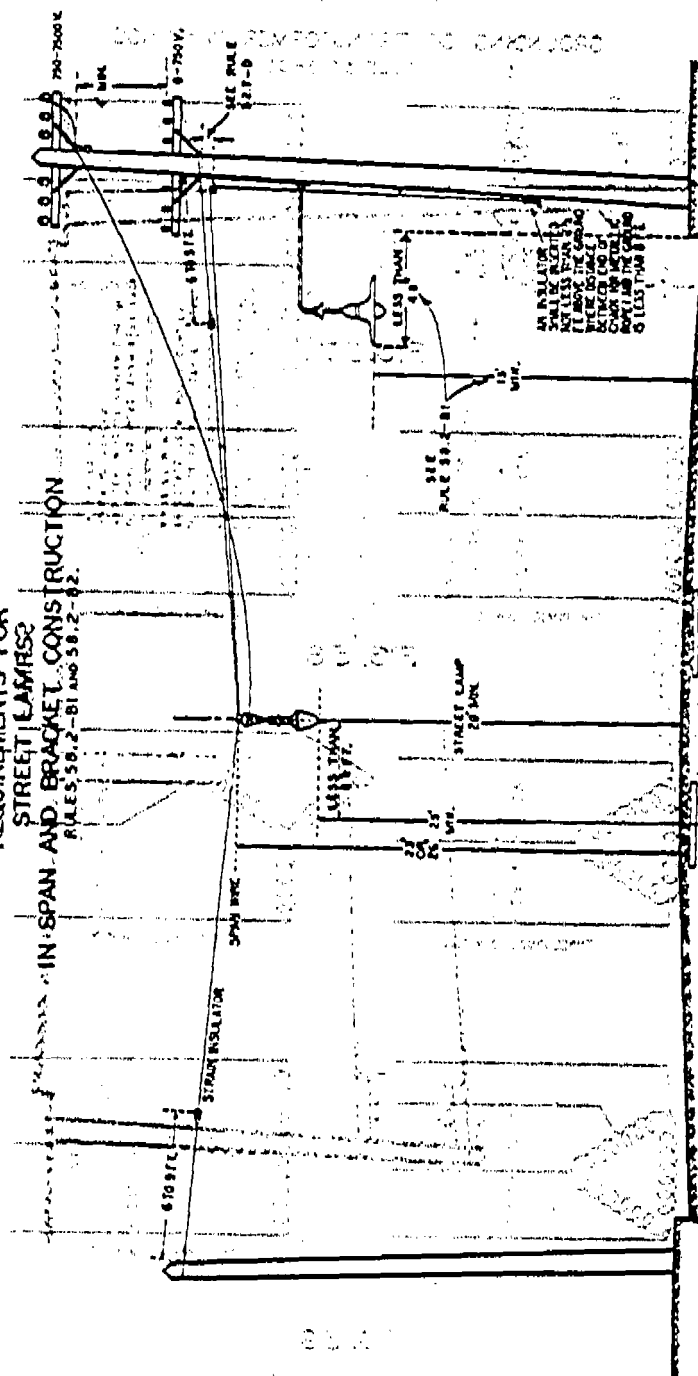


FIG. 56

CONDUCTOR CLEARANCE  
FROM SURFACE OF POLE

RULE 54.9-B1

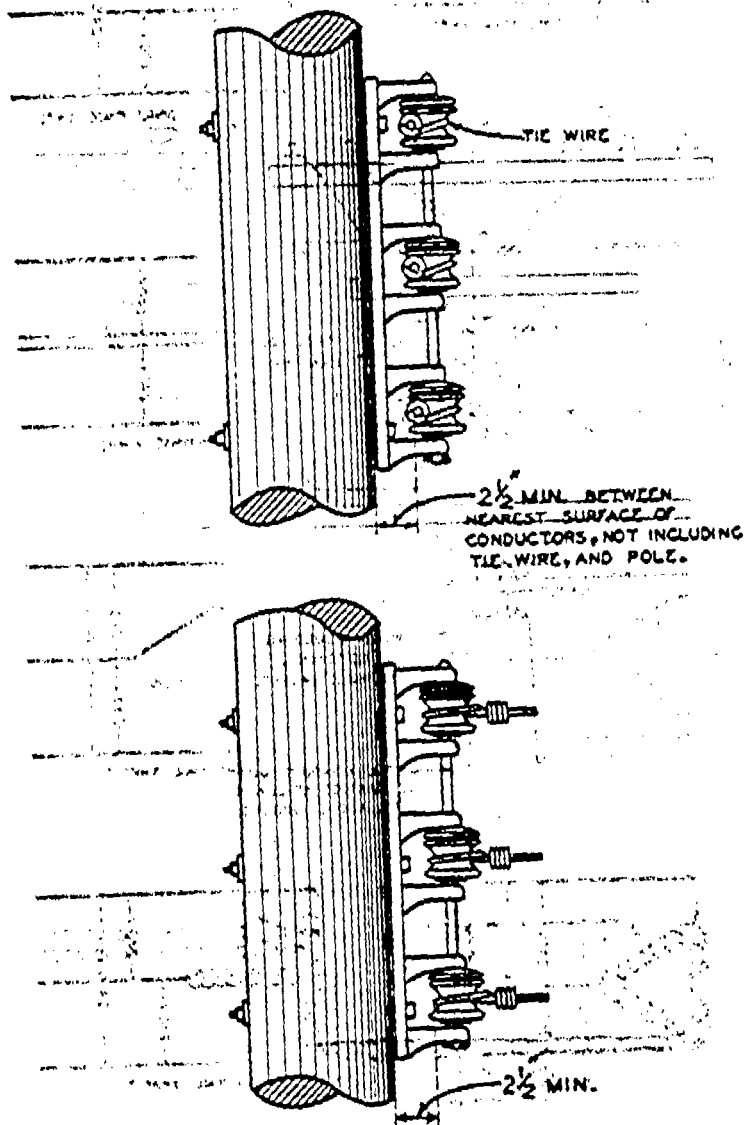


FIG. 60-

## SUPPLY RISERS AND TERMINALS

RULES 54.6-E AND 54.6-F

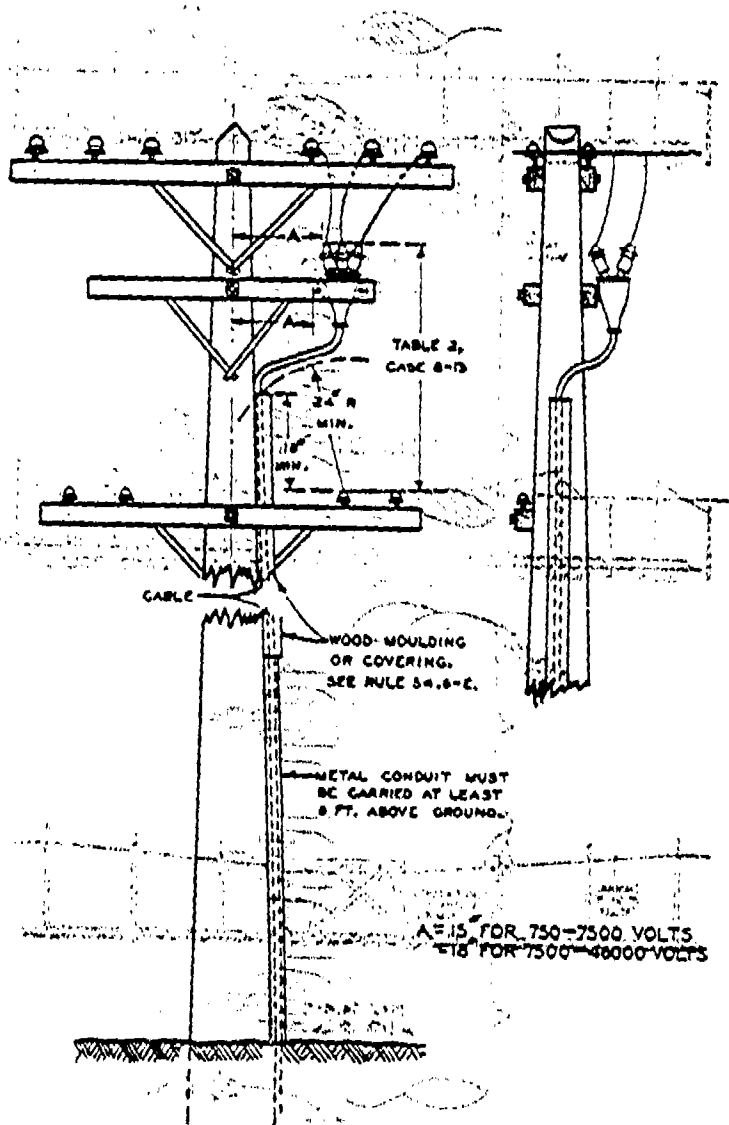
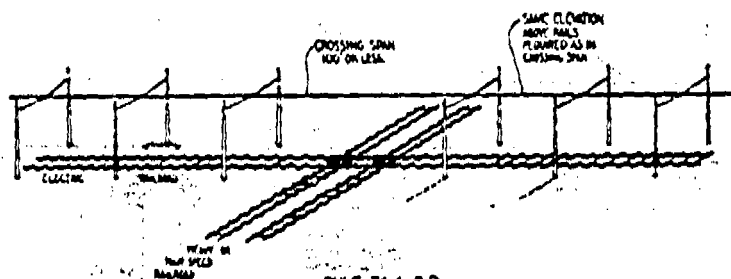
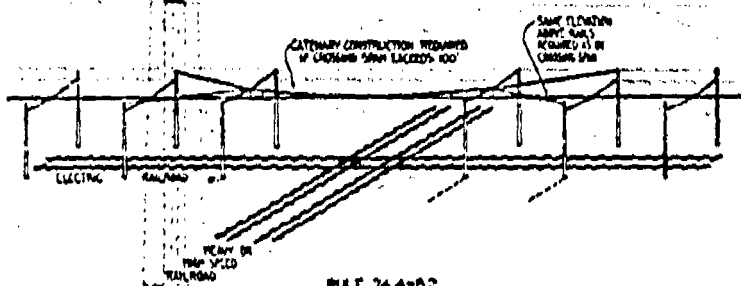


FIG. 61

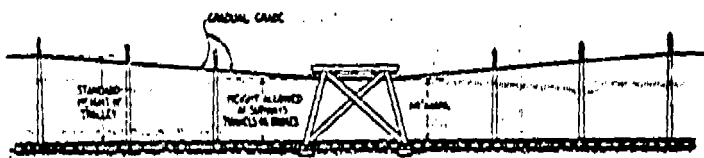
## CONSTRUCTION REQUIREMENTS OF TROLLEY CONTACT CONDUCTORS



RULE 74.4-B2  
FIG. 62

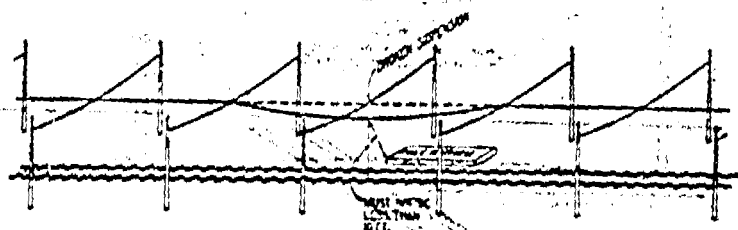


RULE 74A-02  
FIG. 63

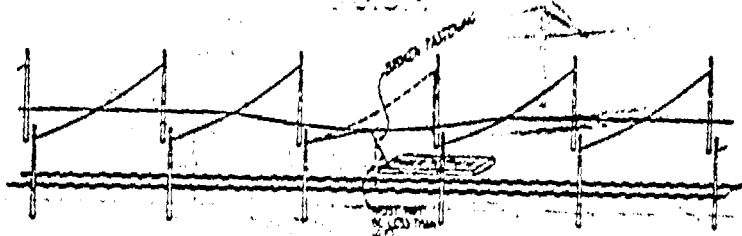


FILE 74-A-2  
FIG. 64

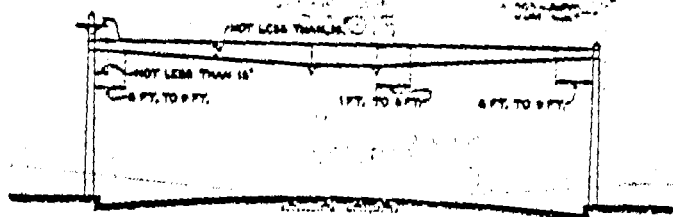
# SPAN WIRE INSULATORS FOR TROLLEY CONDUCTORS



RULE 74.4-F  
FIG. 65



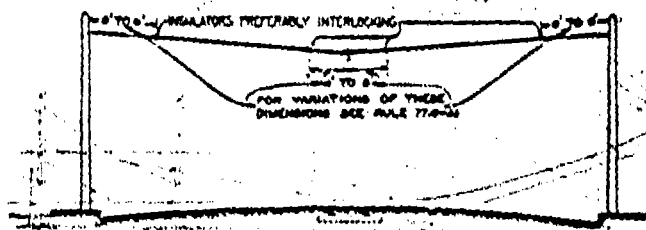
RULE 74.4-F  
FIG. 66



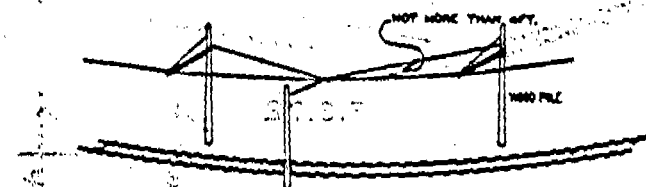
RULES 74.4-GS AND 77-GAS

FIG. 67

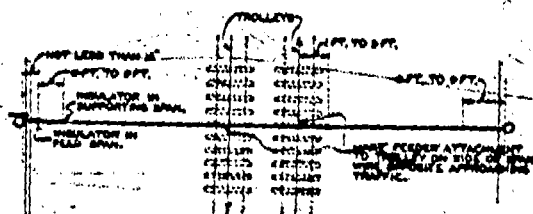
SPAN WIRE INSULATORS  
FOR TROLLEY CONDUCTORS



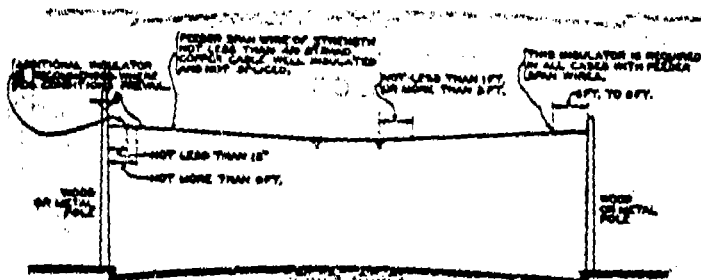
RULE 77.6-A1  
FIG. 68



RULE 77.6-A2  
FIG. 69

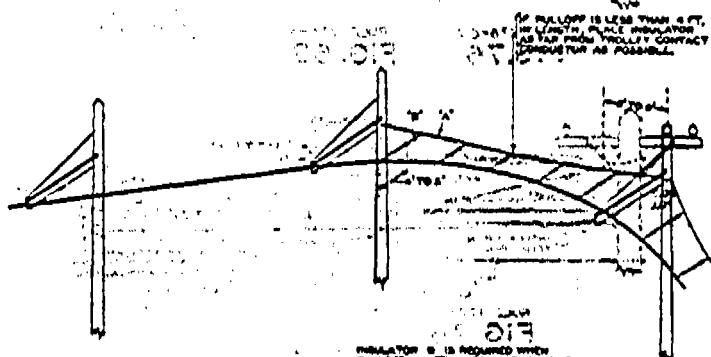
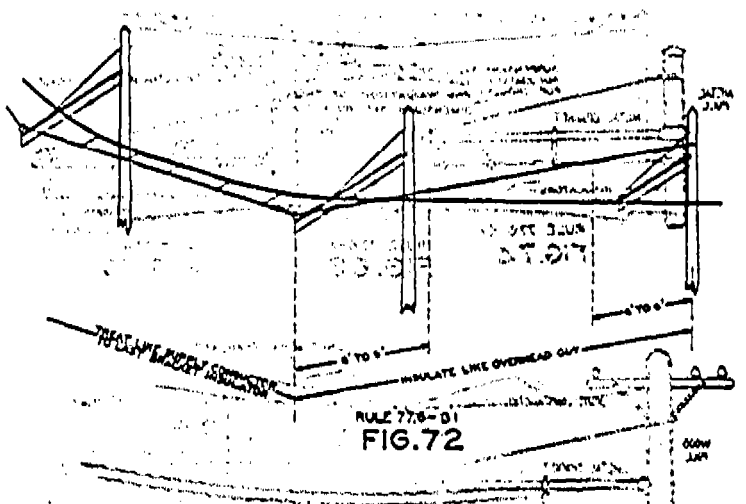


RULE 77.6-A3  
FIG. 70



RULE 77.6-A4  
FIG. 71

## INSULATION OF BACKBONES &amp; PULLOFFS

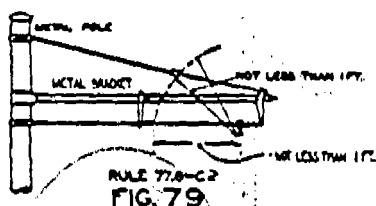
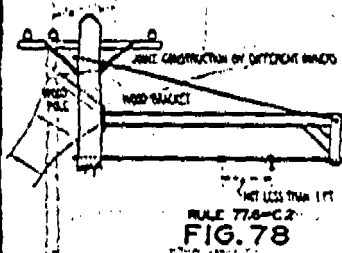
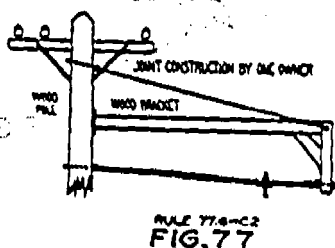
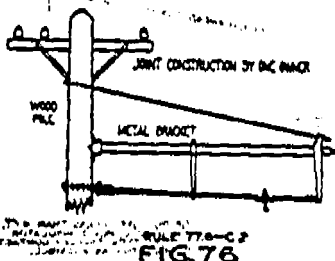
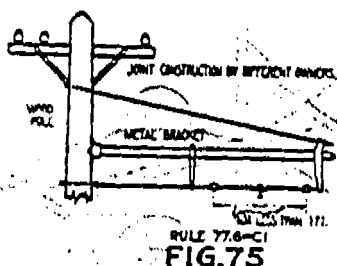
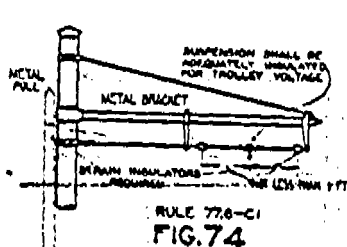


RULES 776-B2 AND 776-B3

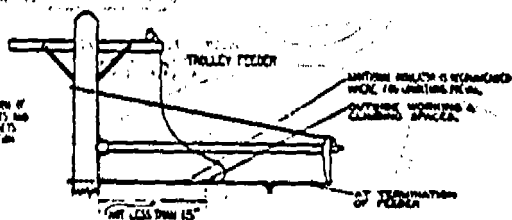
FIG. 73

UNLESS OTHERWISE SPECIFIED  
ALL DIMENSIONS ARE IN INCHES  
UNLESS OTHERWISE SPECIFIED  
ALL DIMENSIONS ARE IN INCHES

BRACKET WIRE INSULATORS  
FOR TROLLEY CONTACT LINES



NOTE:  
USE OF ANY COMBINATION OF  
WOOD POLES AND BRACKETS AND  
METAL POLES AND BRACKETS  
REQUIRES SAME REGULATION  
AS SHOWN HERE



RULE 77.0-C3  
FIG. 80



CLEARANCE OF WIRES, EQUIPMENT ETC. ON POLES

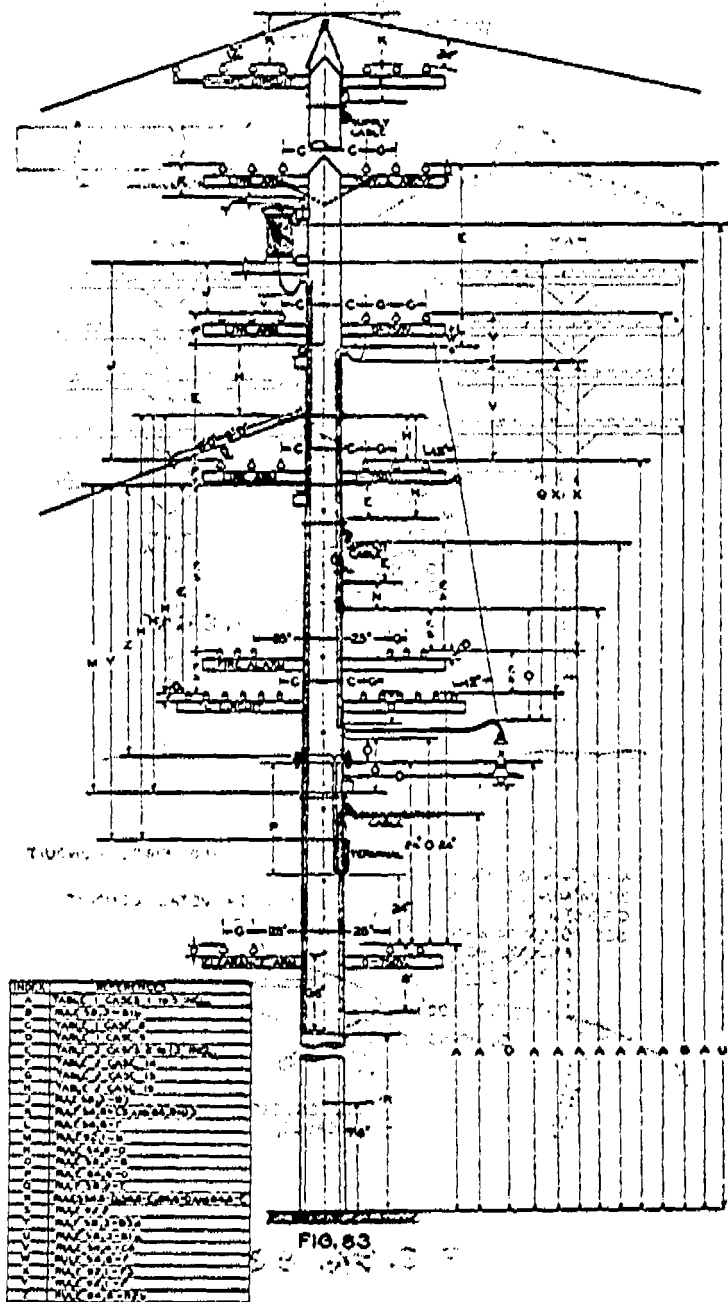
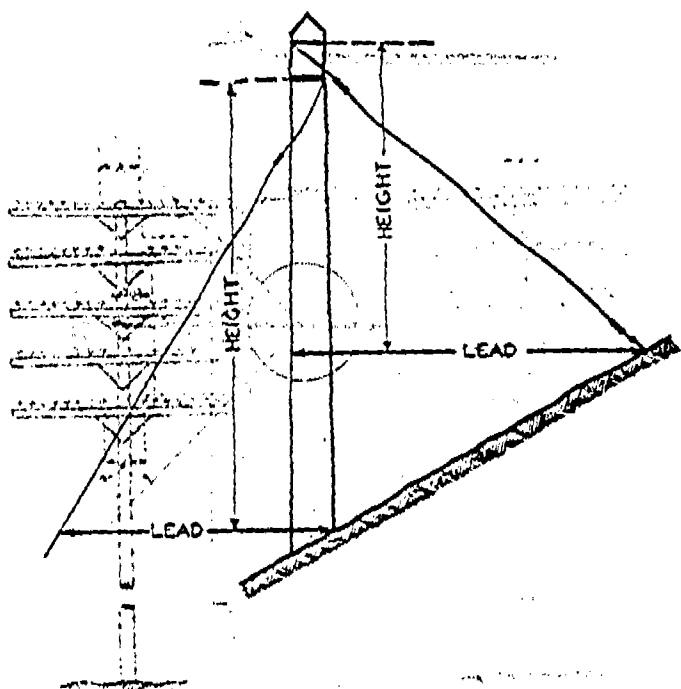


FIG. 63

# GUYING TERMS LEAD AND HEIGHT



## CORNER ANGLES

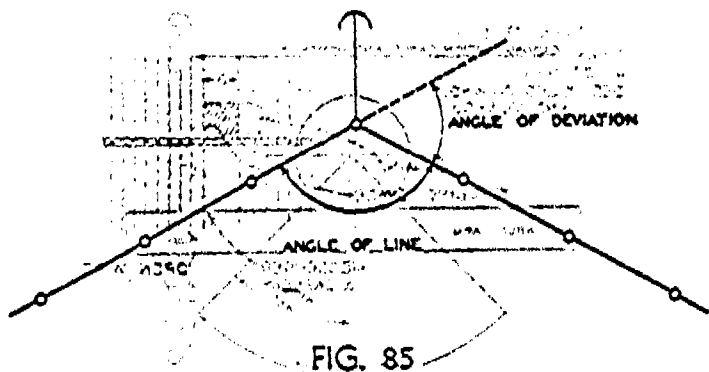


FIG. 85

28.10.17  
29.10.17

QUADRANT OR SIDE OF POLE  
FOR UNCOVERED RUNS OR RISERS  
RULE 84.6-D

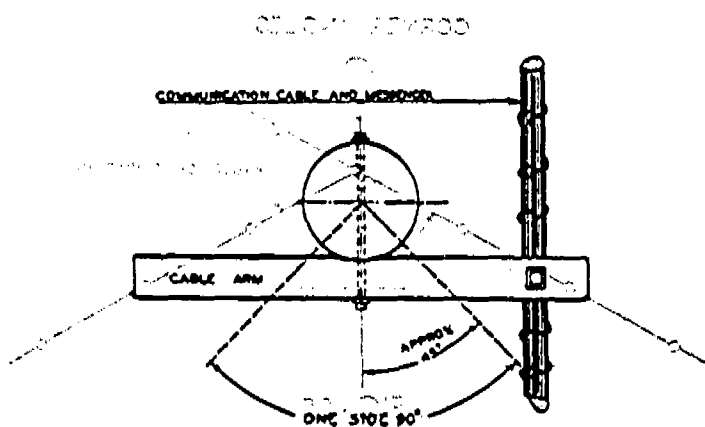
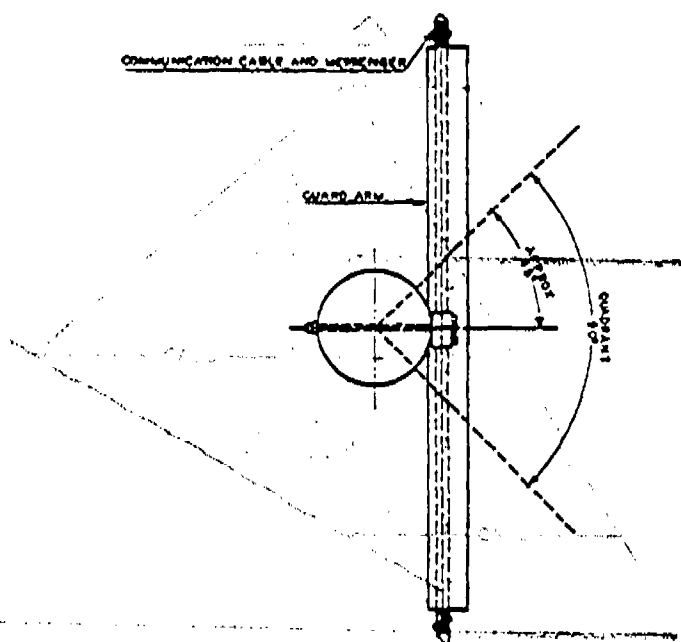


FIG. 86



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